– HERRIMAN CITY –

Zone 2 & 3 Major Water System Improvements
Zone 2 & 3 Pump Station Project

July 2024

HERRIMAN
CITY

– Herriman City –

Zone 2 & 3 Pump Station & Pipeline Project

CONTRACT DOCUMENTS

July 2024

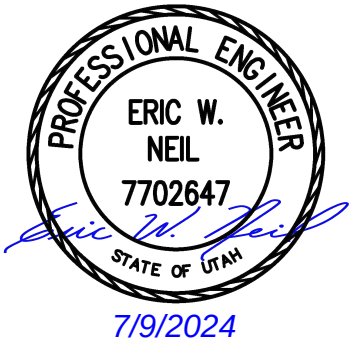
Prepared For:

HERRIMAN CITY
5355 West Herriman Main Street
Herriman, Utah 84096

Prepared By:

BOWEN COLLINS & ASSOCIATES
154 E 14075 South
Draper, Utah 84020

SECTION 00 01 07
SEAL SHEET



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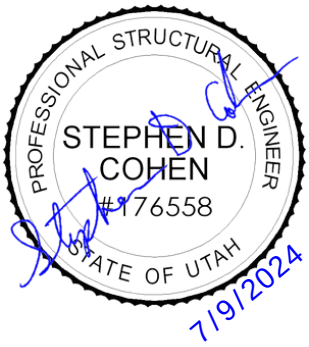

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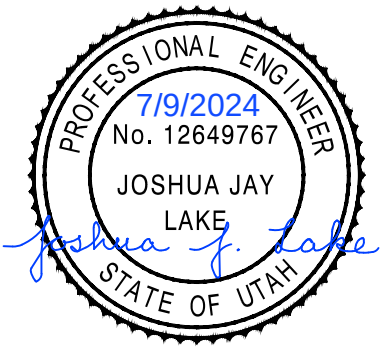

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DIVISION 1
GENERAL REQUIREMENTS

SUPPLEMENTAL SPECIFICATION

SECTION 01 11 13
SUMMARY OF WORK

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

A. Work of this Construction Contract ***comprises work as described in Document 00 11 16 Invitation to Bid and includes all, or any number of the schedules described in the Contract Documents as awarded to the Contractor.***

1.2 CONTRACT METHOD

A. Construct the Work under a single unit price contract.

B. Employ subcontractor[s] assigned by OWNER for: ***Not Applicable***

C. Relations and responsibilities between CONTRACTOR and any Subcontractors assigned by OWNER shall be as defined in the Conditions of the Contract. Assigned Subcontractors shall, in addition:

1. Furnish to CONTRACTOR bonds covering faithful performance of subcontracted work and payment of all obligations there under [when CONTRACTOR is required to furnish such bonds to owner.]
2. Purchase and maintain liability insurance to protect CONTRACTOR from claims for not less than the limits of liability which CONTRACTOR is required to provide to OWNER.

1.3 WORK BY OTHERS

A. Work of the Project which will be executed prior to start of Work of this Construction Contract, and which is specifically excluded from this Contract:

Property Owner Work. Contractor will be required to coordinate mass grading around the pump station and parts of the pipeline alignment prior to beginning construction. See schedule constraints in Document 01 14 00 Work Restrictions.

Rocky Mountain Power. Contractor will be required to with Rocky Mountain Power when conduits and power to the site will be constructed. Anticipated schedule for power installation is described in 01 14 00 Work Restrictions.

B. Work of the Project which will be executed after completion of Work of this Construction Contract, and which is specifically excluded from this Contract:

Not Applicable

1.4 FUTURE WORK

A. ***Not Applicable***

1.5 WORK SEQUENCE

A. Work sequence as described in Document 01 14 00 Work Restrictions.
B. Liquidated Damages: Article 2.4 of the Agreement (Document 00 52 43).

1.6 CONTRACTOR USE OF PREMISES

A. CONTRACTOR shall limit use of premises for Work, for storage, and for access, to allow:

1. Property Owner Access

B. Coordinate use of premises under direction of OWNER.

C. Assume full responsibility for protection and safekeeping of products under this Construction Contract.

D. Obtain and pay for use of additional storage or work areas needed for operations under this Construction Contract.

1.7 OWNER OCCUPANCY

A. ***Not Applicable***

1.8 PARTIAL OWNER UTILIZATION

A. ***Not Applicable***

1.9 PRE-ORDERED PRODUCTS

A. ***Not Applicable***

1.10 OWNER-FURNISHED PRODUCTS

A. Backup Generator

B. Automatic Transfer Switch
C. Main Metering Switchboard
D. MCC
E. Panelboards (480Y/277V and 208Y/120V)
F. Dry-Type Transformer

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF DOCUMENT

SUPPLEMENTAL SPECIFICATION

SECTION 01 14 00
WORK RESTRICTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Conditions affecting construction.

1.2 PROJECT COORDINATION

A. CONTRACTOR is responsible for the coordination of all the work, whether performed by his own personnel, subcontractors, or others.

1.3 SAFETY REGULATIONS

A. CONTRACTOR shall be responsible to ensure that all excavation and construction of this project shall be in compliance with OSHA, state, and local safety regulations.

1.4 CLEANUP

A. Upon completion of construction, all scraps of lumber, forms, steel, wire, concrete materials, excess concrete spills, rocks, debris, excavation material, asphalt, etc., shall be removed from the area and disposed of by CONTRACTOR.

1.5 CONTRACT DRAWINGS

A. Where CONTRACTOR bases his bid upon quantities scaled from Contract Drawings, he shall verify true scale with ENGINEER prior to submitting his bid when scale is not shown or unclear.

1.6 INTERFERING STRUCTURES AND UTILITIES

A. CONTRACTOR shall exercise all possible caution to prevent damage to existing structures and utilities, whether above ground or underground. CONTRACTOR shall notify all utility companies concerned at least one week in advance of construction operations in which a utility's facilities may be involved. CONTRACTOR shall be responsible for coordination with utility companies for acceptable relocation methods (permanent or temporary) for the construction of this project. This shall include, but not be limited to, irrigation, water, telephone, cable, electric, and gas.

B. CONTRACTOR shall pothole utilities as necessary to determine potential utility

conflicts. "Down time" or waiting for engineering evaluation of utility conflicts or grade issues, as well as modifications to existing utilities, shall be borne by CONTRACTOR without any additional costs to the OWNER or ENGINEER.

C. Any property or utilities damaged by the work shall be repaired or replaced in a condition equal to or better than the condition prior to the damage. Such repair or replacement shall be accomplished at CONTRACTOR's expense without additional compensation from the OWNER or ENGINEER.

D. All restorations made to utilities shall be inspected and approved by an authorized representative of the utility before being concealed by backfill or other Work

1.7 CONSTRUCTION SURVEYING

A. CONTRACTOR shall be responsible for all construction surveying on the project. CONTRACTOR shall preserve benchmarks and reference points. In the case of the destruction of an established benchmark or reference point, CONTRACTOR will be charged with the resulting relocation expense and shall be responsible for any mistakes that may be caused by their loss or disturbance.

1.8 SCHEDULE CONSTRAINTS

A. It is the CONTRACTOR's responsibility to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall Work.

B. The listing of schedule constraints below does not mean that all constraints or special conditions have been identified. The list is not a substitute for the duty to coordinate and plan for completion, all Work by the Substantial/Contract Completion Dates specified in the Contract Documents.

C. The following constraints affect the construction schedule.

1. Existing Detention Basin for Zone 1 East Tank. The property owner surrounding the pump station site will need to provide a temporary area to direct drain or overflow water from the Zone 1 East tank during construction. It is assumed the property owner will excavate the detention basin area and dig any necessary ditches to direct drain water to the temporary detention basin.
2. Zone 1 Tank Supply Connection. The Zone 1 Tank is supplied by a 24-inch ductile iron pipe that will need to be relocated to construct the new pump station. The proposed depth of the re-aligned waterline is significantly deeper than existing terrain. The Contractor will need to coordinate work with the Developer that will work to mass grade the area where the new pipeline alignment will be constructed.
3. It is assumed that the property owner of the area surrounding the pump station site will be able to do necessary mass grading if given 3 months notification.
4. The City's Zone 1 East Tank can be taken out of service for 150 days outside of the irrigation season (October 31 to April 1) to facilitate connections to the existing Zone

1 East supply line as necessary to realign the pipe. Zone 1 will receive water from PRV connections to other parts of Herriman City's water system during the realignment connections.

5. Valve Vault Removal. Once the new pipeline alignment for the Zone 1 East supply is made, the old alignment can be removed. This will begin with relocation of SCADA monitoring equipment for the Zone 1 East Tank. The Contractor shall coordinate with the Owner's SCADA consultant to relocate existing SCADA equipment. Once the SCADA equipment is relocated, the valve vault may be removed.
   a. A temporary enclosure will be needed for the existing SCADA equipment. The temporary enclosure. Enclosure to be provided by Owner.
6. Rocky Mountain Power Coordination. Power is unlikely to be available on site. The Contractor should plan on providing power for all construction activities until that time. All conduits and conductors necessary for the work shall be constructed so that it may be connected once Rocky Mountain Power installs its transformer and meter.
7. Pipeline Construction. Many of the areas along the pipeline alignment will have significant grade changes associated with the property owner's proposed development. Contractor will need to notify the property owner a minimum of 3 months in advance of areas that require mass grading before pipeline construction shall commence in those areas.
8. Final testing of the pump station will not be possible until the Zone 2 & 3 tanks are substantially complete.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01 14 33
RIGHTS-OF-WAY

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section covers the designation and conditions related to Work area obtained by Owner.

1.2 RELATED SECTIONS

A. Section 01 11 00 – Summary of Work

B. Section 31 10 00 – Site Preparation

1.3 WORK AREA, EASEMENTS, AND RIGHTS-OF-WAY

A. Work Area:
   1. Work Area Lands: Work areas are shown on the Drawings and are made up of a combination of lands owned by the Owner and lands the Owner has obtained the right to use. Strictly adhere to all requirements related to use of lands, site preparation, site restoration, and related conditions of these Contract Documents. Determine actual boundaries as described in the legal description and plat drawings. In case of discrepancy between work areas shown on the Drawings and the legal description and plat drawings, the legal descriptions and plat drawings will take precedence.

B. Use of Work Area:
   1. Refer to the General Conditions and Supplementary Conditions of the Contract, along with Section 01 11 00 – Summary of Work, and Section 31 10 00 – Site Preparation for specific limitations to the use of project lands and designated work areas. In addition to the referenced Sections, all other conditions of the Contract Documents shall apply. Use the work area only for activities directly related to the performance of the Work. All items moved, relocated, or otherwise disturbed within the work area shall be returned, repaired, reinstalled, or otherwise replaced to a condition equal to, or better than, its original condition, unless otherwise indicated. All Work associated with returning the site to its original condition shall be subject to the final approval of Engineer.
   2. The provisions regarding the use of the work area shall be applicable to all types of temporary use permits, agreements, and other arrangements intended to provide temporary or permanent use of lands to construct, operate, and maintain the facilities included in the Work. These shall include easements, encroachment permits, license agreements, bilateral agreements, permissions to construct, rights-of-entry, and all other similar agreements.
   3. Permission is granted to use specific work areas as specified. Minimize the use of the available work area as much as possible.

C. Lands that have been or will be made available for use prior to the start of Work are identified in the Contract Drawings. These work areas are contained within existing easements and rights of way. Note that not all rights-of-way are available for Contractor's use and some will

require coordinating with other contractors. Constraints within work areas shall be coordinated with Engineer prior to starting Work.

D. Owner will make the easements and other lands available for the Work within a reasonable time period. For all or portions of the work area herein defined that have not been obtained by the time Owner issues written Notice to Proceed for the Work, indicate in initial and subsequent progress schedules, the date at which the unavailability of the subject lands will begin to add to cost and schedule to complete the Work. These dates must be supported by scheduling procedures in full conformance with the Construction Progress Schedule requirements of these Contract Documents, and shall be based on reasonable assumptions regarding performance of the Work. To the maximum extent possible, schedule Work around the subject lands to allow the maximum amount of time before the unavailability of the subject lands results in increased cost to Owner. No change in contract price or extension of contract times (schedule) will be allowed for access to lands obtained prior to, or on the same day as, Owner's written Notice to Proceed or prior to, or on the same day as, the dates established in progress schedules. Work on lands where access rights are acquired after the dates submitted, as described above, and as may be adjusted using subsequent progress schedules reflecting actual Work progress, will be subject to a contract change order in full conformance with the General Conditions of the Contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 25 10
PRODUCTS, MATERIALS, EQUIPMENT AND SUBSTITUTIONS

PART 1 - GENERAL

1.1 DEFINITIONS

A. The word "Products," as used herein, is defined to include purchased items for incorporation into the Work, regardless of whether specifically purchased for the Project or taken from stock of previously purchased products.

B. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form units of work.

C. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items).

D. Definitions in this Article are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," “special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.

E. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying and erection of the Work.

1.2 QUALITY ASSURANCE

A. Source Limitations: To the greatest extent possible for each unit of work, provide products, materials, and equipment of a singular generic kind from a single source.

B. Compatibility of Options: Where more than one choice is available as options for selection of a product, material, or equipment, select an option, which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material and equipment selections.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance
   1. Deliver and store products, materials, and equipment in accordance with manufacturer's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft.
   2. Manage delivery schedules to minimize long-term storage of products at Site and overcrowding of construction spaces. In particular, ensure coordination to minimize holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

B. Transportation and Handling

1. Transport products by methods to avoid damage. Deliver in undamaged condition in manufacturer's unopened containers and packaging.
2. Furnish equipment and personnel to handle products, materials, and equipment, including those provided by Owner, by methods to prevent soiling and damage.
3. Provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

C. Storage and Protection
1. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.
2. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.
3. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.
4. Storage shall be arranged to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.
5. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

D. Maintenance of Storage
1. Periodically inspect stored products on a scheduled basis. Maintain a log of inspections and make the log available on request.
2. Comply with manufacturer's product storage requirements and recommendations.
3. Maintain manufacturer-required environmental conditions continually.
4. Ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.
5. For mechanical and electrical equipment, provide a copy of the manufacturer's service instructions with each item and the exterior of the package shall contain notice that instructions are included.
6. Service products on a regularly scheduled basis. Maintain a log of services and submit as a record document prior to acceptance by Owner in accordance with the Contract Documents.

1.4 PROPOSED SUBSTITUTIONS AND "OR EQUAL" ITEMS

A. Substitution and “or equal” determination shall be submitted and evaluated per the General Conditions included in the Contract Documents.

B. When proposing a substitution, make written application to Engineer on the "Substitution Request Form."

C. Unless otherwise provided by law or authorized in writing by Engineer, submit the "Substitution Request Form(s)" within the 35-day period after award of the Contract.

D. Whenever products, materials, or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular supplier, the naming of the manufacturer is intended to establish the type, function, and quality required. The Contract Price is understood to be based upon furnishing the item specified.

E. If a named item is not available or a particular supplier is no longer doing business, the following shall apply:
1. In the event that a named supplier is no longer doing business under the name indicated, furnish the specified product from the legal successors to the named supplier.

2. In the event that a named product is no longer available from the named supplier due to acquisition or sale of the given product line, but the product is available from another supplier, provide the named product. In such cases, submit a substitution request form and include certification from the supplier that the product being supplied is materially and functionally identical to the product named in the Contract Documents.
3. In the event that the named product is no longer available from the named supplier or any other supplier, notify Owner in writing and Owner will direct Engineer to identify suitable substitute products. Provide one of the suitable substitute products.

F. The procedure for review by the Engineer will include the following:
1. Wherever a proposed substitution has not been submitted within said 35-day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by Engineer, provide the product, material, or equipment indicated in the Contract Documents.
2. Certify that the proposed substitution will adequately perform the functions and achieve the results called for by the general design, and be similar and of equal substance to that indicated, and be suited to the same use as that indicated.
3. Engineer will evaluate each proposed substitution within a reasonable period of time.
4. As applicable, do not make shop drawing submittals for a substitution without Engineer's prior written acceptance of the "Substitution Request Form." Do not order, install, or utilize any substitution item prior to written acceptance of the "Substitution Request Form."
5. Engineer will record the time required by Engineer in evaluating substitutions and in making changes by Contractor in the Contract Documents occasioned thereby.

G. Application using the "Substitution Request Forms" shall contain the following statements and information, which shall be considered by Engineer in evaluating the proposed substitution:
1. The evaluation and acceptance of the proposed substitution shall not prejudice the achievement of substantial completion on time.
2. Whether or not acceptance of the substitution for use in the Work will require a change in any of the Contract Documents to adapt the design to the proposed substitution.
3. Whether or not incorporation or use of the substitution in connection with the Work is subject to payment of any license fee or royalty.
4. All variations of the proposed substitution from the items originally specified shall be identified.
5. Available maintenance, repair, and replacement service shall be indicated. The manufacturer shall have a local service agency (within 50 miles of the site) which

maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.

6. Itemized estimate of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and claims of other contractors affected by the resulting change.

H. Without any increase in cost to Owner, be responsible for, and pay all costs in connection with proposed substitutions and costs of inspections and testing of equipment or materials submitted for review prior to purchase thereof for incorporation in the Work, whether or not Engineer accepts the proposed product, equipment, or material. Reimburse Owner for the charges of Engineer and other authorized representatives for evaluating each proposed substitution.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SUBSTITUTION REQUEST FORM

To: _____ Project: _____

_____ Date: _____

_____ Owner: _____

Specified Item:

Section	Page	Paragraph	Description

The undersigned requests consideration of the following:

Proposed Substitution: _____

Attached data includes product description, specifications, drawings, photographs, performance and test data adequate for evaluation of the request. Applicable portions of the data are clearly identified.

The undersigned states that the following paragraphs, unless modified on attachments, are correct:

1. The proposed substitution does not affect dimensions shown on Drawings and will not require a change in any of the Contract Documents.
2. The undersigned will pay for changes to the design, including engineering design, detailing, and construction costs caused by the request substitution which is estimated to be $.
3. The proposed substitution will have no adverse effect on other contractors, the construction schedule (specifically the date of substantial completion), or specified warranty requirements.
4. Maintenance and service parts will be locally available for the proposed substitution.
5. The incorporation or use of the substitute in connection with the work is not subject to payment of any license fee or royalty.

The undersigned further states that the function, appearance, and quality of the proposed substitution are equivalent or superior to the specified item.

Submitted by **Contractor:**		Reviewed by **Engineer:**	
Firm:		☐ Accepted as Submitted	☐ Accepted as Noted
By:		☐ Not Accepted	☐ Received too Late
Signature:		By:	
Telephone:		Title:	
Attachments:		Date:	
Comments:		Comments:	

SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 GENERAL

A. This Section defines the process whereby the Schedule of Values shall be developed and incorporated into the Construction Progress Schedule as specified in Section 01 32 16 – Construction Progress Schedule. Monthly progress payment amounts shall be determined from the weekly progress updates of the scheduled activities. The schedule of values shall, as a minimum, list the value of every activity on the schedule, and shall include such additional breakdowns as required herein. The values in the Schedule of Values do not establish a commitment by either Contractor or Owner when negotiating changes to the Contract Documents.

1.2 DETAILED SCHEDULE OF VALUES

A. Prepare and submit a detailed Schedule of Values to Engineer as part of the Construction Progress Schedule submittal. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts, sufficient detailed breakdown shall be provided to meet this requirement. The Schedule of Values shall have a one-to-one relationship to the work activities of the Construction Progress Schedule even though additional detailed breakdowns for the Schedule of Values may be required. Engineer will be the sole judge of acceptable breakdowns, details, and descriptions of the values established. If, in the opinion of Engineer, a greater number of Schedule of Values items than proposed is necessary, add the additional items so identified.

B. The minimum details of a breakdown of the major Work components are indicated below. Provide greater detail when directed by Engineer.
   1. Mobilization: Five percent of Contract Price.
   2. Construction Progress Schedule shall be broken down by initial submittal and monthly updates.
   3. Break down Civil site Work into roadways, individual drainage systems, site concrete, soil cement, paving, excavation cut and fill, clearing and grubbing and any other items determined to be necessary for the establishment of pay and activity items.
   4. Break down concrete structures into excavation, subgrade preparation, and appurtenant pre-foundation Work, concrete foundation construction, slabs on grade, walls, columns, suspended slabs, etc. (provide sufficient breakdown to accommodate necessary schedule detail.
   5. Break down mechanical Work within each structure to identify individual piping systems, equipment installation by equipment name and number, and equipment testing and checkout.
   6. Break down electrical and Instrumentation Work within each structure to identify individual systems, equipment installation by equipment name and number, and equipment testing and checkout.

7. Break down protective coating Work by system. Where specific coating Work may be critical to performing the Work to meet milestone and schedule dates, such Work shall be included as individual pay and activity items.
8. Break down utility relocation Work into individual pipelines running from and to termination points. Each pipeline shall be an individual pay item unless otherwise allowed by the Engineer.
9. Provide breakdown for disinfection, testing, and commissioning of pipelines and reservoirs.
10. Operations and Maintenance (O & M) Manuals shall be broken down into one O & M Manual per piece of equipment or one O & M Manual per group of like-kind pieces of equipment for establishment of pay and schedule activity items.
11. Break down all other Work not specifically included in the above items as necessary for establishment of pay and schedule activity items.

C. After submittal of the Schedule of Values, as part of the Construction Progress Schedule submittal, meet with Engineer and jointly review the schedules. Review the value allocations and extent of detail to determine any necessary adjustments to the values and to determine if sufficient detail has been proposed. Make adjustments deemed necessary to the value allocation or level of detail and submit a revised detailed Schedule of Values within 5 work days from receipt of comments from Engineer.

1.3 CHANGES TO SCHEDULE OF VALUES

A. Assign values, approved by Engineer, for changes to the Construction Schedule which add activities not included in the original Construction Schedule but are included in the original Work (schedule omissions). Reduce other activity values to provide equal value adjustment increases for added activities as approved by Engineer.

B. In the event that Contractor and Engineer agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made. Engineer may direct changes to the schedule when inequities are discovered and agreement on the reallocation cannot be achieved.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SUPPLEMENTAL SPECIFICATION

SECTION 01 31 13
COORDINATION

This specification changes a portion of APWA Standard Specification Section 01 31 13. All other provisions of the Section remain in full force and effect.

Add the following paragraph to Article 1.5.

1.5 COORDINATION WITH ADJACENT PROPERTY OWNER

F. Once each week hand deliver a written **"Construction Status Update Notice"** to all residents, businesses, schools and property owners adjacent to and affected by the Work. Notice shall be on CONTRACTOR's company letter head paper and be secured to door knob should occupants not be home. Obtain ENGINEER's review of notice prior to distribution. As a minimum the notice shall contain the following.

1. name and phone number of CONTRACTOR's representative for the project;
2. work anticipated for the next 7 days including work locations and work by subcontractors and utility companies;
3. rough estimate of construction schedule through end of project;
4. anticipated driveway approach closures;
5. anticipated water, sewer or power outages;
6. anticipated vehicular traffic impacts, rerouting or lane closures;
7. anticipated pedestrian impacts and sidewalk closures;
8. changes to public transportation bus routes; and
9. any other construction or work items which will impact or restrict the normal use of streets and amenities.

Failure to comply with this contract provision is considered grounds for project suspension per Article 15.1 of the General Conditions (Document 00 72 00).

Add the following Article to Part 1:

1.8 PUBLIC AGENCIES PERSONNEL TO CONTACT

A. Utility Companies: Utility companies generally require a minimum of 48 hours notice if their utility requires location, relocation or protection. Contact the following individuals to coordinate utility impacts on this project.

Utility	Contact	Contact Information	Utility Involvement
Herriman City General	*Jonathan Bowers, PE Herriman City Engineer*	*801-446-5323 jbowers@herriman.org*	*Existing City Facilities in Area*
Herriman City Culinary Water	*Justun Edwards Water Superintendent*	*801-446-5323 jedwards@herriman.org*	*Culinary Water Facilities*
Herriman City Roads and Streets	*Jonathan Bowers, PE Herriman City Engineer*	*801-446-5323 jbowers@herriman.org*	*Existing City Facilities in Area*
Herriman City Storm Drain	*Jonathan Bowers, PE Herriman City Engineer*	*801-446-5323 jbowers@herriman.org*	*Existing City Facilities in Area*
Jordan Valley Water Conservancy District	*Gordon Batt Jordan Valley Water Conservancy District Engineer*	*801-565-4300*	*Potential Existing Utilities in Area*
Sanitary Sewer	*South Valley Sewer District*	*801-571-1166*	*Potential Existing Utilities in Area*
Gas Utilities	*Steve Eldredge Enbridge Gas*	*801-324-3954*	*Potential Existing Utilities in Area*
Irrigation	*Harmon Butterfield Herriman Irrigation Co.*	*801-971-0595*	*Potential Existing Utilities in Area*
Telephone Utilities	*Arlene Denney Century Link*	*801-974-8130*	*Potential Existing Utilities in Area*
Power Utilities	*Louis Lopez Rocky Mountain Power*	*801-576-6227*	*Potential Existing Utilities in Area*

END OF SECTION

SECTION 01 31 30
SAFETY

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor's safety program shall conform to the requirements specified in the General Conditions and Supplementary Conditions.

1.2 DEFINITIONS

A. For the purposes of this Section, an "active construction area" is any area where construction activities are occurring or construction activities could be considered a potential hazard to people.

B. A "Designated Safety Officer" or "Safety Representative" for the purposes of this Contract, means anyone who is capable of identifying the existing and predictable hazards in the areas surrounding a construction project or those working conditions at a construction project that are unsanitary or dangerous to employees. A "Designated Safety Officer" has the authority to make prompt corrective measures to eliminate those hazards.

1.3 SUBMITTALS

A. Demonstrate compliance action with the stipulations of Occupational Safety and Health Administration (OSHA), Mine Safety and Health Administration (MSHA), and other applicable local, state, and federal safety requirements by submitting to Engineer a copy of all safety plans, programs, and permits. Such plans and programs shall include, but are not limited to:
   1. Hazard Analysis Prior to Major Activities (job safety analysis, JSA).
   2. Emergency Plan.
   3. Rigging and Hoisting Plans.
   4. Excavation and Trenching Plans.
   5. Respiratory Protection Program.
   6. Fire Protection Plan.
   7. Confined Space Entry Program.
   8. Electrical Safety (drop cords, temporary power, GFCI's, etc.)
   9. Lock Out/Tag Out.
   10. Fall Protection.
   11. Heavy Equipment Operations.
   12. Burning and Welding Operations.
   13. Training Plan.
   14. Tunneling/Underground/Jacking/Boring Operations.
   15. Project Site Rules and Regulations (hazard protection plan).
   16. Material Handling (storage-disposal).
   17. Fuel Storage and Refueling.
   18. Hazard Communication/Right to Know.
   19. Subcontractor Requirements.
   20. Ventilation.

21. Personal Protective Equipment (hearing, eye, face).
22. Power Transmission/Distribution (temporary and/or permanent).
23. Traffic Control.
24. Environmental Controls.
25. Safety Meetings.
26. Spill Control Plan.
27. First Aid Facilities.

B. Engineer's receipt of safety plans or programs will not relieve Contractor in any way from the full and complete responsibility for safety and training of its personnel, and the onsite personnel of Owner, Engineer, and other visitors to areas of active construction areas. On a daily basis, inform Engineer of changes to the boundaries of the active construction areas.

C. Be responsible for safety training all personnel who will have access to the active construction areas to meet state, federal, local and Contractor requirements. Maintain reasonable, regularly scheduled training sessions in mutually accessible facilities through entire Contract. Training costs for all personnel and visitors, except those costs associated with training personnel of Contractor, subcontractors, suppliers, and visitors will be considered incidental to other lump-sum portions of the Work and no additional compensation for such training will be provided.

D. Safety Program Requirements:
   1. Safety Representative Requirements:
      a. Assign a Safety Representative as defined in the General Conditions of the Contract.
      b. The Safety Representative's duties and responsibilities will be hazard recognition, accidents prevention, new employee orientation (including subcontractors), and the maintaining and supervising of safety precautions and program. The Safety Representative or a qualified and approved deputy shall be onsite at all times while Work is ongoing.
      c. Qualifications of the Safety Representative and assigned deputies shall be submitted to Engineer for review. Acceptance of their qualifications by Engineer is required prior to the start of any activity on the Project. The Safety Representative will, as a minimum, meet the requirements of regulations for the Occupational Safety & Health Enforcement Program.
   2. Hazardous Substances:
      a. Provide Engineer with a list of all hazardous substances anticipated to be brought on-site.
      b. Maintain on site Material Safety Data Sheets (MSDS) prior to arrival of any hazardous substances on the Project.
      c. Use storage area(s) as outlined in the spill control plan.
   3. Job Safety Analysis (JSA):
      a. Outline the sequence of the Work, equipment to be used, identify hazards that may exist or may be created and what procedures and/or safety equipment will be used to eliminate or reduce these hazards. A Scope of Work JSA shall be prepared and provided to the Engineer prior to the start of unusual, hazardous, or have risk potential activities on the Project. The name of the competent person assigned to this activity will be included on the JSA.

b. Complete a JSA for any activity, which may be of an unusual nature or involves unique hazards.

4. Reports
   a. Provide to Engineer copies of Contractor's and subcontractor's:
      1) First aid, recordable, lost time and near miss, monthly logs.
      2) OSHA 200 injury log (annually).
      3) Safety meeting reports and topics (weekly).
      4) List of competent persons as required by OSHA and the Project Health and Safety Manual for each required task and their qualification as such.
      5) Injury and accident reports will be submitted to Engineer within 24 hours of any incident. **Immediate** notification to Engineer of an accident is **required**. Full cooperation with Engineer in accident investigation is required.
   b. Conduct weekly safety inspections. Corrective actions shall be taken within 24 hours to address all deficiencies identified during inspections. Deficiency reports shall be prepared and submitted to Engineer within 48 hours indicating corrective actions taken. Failure to comply with required corrective measures identified in the safety inspection will result in the delayed signing of the monthly application for progress payment by Engineer.
   c. Provide Engineer with a report of any periodic audit of Contractor's safety performance and/or records.

END OF SECTION

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 GENERAL

A. Employ a bar chart schedule for the planning and scheduling of all Work required under the Contract Documents.

B. In addition to the scheduling aspect, the same chart shall show an "S" curve for scheduled dollar expenditures versus time.

C. In the process of preparing baseline schedule and monthly updates, consult with all key subcontractors and suppliers to assure concurrence with the feasibility and achievability of planned start dates, sequencing, durations, and completion dates.

1.2 RELATED SECTIONS

A. Section 01 22 00 – Measurement and Payment

1.3 QUALIFICATIONS

A. Demonstrate competence through the submission of a fully compliant Construction Progress Schedule with the initial schedule submission. Upon failure to so demonstrate competence in scheduling, Engineer may direct Contractor to employ the services of a scheduler that can demonstrate competence. Comply with such directives.

1.4 SUBMITTAL PROCEDURES

A. Submittal Requirements
   1. Submit Construction Progress Schedule on a standard drawing sheet, size 24 inches by 36 inches.
   2. The time scale (horizontal) shall be in weeks. The activities shall be listed on the left hand side (vertical).
   3. Break down activities into sufficient detail to show all work activities. The listing from top to bottom shall be in a logical manner of which the Work will be accomplished. Provide space between activities or within bars to allow for marking of actual progress.
   4. Provide a written narrative of the planning logic along with a description of Work and quantities included in each activity of the bar chart schedule.
   5. Duration: The duration indicated for each activity shall be in units of whole working days and shall represent the single best time considering the scope of the Work and resources planned for the activity, including time for holidays and inclement weather. The calendar for the network shall be in calendar days. Except for certain non-labor activities, such as curing concrete or delivering materials, activity durations shall not exceed 14 days, be less than one day, nor exceed $50,000 in value unless otherwise accepted by Engineer.

B. Time of Submittals

1. Submit the bar chart schedule with "S" curves and narrative within fifteen (15) working days after Notice to Proceed for review by Engineer. The schedule submitted shall indicate a project completion date the same as the contract completion date.
2. Submit a copy of the schedule, clearly showing progress made and actual "S" curves, on a two or four week basis depending on the duration of the project and reporting time agreed to in the preconstruction meeting.

C. Acceptance

1. The bar chart schedule and "S" curves, when accepted by Engineer, constitute the Construction Progress Schedule unless a revised schedule is required due to one or more of the following:
   a. Substantial changes in the Work scope.
   b. A change in Contract time.
   c. Delinquency by Contractor that requires a recovery schedule.
2. Owner's review and acceptance of the Construction Progress Schedule is for conformance to the requirements of the Contract Documents only. Review and acceptance by Owner of Contractor's Construction Progress Schedule does not relieve Contractor of any of its responsibility whatsoever for the accuracy or feasibility of the Construction Progress Schedule, or of Contractor's ability to meet interim milestone dates and the Contract completion date, nor does such review and acceptance expressly or impliedly warrant, acknowledge, or admit the reasonableness of the logic and durations of the Construction Progress Schedule.

1.5 SCHEDULE UPDATES

A. The Construction Progress Schedule shall be updated to reflect the as-built conditions of the Work and to accurately forecast the status of incomplete activities. Provide progress reports at each weekly progress meeting, stating actual percent earned versus percent planned. Submit Construction Progress Schedule updates to Engineer with each payment request, including approved changes in the Work and accurately depicting the current status and sequence of all activities.

B. Submit the updated Construction Progress Schedule in the form, sequence, and number of copies requested for the initial schedule.

C. Engineer will review each submitted Construction Progress Schedule update and provide comments within seven days of the submittal. Revise and resubmit the schedule within five days of receipt of comments from Engineer. Engineer will review the re-submittal within five days and provide comments if the schedule update is still unacceptable. Revise and resubmit the schedule within five days of receipt of comments from Engineer.

1.6 PROGRESS MEETINGS AND LOOK-AHEAD SCHEDULES

A. For the weekly progress meetings, submit a look-ahead schedule. This schedule will cover four weeks: the immediate past week, the current week, and the forthcoming two weeks. List all activities from the accepted Construction Progress Schedule, which are complete, are scheduled for Work during the period, are currently planned to be worked, even if out of sequence, and Work which is unfinished but scheduled to be finished. Provide actual start

and completion dates for the Work that has been completed the prior week. Forecast early start and early finish dates for the Work that is in process or upcoming.

B. Identify each activity noted above by activity number corresponding to the accepted Construction Progress Schedule and detailed description of the activity.

C. Deliver the look-ahead schedule to Engineer 24 hours prior to the weekly progress meeting in a format approved by Engineer.

1.7 CONSTRUCTION SCHEDULE REVISIONS

A. Engineer may direct and, if so directed, Contractor shall propose, revisions to the Construction Progress Schedule upon occurrence of any of the following instances:
   1. The actual physical progress of the Work falls more than five percent (5%) behind the accepted Construction Progress Schedule, as demonstrated by comparison to the accepted monthly Construction Progress Schedule updates or as determined by Engineer if a current accepted Construction Progress Schedule does not exist.
   2. Engineer considers milestone or completion dates to be in jeopardy because of "activities behind schedule". "Activities behind schedule" are all activities that have not or cannot be started or completed by the dates shown in the Construction Progress Schedule.
   3. A Change Order has been issued that changes, ads, or deletes scheduled activities, or affects the time for completion of scheduled activities.

B. When instances requiring revision to the Construction Progress Schedule occur, submit the proposed revised Construction Progress Schedule within ten (10) working days after receiving direction from Engineer to provide such schedule. No additional payment will be made for preparation and submittal of proposed revised Construction Progress Schedules. However, if Engineer accepts the proposed revised Construction Progress Schedule, it shall replace and supersede all previous Construction Progress Schedules and substitute for the next monthly Construction Progress Schedule update that would otherwise be required.

C. Revisions to the Construction Progress Schedule shall comply with all of the same requirements applicable to the original schedule.

1.8 SCHEDULE RECOVERY

A. If a revised Construction Progress Schedule accepted by Engineer requires additional manpower, equipment, hours of work or work shifts, or to accelerate procurement of materials or equipment, or any combination thereof, as schedule recovery measures to meet Contract milestones, implement such schedule recovery measures without additional charge to Owner.

1.9 EARLY COMPLETION SCHEDULES

A. Early completion schedules are generally not acceptable to Owner but may be accepted as a convenience to Contractor and under the following conditions.
   1. Submit a specific written request outlining the specific reasons for using the early completion schedule.

2. Acknowledge and agree in writing that the proposed reduction in time represents Project time already paid for by Owner as part of the Bid Price, and available to both Contractor and Owner for the mitigation of impacts to the Project from any source. Contractor is not entitled to any increase in Contract price for failure to achieve the early completion and waives all claim to same.
3. Early completion schedules shall not be based upon or rely on expedited approvals by Owner or Engineer.
4. Early completion schedules must meet all other requirements of the Contract.

B. Revise early completion schedules, which have activities behind schedule, when and as requested by Engineer.

1.10 BASIS OF SCHEDULE NARRATIVES

A. Furnish a basis of schedule narrative to Engineer with each Application for Payment. If the Work falls behind schedule, submit additional narrative at such intervals as Engineer may request.

B. In each narrative, include a summary of progress for the month, description of any current and anticipated delaying factors, a variance analysis for varying activities, impacts on the construction schedule, and proposed corrective actions. Any Work reported complete, but which is not readily apparent to Engineer, must be substantiated with satisfactory evidence.

C. In each narrative, include a list of the activities completed during the preceding month and a list of the activities started during the month but not yet completed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SUPPLEMENTAL SPECIFICATION

SECTION 01 33 00
SUBMITTAL PROCEDURES

This specification changes a portion of Section 01 33 00 in the Manual of Standard Specifications, 2017 Edition. All other provisions of the Section remain in full force and effect.

Add the following articles to part 1.

1.8 TRANSMITTAL FORM

A. Use the attached transmittal form (Form 01 33 00-1) when making any submittal to the ENGINEER.

B. Determine appropriate review due dates for each submittal and link the due date to the Progress Schedule (Section 01 32 16).

1.9 SUBMITTAL REGISTER

A. The Manual of Standard Specifications, 2017 Edition, and this Project Manual indicate submittals which are required for the Project. Using both of these publications, list the required submittals on the attached submittal register form (Form 01 33 00-2) [*Blank Submittal Register forms will be furnished by ENGINEER on request]*.

1. Identify the submittals which are for information only (see article 1.10).

2. Identify the submittals which require the ENGINEER's review or action (see article 1.11)

B. ***Submit the submittal register as the first submittal presented for review***.

1.10 SUBMITTALS FOR INFORMATION ONLY

A. Submittals identified in the Manual of Standard Specifications, 2017 Edition, or in the Project Manual which are not identified in this section are for information only and do not require review or action by ENGINEER or Resident Project Representative. Such submittals, however, will be monitored and spot checked. When spot checks indicate non-compliance, CONTRACTOR will be notified.

Add the following article to part 1.

1.11 SUBMITTALS REQUIRING REVIEW OR ACTION

A. The following table lists submittals which require ENGINEER's review or action. Transmit these submittals to the ENGINEER, or to the Resident Project Representative on site.

Table 1 - SUBMITTALS REQUIRING REVIEW OR ACTION

No.	Submittal	Section Reference	When Due
1	Submittal Register	01 33 00	Pre-construction conference
2	Preliminary Progress Schedule	00 72 00	Pre-construction conference
3	Quality Control Program	01 45 00	Pre-construction conference
4	Testing Agency Name, Address, Telephone No., Manager Name, Licenses and certificates	01 45 00	Pre-construction conference
5	Permits for Work	00 72 00	Prior to Starting Work
6	Progress Schedule	01 32 16	With Each Pay Request
7	Written Permission to use Private Citizen's Property and Water		24 Hours Prior to Use
8	Field Test Reports	01 45 00	End of Current Day
9	Laboratory Test Reports	01 45 00	Within 48 Hours
10	Construction Surveyor Name, Address, Registration No.	01 71 23	72 Hours Prior to Starting Work
11	Untreated Base Course Gradation	32 11 23	Prior to Use
12	Passing Untreated Base Course Compaction Test Control Reports	32 05 10	Daily as UTBC is placed
13	Depth of Backfill Lift if greater than specified	33 05 20	Prior to Change
14	Select Fill Mix Design		Prior to Use
15	Asphalt Concrete Mix Design Supplier's Mix No.	32 12 05	Prior to Use
16	Asphalt Concrete Batch Delivery Ticket		Upon Delivery to Site
17	Passing Asphalt Concrete Compaction Test Control Reports	32 12 05	Daily as Asphalt is placed
18	Concrete Mix Design Supplier's Mix No.	03 30 04	Prior to Use
19	Concrete Batch Delivery Ticket	03 30 05	Upon Delivery to Site
20	Portland Cement Concrete Source Data and Supplier's Mix No.	32 13 13	Prior to Use
21	Water System Product Data	33 11 00	Prior to Installation
22	Waterproofing	07 19 00	Prior to Installation
23	Water System Disinfection Report	33 13 00	Prior to Water Line Use
24	Pipeline Commissioning	33 08 00	Prior to System Use
25	Portland Cement Concrete Quality Control Test Reports	32 13 13	Daily as applicable

No.	Submittal	Section Reference	When Due
26	Portland Cement Concrete Batch Delivery Ticket	32 13 13	Upon Delivery to Site
27	Electrical Shop Drawings	26 05 00	Within 15 days after contract award
28	Electrical Materials	26 05 00	Within 15 days after contract award
29	Electrical Testing	26 05 00	Prior to Use
30	Electrical Operating Instruction Manuals	26 05 00	Prior to Use
31	Electrical System Product Data	26 05 00	Prior to Installation
32	Operator Manuals	01 78 23	Prior to Use
33	Water Line Commissioning Test Reports	33 08 00	Prior to Final Payment
34	Valves, Meters, and Appurtenances	33 11 00, 33 12 16, 33 12 19, 33 12 33	Prior to Installation
35	Certification of Compliance and Request for Final Inspection	00 72 00	5 Working Days Prior to Substantial Completion
36	Evidence of Payment to Suppliers and Subcontractors	00 72 00	Prior to Final Payment
37	As-Built Drawings/Redlines	01 78 39	Prior to Final Payment
38	Summary Reports	01 45 00	Prior to Final Payment

NOTES:

1. Section references listed in this table but not found in this Project Manual may be found in the APWA Manual of Standard Specifications.

TRANSMITTAL FORM	DATE	[ ] NEW SUBMITTAL [ ] RESUBMITTAL

Section I	REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS (This section will be initiated by the CONTRACTOR)	
TO	FROM	TRANSMITTAL No. PREVIOUS TRANSMITTAL No.
SPECIFICATION SECTION NUMBER (See instructions)	CONTRACT TITLE	CONTRACT No.

SUBMITTAL ITEM No.	DESCRIPTION OF ITEM SUBMITTED (Type, size, model number, etc.)	SAMPLE OR CERTIFICATE (See instructions)	NO. OF COPIES	CONTRACT REFERENCE DOCUMENT		VARIATION (See instructions)	ENGINEER REVIEW CODE (See instructions)
				SPEC. PARA. No.	DRAWING SHEET No.		
a.	b.	c.	d.	e.	f.	g.	h.

REMARKS	I certify that the above submitted items have been reviewed in detail and are correct and conform with the contract Drawings and specifications except as otherwise noted. _____ NAME AND SIGNATURE OF CONTRACTOR

Section II	OWNER'S ACTION This section will be completed by the ENGINEER)	
ENCLOSURES RETURNED (List by Item No.)	SIGNATURE OF REVIEWING AGENT	DATE

FORM 01 33 00-1 (Read Instructions on the reverse side prior to initiating this form)

INSTRUCTIONS

GENERAL

1. Form is self-transmittal. Letter of transmittal is not required.
2. Submittals requiring expeditious handling will be submitted individually on this Form.
3. ENGINEER's review of submittals does not release or relieve CONTRACTOR from complying with all requirements of the Contract Documents.

SECTION I

1. TRANSMITTAL No: Number each transmittal consecutively in the space entitled "Transmittal No.". This number will identify each submittal.
2. PREVIOUS TRANSMITTAL No: Mark the box for resubmittal and insert the transmittal number of last submission as well as the new submittal number in the spaces provided. Each resubmittal will become a new transmittal.
3. SPECIFICATION SECTION No.: Cover only one specification section with each transmittal.
4. Column "a": For each entry on this form, the "SUBMITTAL ITEM No." will be the same as the SUBMITTAL ITEM No. indicated on the Submittal Register (Form 01335-2).
5. Column "c": When a sample of material or Manufacturer's Certificate of Compliance is transmitted, indicate "Sample" or "Certificate".
6. Column "g": CONTRACTOR will place a check mark in the "Variation" column when a submittal is not in accordance with the plans and specifications - also, a written statement to that effect shall be included in the space provided for "Remarks" or on a separate page.
7. Column "h": For each item reviewed, ENGINEER shall assign action codes as follows.

A. No Exceptions Taken.
B. Make Corrections Noted. Resubmission not required.
C. Submit Specified Item.
D. Rejected.
E. Resubmit
F. Do Not Resubmit. Receipt acknowledged.
G. Will be returned by separate correspondence.
H. Other (Specify).

SUBMITTAL REGISTER				PROJECT TITLE LOCATION CONTRACTOR											No.						
SCHEDULED ACTIVITY	SUBMITTAL ITEM No.	SPECIFICATION PARAGRAPH NUMBER	DESCRIPTION OF SUBMITTAL	TYPE OF SUBMITTAL											REVIEW ACTION	CONTRACTOR NEED DATES			ENGINEER ACTION DATES		OTHER
				SAMPLES	SHOP DRAWINGS	PARTS LIST	PRODUCT DATA	DESIGN DATA	SPECIFICATIONS	CERTIFICATES	INSTRUCTIONS	TESTING RESULTS	O & M MANUAL	OTHER	REVIEW REQUIRED BY	SUBMITTAL DATE	APPROVAL NEEDED BY	MATERIAL NEEDED BY	DATE RECEIVED	ACTION CODE	

FORM 01 33 00-2

INSTRUCTIONS

GENERAL

1. CONTRACTOR to Complete Form: Review the Contract Documents to insure completeness. Expand general category listings. Show individual entries on this form for each item.

    a. As an example, a general category would be "Plumbing Fixtures" which the CONTRACTOR is to breakdown into individual entries such as "Toilet P-1, Lavatory P-2, etc." Complete the Submittal Register, attach it to Form 01335-1 and submit it to ENGINEER.

2. Resubmittals: If a submittal is returned for correction, provide a new Submittal Identification Number. Identify the number on the submittal register and resubmit the information for review. Do not amend the data already contained on the submittal register.

SUBMITTAL REGISTER

1. SCHEDULED ACTIVITY: If an activity on the Progress Schedule is assigned to the submittal, place the schedule activity number in the "SCHEDULED ACTIVITY" column.

2. SUBMITTAL ITEM No.: Assign to each entry on the Submittal Register a sequential number in the "SUBMITTAL IDENTIFICATION (ITEM NUMBER)" column.

3. REVIEW ACTION: The "REVIEW ACTION" column identifies technical review responsibility of submittal. Review of all products and materials is the CONTRACTOR's responsibility; however, certain specified submittals will also require ENGINEER's review.

    a. If REVIEW ACTION Column is Blank: Identified submittal shall be approved by the CONTRACTOR and then submitted to the ENGINEER for information.

    b. If the "ENGINEER" is Identified in the REVIEW ACTION Column: Identified submittals shall be first approved by the CONTRACTOR and then submitted to the ENGINEER for review.

4. ENGINEER ACTION DATES: This column is for ENGINEER's use to record date submittal was received and the action code assigned in the submittal review process.

END OF SECTION

SECTION 01 35 53
SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Protect the active construction areas of the Work, including all material, equipment, field office trailers, and their contents from theft, vandalism, and unauthorized entry.

1.2 DEFINITIONS

A. For the purposes of this Section, an "active construction area" is any area where construction activities are occurring or construction activities could be considered a potential hazard to people.

1.3 SUBMITTALS

A. Prior to performance of any work at the Project Site, submit to Engineer for record only, two copies of the security plan commensurate with the needs of the Project, signed by officer of Contractor. Be solely responsible for adequacy of the security plan.

B. Provide Engineer with drawing and data showing temporary fencing and gate locations, along with materials to be used.

C. Provide Engineer with a list of 24-hour emergency phone numbers for Contractor personnel.

D. Submit to Engineer an updated progressive inventory of materials and equipment received on-site.

E. Submit log of workmen and visitors to Project Site.

1.4 SECURITY PROGRAM

A. Protect Work and existing premises, including the field office trailers and their contents, from theft, vandalism, and unauthorized entry during working and non-working hours.

B. Accept sole responsibility for Project Site security and protection of the Work.

C. Initiate the security program at job mobilization and maintain the security program throughout construction period.

D. Limit lighting to basic safety and security requirements, and shield when possible.

E. Be responsible for the security of storage compound and lay down area, and for all plant material, equipment, and tools at all times.

F. Prohibit firearms for the Project Site.

G. Prohibit dogs from the Project Site, with the exception of those clearly used for security purposes within fenced areas.

H. Erect and maintain temporary security fencing as required to protect the Work, the Project Site, and existing facilities on the Project Site. The location of all temporary security fencing shall be approved in advance by Engineer.
   1. Fence Height: 6 ft
   2. Fence Material: Chain Link

1.5 ENTRY CONTROL

A. Entry control shall not unreasonably limit the personnel of Owner, Engineer, and their operations and maintenance groups from performing assigned duties. Temporary access limitations will be identified to Engineer and the operations and maintenance groups at least 24 hours prior to such limitation.

B. Restrict entry of unauthorized persons and vehicles into Project Site.

C. Allow entry only to authorized persons with proper identification.

D. When requested by Owner, implement a security badge system for the Project Site, approved by Owner.

E. Contractor has the right to refuse access to the Project Site or require that a person or vehicle be removed from the Project Site if found violating any of the project rules.

F. Give jobsite security orientation training to all affected employees, including subcontractor employees. Employee participation in the security orientation shall be acknowledged by their respective individual signatures affixed to an orientation roster.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 41 26
PERMITS

PART 1 - GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

A. Obtain permits required for the execution of Work in accordance with the Contract Documents. Provide copies of these permits to Owner.

B. The intent of this Section is to furnish the known list of required permits for the Work under the Contract Documents. Owner does not guarantee that this list is complete. Be responsible for determining and verifying the extent of all permits required and for obtaining such permits.

C. In the Bid Price, include costs for obtaining all necessary permits, including application fees and other costs, and the costs of complying with the conditions of all permits. Any fees listed in this section are estimates and are for information only. Verify and pay all actual fees.

D. Within 30 Days of the Limited Notice to Proceed, submit a list of all permits and licenses to be obtained, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

1.2 SUMMARY OF PERMITS TO BE OBTAINED BY CONTRACTOR

A. Obtain the following permits. Submit copies of these permits to Engineer and maintain copies on-site. Comply with all conditions of the permits.
   1. Utah Occupational Safety and Health Administration:
      a. Construction Permit: Covers worker safety and health for all project features.
   2. Utah Department of Environmental Quality, Division of Water Quality:
      a. UPDES General Permit for Construction Dewatering/Hydrostatic Testing of Pipelines: Covers discharge waters associated with dewatering operations and hydrostatic testing of pipelines.
         1) Agency: Utah Department of Environmental Quality, Division of Drinking Water
         2) Contact Person: Harry Campbell
         3) Telephone No.: (801) 538-6923
         4) Email: hcampbell@utah.gov
      b. Notification of Chlorinated Water Discharge: This notification provides 30 days notice prior to disinfection of pipeline and discharge of pipeline and discharge of chlorinated water.
   3. Utah Division of Environmental Protection, Bureau of Water Pollution Control
      a. Temporary Groundwater Discharge Permit is necessary if groundwater is present.
   4. Utah Division of Environmental Protection, General Storm Water Permit for Construction Activities:
      a. As a condition of contract award, sign a certification of agreement to comply with the terms and conditions of the permit. Permit not required if area of disturbance is less than one acre.

b. Agency and Contact Person:
1) Agency: Utah Department of Environmental Quality, Division of Drinking Water
2) Contact Person: Tom Rushing
3) Address: 288 North 1460 West (Cannon Building) 3rd Floor, PO Box 144870, Salt Lake City, Utah 84114-4870
4) Telephone No.: (801) 538-6951
5) Email: trushing@utah.gov

5. Utah State Division of Health:
a. Letter of Approval to Construct: Letter and Certificate are required for construction and operations of a water supply system.

6. Salt Lake County
a. Building and Excavation Permit: Permit is for construction in unincorporated Salt Lake County. A Traffic Control Plan will be required with this permit.
1) Agency: Salt Lake County
2) Contact: Planning and Development
3) Address: 2001 South State Street #N3600
4) Telephone No. (801) 468-2000

7. Herriman City
a. Excavation Permit is required for excavations within City right-of-way. A Traffic Control Plan will be required with this permit.
1) Agency: Herriman City
2) Contact Person: Destiny Skinner
3) Address: 13011 South Pioneer St., Herriman, Utah, 84096
4) Telephone No.: (801) 446-5323
5) Email: dskinner@herriman.org

1.3 SUMMARY OF PERMITS OBTAINED BY OWNER

A. The following permits have been or will be obtained by Owner for this Project. Verify and comply with conditions of said permits.
1. Utah Department of Natural Resources, Division of Water Rights:
a. Joint Permit Application Form
1) Agency: U.S. Army Corps of Engineers and Utah State Engineers Office
2) Contact Person: Chuck Williamson
3) Telephone No.: (801) 538-7404
4) Email: charleswilliamson@utah.gov

2. Utah Department of Environmental Quality, Division of Drinking Water
a. Project Notification Form and Plan Review/Construction Approval
1) Agency: Utah Department of Environmental Quality, Division of Drinking Water
2) Contact Person: Robert Hart
3) Telephone No.: (801) 536-0054
4) Email: bhart@utah.gov

END OF SECTION

SECTION 01 42 13
ABBREVIATIONS OF INSTITUTIONS

PART 1 - GENERAL

1.1 GENERAL

A. Wherever in the Contract Documents, references are made to the standards, specifications, or other published data of the various international, national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the reader, the following acronyms or abbreviations which may appear in the Contract Documents shall have the meanings indicated herein.

1.2 ABBREVIATIONS

AAMA	Architectural Aluminum Manufacturer's Association
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturer's Association, Inc.
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute, Inc.
APA	American Plywood Association
API	American Petroleum Institute
APWA	American Public Works Association

ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASLE	American Society of Lubricating Engineers
ASME	American Society of Mechanical Engineers
ASQC	American Society for Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CLSI	Clinical and Laboratory Standards Institute
CRSI	Concrete Reinforcing Steel Institute
EIA	Electronic Industries Association
ETL	Electrical Test Laboratories
EPA	Environmental Protection Agency
FM	Factory Mutual System
FPL	Forest Products Laboratory
HI	Hydronics Institute
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Power Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers

IES	Illuminating Engineering Society
IP	Institute of Petroleum (London)
IPC	Institute of Printed Circuits
ISA	Instrument Society of America
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
MBMA	Metal Building Manufacturer's Association
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society
MTI	Marine Testing Institute
NAAMM	National Association of Architectural Metal Manufacturer's
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NLGI	National Lubricating Grease Institute
NSF	NSF International
NWMA	National Woodwork Manufacturers Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PPI	Plastics Pipe Institute
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers

SAMA	Scientific Apparatus Makers Association
SMACCNA	Sheet Metal and Air Conditioning Contractors National Association
SPI	Society of the Plastics Industry, Inc.
SPR	Simplified Practice Recommendation
SSPC	Society for Protective Coatings
SSPWC	Standard Specifications for Public Works Construction
TIA	Telecommunications Industry Association
UL	Underwriters Laboratories, Inc.
WEF	Water Environment Federation
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association
WWPA	Western Wood Products Association (WWPA)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 19
REFERENCE STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Titles of Sections and Paragraphs: Captions accompanying Specification Sections and Paragraphs are for convenience of reference only, and do not form a part of the Specifications.

B. Applicable Publications: Whenever in these Specifications, references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is specified, only the latest specifications, standards, or requirements of the respective issuing agencies, which have been published as of the date that the Work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

C. Specialists, Assignments: In certain instances, Specification text requires (or implies) that specific Work is to be assigned to specialists or expert entities, who must be engaged for the performance of that Work. Such assignments shall be recognized as special requirements with no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the Work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of Work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, accept the final responsibility for fulfillment of the entire set of contract requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all Work specified herein shall conform to or exceed the requirements of applicable codes and the applicable requirements of the following documents.

B. References herein to "Building Code", “Plumbing Code”, “Mechanical Code”, “Fuel Gas Code”, or “Fire Code” shall mean the latest adopted version of the International Building Code (IBC), the International Plumbing Code (IPC), the International Mechanical Code (IMC), the International Fuel Gas Code (IFGC), and the International Fire Code (IFC) as published by the International Code Council (ICC). Similarly, references to the "Uniform Mechanical Code" or the "Uniform Plumbing Code" shall mean the Uniform Mechanical Code or the Uniform Plumbing Code as published by the International Association of Plumbing and Mechanical Officials (IAPMO) References to the "Electric Code" or "National Electric Code (NEC)" shall mean the National Electric Code of the National Fire Protection Association (NFPA). The latest edition of any “building” code as approved by the Municipal Code and adopted by the authority having jurisdiction, shall apply to the Work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

C. In case of conflict between codes, reference standards, Drawings and the other Contract Documents, the most stringent requirements shall govern. Bring all conflicts to the attention of Engineer for clarification and directions prior to ordering or providing any materials or furnishing labor. Bid the most stringent requirements.

D. Construct the Work indicated herein in accordance with the requirements of the Contract Documents and the referenced portions of those referenced codes, standards, and specifications listed herein.

E. Applicable Standard Specifications: References in the Contract Documents to the "Standard Specifications" shall mean the *Manual of Standard Specifications* (APWA), latest version.

F. References herein to "OSHA Regulations for Construction" shall mean *Title 29, Part 1926, Construction Safety and Health Regulations***,** Code of Federal Regulations (OSHA), including all changes and amendments thereto.

G. References herein to "OSHA Standards" shall mean *Title 29, Part 1910, Occupational Safety and Health Standards***,** Code of Federal Regulations (OSHA), including all changes and amendments thereto.

H. References herein to "UDOT Standards" shall mean *Standard Specifications for Road and Bridge Construction*.

I. References herein to "MSHA Standards" shall mean *Mine Safety and Health Administration Standards*, latest version.

1.3 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. Be responsible that all Work included in the Contract Documents, regardless if shown or not, complies with all EPA, OSHA, RCRA, NFPA, and any other Federal, State, and Local Regulations governing the storage and conveyance of hazardous materials, including petroleum products.

B. Where no specific regulations exist, all chemical, hazardous, and petroleum product piping and storage in underground locations must be installed with double containment piping and tanks, or in separate concrete trenches and vaults, or with an approved lining which cannot be penetrated by the chemicals, unless waived in writing by Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SUPPLEMENTAL SPECIFICATION

SECTION 01 43 00
QUALITY ASSURANCE

Add Paragraph 1.6, Inspection and Testing Laboratory Services, and 1.7, Manufacturers' Field Services and Reports, as follows:

1.6 INSPECTION AND TESTING LABORATORY SERVICES

A. CONTRACTOR shall employ and pay for the services of a qualified independent testing consultant, approved by the OWNER, to perform specified services for the testing of:

Soils Compaction Control	Material Aggregate Control
Concrete Control	Paving and Asphalt Surfacing Control

B. Inspections, tests, and other services specified in individual specification Sections will be accomplished under the direction of ENGINEER.

C. Reports will be submitted through ENGINEER in accordance with Section 01 35 10, in duplicate except as noted otherwise in Section 01 33 00, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

D. Furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.

E. Notify Engineer 48 hours prior to expected time for testing operations. Make arrangements with independent firm to perform quality control services. Provide Firm SOQ to OWNER for acceptance and approval prior to work. OWNER may request alternate testing firm at any time during project work as deemed solely necessary by OWNER at no additional cost to OWNER.

F. Retesting required because of non-conformance to specified requirements shall be performed under the direction of ENGINEER. Payment for retesting will be borne by CONTRACTOR.

1.7 MANUFACTURERS' FIELD SERVICES AND REPORTS

A. When specified in individual specification Sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment as applicable, and to initiate instructions when necessary.

B. Individuals to report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

C. Submit report in duplicate within 30 days of observation to ENGINEER for review.

END OF SECTION

SUPPLEMENTAL SPECIFICATION
SECTION 01 45 00
QUALITY CONTROL

This specification changes a portion of Section 01 45 00 of the Manual of Standard Specifications, 2017 Edition. All other provisions of the Section remain in full force and effect.

Add the following Article to Part 1.

1.7 QUALITY CONTROL PROGRAM

A. **Quality Control Program**: Provide a quality control program which includes procedures and organization so equipment, workmanship, fabrication, construction, operations, and inspections comply with the Contract Documents.

B. **Quality Control Program Manager Qualifications**:

1. Not CONTRACTOR's work or site superintendent.
2. Quality control experience with projects of similar type and magnitude.
3. Authorized as CONTRACTOR's representative for all quality control and quality assurance matters.

C. **Quality Control Program Manager Responsibilities**:

1. Manage and supervise quality control plan and quality control surveillance personnel.
2. Verify that testing procedures comply with contract requirements.
3. Verify that facilities and testing equipment are available and comply with testing standards.
4. Check test instrument calibration data against certified standards.
5. Verify that recording forms, including all the documentation requirements, have been prepared.
6. Prepare copies of each test result with all necessary data recorded and with documentation and computations compiled.
7. Provide more testing, if, in ENGINEER's opinion, work is not being adequately controlled.
8. Immediately report any non-compliance of materials and mixes to ENGINEER and CONTRACTOR.
9. When an out-of-tolerance condition exists, perform additional control testing until tolerance is attained.
10. Correlate CONTRACTOR's assurance testing program (Section 01 43 00) with ENGINEER's acceptance testing program (Section 01 35 10).

END OF SECTION

SECTION 01 50 10
SITE ACCESS AND STORAGE

PART 1 - GENERAL

1.1 REFERENCES

A. U.S. Dept. of Transportation, Federal Highway Administration (FHWA) standards.

MUTCD	Manual of Uniform Traffic Control Devices

B. U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA) standards.

Subpart G, Part 1926	Safety and Health Standards for Construction

1.2 SUBMITTALS

A. Provide design and engineering calculations for custom temporary bridges or steel plates to be employed.

B. Submit hazardous materials storage plan.

C. Submit the EPA issued number for wastes generated at the site.

1.3 ROADWAY AND TRAFFIC LIMITATIONS

A. Investigate the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the Work. Comply with the provisions specified in the Traffic Management Plan. Accept responsibility to construct and maintain any haul roads required for construction operations.

B. Maintain a maximum speed limit of 25 mph while on the Project Site.

C. Confine all vehicles to the designated construction area. Cross-country travel is prohibited.

1.4 TEMPORARY CROSSINGS

A. General: Provide continuous, unobstructed, safe, and adequate pedestrian and vehicular access to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, and hospitals. Provide safe and adequate public transportation stops and pedestrian crossings at intervals not exceeding 300 fee. Cooperate with parties involved in the delivery of mail and removal of trash and garbage to maintain existing schedules for such services. Maintain vehicular access to residential driveways to the property line except when necessary construction precludes such access for reasonable periods of time.

B. Temporary Bridges: Wherever necessary, provide suitable temporary bridges or steel plates over unfilled excavations, except where written consent of the individuals or authorities

concerned to omit such temporary bridges or steel plates has been secured. Any such obtained written consent shall be delivered to Engineer prior to excavation. Maintain all such bridges or steel plates in service until access is provided across the backfilled excavation. Temporary bridges or steel plates for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case. Adopt designs furnished by said authority for such bridges or steel plates, or submit designs to said authority for approval, as may be required. New designs shall be stamped and signed by a professional engineer, licensed to practice in the State which the work is taking place.

C. Street Use: Nothing herein shall be construed to entitle Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work hereunder. Conduct operations so as not to interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleyways, or parking areas. No street shall be closed to the public without first obtaining permission of Engineer and proper governmental authority. Where excavation is being performed in primary streets or highways, maintain one lane in each direction open to traffic at all times unless otherwise indicated. Provide toe boards to retain excavated material if required by Engineer or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the Work shall be kept accessible to fire-fighting equipment at all times. Temporary provisions shall be made to assure the use of sidewalks and the proper functioning of all gutters, storm drain inlets, and other drainage facilities.

D. Traffic Control: For the protection of traffic in public or private streets and ways, provide, place, and maintain all necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of the MUTCD, Part VI - Traffic Controls for Street and Highway Construction and Maintenance Operations."

E. Take all necessary precautions for the protection of the Work and the safety of the public. All barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. Station such guards or flaggers and conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. All signs, signals, and barricades shall conform to OSHA Safety and Health Standards for Construction.

F. Temporary Street Closure: If closure of any street is required during construction, apply in writing to the authority having jurisdiction at least 30 days in advance of the required closure for signage and detour requirements.

G. Temporary Driveway Closure: Notify property owner or occupant (if not owner-occupied) of the closure of the driveways to be closed more than one eight-hour work day at least three working days prior to the closure. Minimize the inconvenience and minimize the time period that the driveways will be closed. Fully explain to the owner/occupant how long the work will take and when closure is to start.

1.5 WORK AND STORAGE AREA

A. Owner will designate as indicated in the Contract Documents, and arrange for the Contractor's use, a portion of the property [Specify location of Contractor storage/work site] fo

r use during the term of the Contract as a storage and shop area for construction operations on the Work. Provide a plot plan of intended storage/work area use to Engineer.

B. Make independent arrangements for any necessary off-site storage or shop areas necessary for the proper execution of the Work.

C. Lands to be furnished by Owner for construction operation and other purposes are indicated. Should it be necessary to use any additional land for staging or for other purposes during the construction of the Work, independently arrange for the use of such lands and pay any required rental or use fees. Unless otherwise shown, specified, or agreed, all sites shall be returned to their original condition or better upon completion of the Work.

D. Nothing herein shall imply granting an exclusive use of roadways or public and/or private land employed to perform the Work.

E. Temporary Storage Buildings and Enclosures
   1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials to be stored therein.
   2. Arrange and partition to provide security of contents and ready access for inspection and inventory.

F. Construct and use a separate storage area with adequate spill containment for hazardous materials used in constructing the Work.
   1. For the purpose of this paragraph, hazardous materials to be stored in the separate area are all products labeled with any of the following terms: Warning, Caution, Poisonous, Toxic, flammable, Corrosive, Reactive, or Explosive. In addition, whether or not so labeled, the following materials shall be stored in the separate area: diesel fuel, gasoline, new and used motor oil, hydraulic fluid, cement, paints and paint thinners, two-part epoxy coatings, sealants, asphaltic products, glues, solvents, wood preservatives, sand blast materials, and spill absorbent.
   2. Hazardous materials shall be stored in groupings according to the Material Safety Data Sheets.
   3. Develop and submit to Engineer a plan for storing and disposing of the materials above.
   4. The separate storage area shall meet the requirements of authorities having jurisdiction over the storage of hazardous materials.
   5. Hazardous materials which are delivered in containers, shall be stored in the original containers until use. Hazardous materials which are delivered in bulk, shall be stored in containers which meet the requirements of authorities having jurisdiction.
   6. Obtain and submit to Engineer a single EPA number for wastes generated at the site.
   7. The separate storage area shall be inspected by the proper authorities prior to construction of the area, upon completion of construction of the area, and upon cleanup and removal of the area.

G. In the event machinery and equipment need servicing on site, be responsible to clean environmentally hazardous materials from the site immediately.

1.6 PARKING

A. Employees shall park in areas indicated **or** as directed by Engineer.

B. Traffic and parking areas shall be maintained in a sound condition, free of excavated material, construction equipment, mud, and construction materials. Repair breaks, potholes, low areas, which collect standing water, and other deficiencies.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SUPPLEMENTAL SPECIFICATION

SECTION 01 71 23.16
CONSTRUCTION SURVEYING

This specification changes a portion of APWA Standard Specification Section 01 71 23. All other provisions of the Section remain in full force and effect.

Add Section 1.4 and 1.5 as follows:

1.4 OWNER SUPPLIED SURVEYING

A. Survey benchmarks for the project have been provided by the ENGINEER via Apex Land Surveyors, Inc. Contact Gary Wier at 801-302-3343 (cell 801-372-8558).

1.5 CONTRACTOR SUPPLIED SURVEYING

A. All construction surveying required for this project shall be supplied by the CONTRACTOR. The Contractor shall arrange a survey conference prior to beginning construction so that the City, Property Owner, and Contractor's surveyors can verify northing/eastings and elevations of at least two control points prior to beginning construction. Any conflicts or discrepancies shall be resolved prior to beginning construction. The Owner may verify survey elevations periodically during construction at their discretion.
   1. Project coordinates are based on the Utah State Plane coordinate system, NAD 1983, Utah Central Zone, US Survey feet. To match the property owner's local coordinate system (used for proposed development design), points were translated on the E. ¼ Corner of Section 18 and rotated 0°00'14" right. The average correction scale factor (CSF) used was 1.000279.
   2. The vertical datum was established using the State of Utah (TURN) GPS VRS Network. The property owner's developer has been surveying with a historic Salt Lake County datum that is 0.4 feet lower than the State of Utah GPS VRS Network. It will be critical that the contractor's surveyor rely only on the benchmarks provided by Apex Land Surveyors in its construction staking. If additional control points or benchmarks are needed for construction purposes (due to removal, disturbance, or proximity concerns), the contractor will be required to coordinate with Apex Land Surveyors to provide additional control points or benchmarks.

END OF SECTION

SECTION 01 74 19
DISPOSAL OF WATER

PART 1 - GENERAL

1.1 SUMMARY

A. Prepare a detailed listing of all discharges and overflows that will occur during the disinfection procedure.

1.2 REFERENCES

A. American Water Works Association (AWWA) standards, latest edition.

AWWA C651	Disinfection Water Mains
AWWA C652	Disinfection of Water Storage Facilities

1.3 SUBMITTALS

A. Submit a listing of every significant discharge from a drain valve, pump well, overflow, drain piping, and from all related appurtenances. "Significant discharge" is defined as a volume that is greater than that required to exercise or fill piping with chlorinated water and briefly flush. The listing shall be utilized as input for the Construction Progress Schedule to identify the volume and duration for every discharge that must be accounted for. Very minor discharges for air-release piping or drains that are exercised briefly to ensure disinfection do not need to be identified on the Construction Progress Schedule for dechlorination or discharge.

B. Include the proposed method and equipment for dechlorination, including type of agent; temporary feed pumps, and appurtenant feed equipment.

C. Final Report: Submit to Engineer a final report of each significant discharge, its locations, dates sampled for effectiveness of dechlorination, and the test results.

PART 2 - PRODUCTS

2.1 MATERIALS FOR DECHLORINATION

A. Where dechlorination of water released back to the environment is required, use a sodium bisulfate or equivalent dechlorinator. Sodium bisulfite, if used, shall be applied at a ratio of at least 1.47 parts per every part of chlorine to be removed. This is to remove all of the free active chlorine. Since the reaction produces a byproduct of hydrochloric acid, it will also tend to lower the pH of the water and remove calcium carbonate from the water. If the pH drops below 6.0, add calcium carbonate back into the water during the dechlorination process to restore the pH to an acceptable level of at least 6.0.

B. The process of dechlorination consists of utilizing a chemical metering pump to inject a 44 percent (or less) solution of sodium bisulfite into a temporary discharge pipe with a static mixer and after a few seconds (plus or minus three) withdrawing sample for a chlorine residual analyzer. Based on the results, the analyzer shall send a signal to adjust the chemical feed rate.

PART 3 - EXECUTION

3.1 MAJOR DISCHARGES, PUMP WELLS, OVERFLOWS

A. General: List each drain valve, pump well, and overflow, along with proposed volume and duration of discharge during the disinfection procedure. Locations requiring dechlorination shall be indicated. Refer to Drawings to obtain detailed information on size, location, and layout of facilities and access conditions. Review the site of each proposed discharge for the conditions at the proposed discharge.

END OF SECTION

SUPPLEMENTAL SPECIFICATION

SECTION 01 76 00
PROTECTION AND RESTORATION OF EXISTING FACILITIES

PART 1 GENERAL

1.1 REQUIREMENTS INCLUDED

A. This section is intended to include requirements associated with protection and restoration of existing facilities such as underground facilities and surface improvements.

1.2 NOTIFICATION OF UTILITIES

A. Utilities are to be contacted by CONTRACTOR prior to any excavation activities requesting locations on underground utilities.

1.3 INTERRUPTION TO UTILITIES

A. Any underground facilities located by utilities or indicated in Contract Documents shall be treated according to paragraph 4.3.A of General Conditions.

B. Any underground facilities not located by utilities and not indicated in Contract Documents shall be treated according to paragraph 4.3.B of General Conditions.

C. Exact locations and depths of all underground utilities shall be verified, by uncovering, prior to commencing any Work activities. When such exploratory excavations show the underground utility locations as indicated in Contract Documents to be in error, the CONTRACTOR shall so notify the ENGINEER in writing.

D. Where utilities are to be relocated, CONTRACTOR shall make proper application and notify ENGINEER of specified time and conditions of necessitated Work.

E. All restorations made to utilities shall be inspected and approved by an authorized representative of the utility before being concealed by backfill or other Work.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Contract closeout, including final cleaning, preparation, and submittal of closeout documents, warranties and bonds, and final completion certification.

B. Closeout submittals and submittal forms in both hard copy and electronic format.

1.2 RELATED SECTIONS

A. Section 01 45 00 – Quality Control.

B. Section 01 78 39 – Project Record Documents

1.3 SUBMITTALS

A. Closeout Documents: Submit the following closeout documents prior to making a written request for Final Completion.
   1. Project record drawings and documents per Section 01 78 39 – Project Record Documents.
   2. Shop drawings.
   3. Keys and keying schedule.
   4. Post construction survey record documents, where required.
   5. Quality Control reports per Section 01 45 00 – Quality Control.
   6. Final Operation and Maintenance Manuals.
   7. Maintenance stock items; spare parts and special tools.
   8. Written warranties and bonds where required.
   9. Bonds for roofing or maintenance, if indicated.
   10. Access Badges and Parking Permits.
   11. Release of liens or release of claims forms submitted by all subcontractors and suppliers, if requested by Owner

B. Evidence of Compliance With Inspections and Other Requirements of Governing Authorities: Submit the following:
   1. Special Inspection Reports.
   2. Certificate of Occupancy, if applicable.
   3. Release from each affected property owner or agency indicating final acceptance.

C. Operation and Maintenance Manuals
   1. One percent of the contract price will be withheld from any monies due as progress payments, if at the 75 percent construction completion point, the approved *Operations and Maintenance Manual* complying with Section 01 33 00- Contractor Submittals has not been submitted. The aforementioned amount will be withheld by Owner as the agreed, estimated value of the approved *Operations and Maintenance Manuals.* Any such retention of money for failure to submit the approved *Operations*

and Maintenance Manuals on or before the 75 percent construction completion point shall be in addition to the retention of any payments due under General Conditions of the Contract.

D. Final Change Order: A final Change Order shall be submitted and processed if required. Final payment and close-out procedures shall comply with requirements of the Contract Documents.

1.4 CLOSEOUT TIMETABLE

A. Establish dates for equipment testing, acceptance periods, and on-site instructional periods as required under the Contract Documents. Such dates shall be established not less than one week prior to beginning any of the required activities, to allow Owner, Engineer, and their authorized representatives sufficient time to schedule attendance at such activities.

1.5 COMPLETION PROCEDURES

A. When Contractor believes Substantial Completion has been achieved, request in writing to Engineer that Substantial Completion be recognized as having been achieved and request that Owner issue a Certificate of Substantial Completion. Prior to making such request, the following must be complete:
   1. Work necessary for the safe, proper, and complete use or operation of the facility as intended.
   2. Punch list of items remaining to be completed, for submission with the request for issuance of a Certificate of Substantial Completion.
   3. Submit and receive acceptance of accurate record drawings for all work completed to date.
   4. Submit and receive acceptance of all specified warranties, bonds, guarantees and operation and *Operations and Maintenance Manuals*.
   5. Complete all required vendor training, testing, and where required, start-up.
   6. Deliver all required spare parts, maintenance stock items, and special tools.
   7. Complete equipment and communications system testing successfully.

B. Upon receipt of the request, Engineer and designated representatives will review the request, the Work, and the above requirements to determine whether Substantial Completion has been achieved. If this review fails to support Substantial Completion, Engineer will notify Contractor in writing citing the reasons for rejection. If Engineer determines that Substantial Completion has been achieved, the following procedures will be followed:
   1. Engineer, his/her representative, and user representatives will review the Work and the punch list to assure all deficiencies are noted on a final punch list.
   2. Engineer will schedule and conduct a pre-final walk-through of the facility with representatives of Owner, Engineer, Contractor, and others, for the purpose of formally reviewing the Work, the final punch list, and the readiness of the Work for use. A copy of the final punch list will be furnished to all participants and any additional items noted during the walk-through will be added to the list.
   3. Upon completion of the pre-final walk-through, Engineer will prepare a request to Owner establishing the date for Substantial Completion as date of the walk-through, provided the walk-through has verified that the Work is in fact ready for use and

occupancy by Owner for its intended purpose. Upon approval of this request by Owner, the facility will be considered Substantially Complete.

C. Final Completion will be deemed to have occurred when Work is completed including the following:
   1. All final punch list items have been corrected, signed off by Contractor and Engineer, and demonstrated to Owner during a final walk-through.
   2. All updates to record drawings, and *Operations and Maintenance Manuals* have been made.
   3. Demobilization and site cleanup are complete.
   4. Facilities and/or equipment have been properly demonstrated to be functioning as required.
   5. Owner has received releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.
   6. New permanent cylinders and key blanks for all locks have been provided to Owner.

D. Certificate of Final Completion
   1. When all items have been completed or corrected, submit written documentation to Engineer that the entire Work is complete in accordance with the Contract Documents and request final inspection.
   2. Upon completion of final inspection by Owner and Engineer, Owner will either prepare a Certificate of Final Completion of the entire Work or advise all parties of Work not satisfactorily complete. If necessary, repair or replacement and inspection procedures will be repeated until Owner accepts the Work and issues a Certificate of Final Completion.

E. Partial Utilization may be desired at Owner's option, as described in the General Conditions. If Partial Utilization is requested, the same procedure for completion of that portion of the Work as indicated in paragraphs A and B above, will be used.

1.6 CLOSE-OUT PROCEDURE

A. Engineer and Contractor shall meet and resolve all outstanding issues including, but not limited to:
   1. Claims and adjustments for time or costs
   2. Outstanding, unused allowances
   3. Procedures for handling warranty issues.

B. A Final Change Order shall be processed if required. Final payment and close out procedures shall comply with all requirements of the Contract Documents.

1.7 MAINTENANCE AND GUARANTEE

A. Comply with the maintenance and guarantee requirements contained in General Conditions of the Contract.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless Contractor has obtained a statement in writing from the

affected private authority or public agency releasing Owner from further responsibility in connection with such repair or resurfacing. Submit such release(s) to Engineer.

C. Make all repairs and replacements promptly upon receipt of written order from the Owner. If the Contractor fails to make such repairs or replacements promptly, the Owner reserves the right to do the Work and the Contractor and his surety shall be liable to the Owner for the cost thereof.

1.8 BOND

A. Furnish a Performance Bond as required by General Conditions of the Contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. Certificate of Final Completion of the Work by Owner will be withheld until requirements for final cleanup of the Project Site are complete as follows:
   1. Perform final cleaning prior to inspections for final acceptance.
   2. Employ skilled workers who are experienced in cleaning operations.
   3. Use cleaning materials that are recommended by manufacturers of surfaces to be cleaned.
   4. Avoid scratching, discoloring, and otherwise damaging surfaces being cleaned.
   5. Clean roofs.
   6. Broom clean and power wash exterior paved surfaces and rake clean other surfaces of sitework. Police yards and grounds to keep clean.
   7. Remove dust, cobwebs, and traces of insects and dirt.
   8. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, fixtures, and Equipment.
   9. Remove nonpermanent protection and labels.
   10. Polish finish hardware.
   11. Wash and shine mirrors.
   12. Polish glossy surfaces to clear shine.
   13. Clean ducts, blowers, and coils when units were operated without filters during construction.
   14. Clean light fixtures and replace burned-out or dim lamps.

3.2 WASTE DISPOSAL

A. Remove temporary structures and facilities and arrange for and dispose of surplus materials, waste products, and debris as follows:
   1. Prior to making disposal on private property, obtain written permission from owner of such private property.
   2. Do not fill ditches, washes, or drainage ways which may create drainage problems.
   3. Do not create unsightly or unsanitary nuisances during disposal operations.

4. Maintain disposal site in safe condition and good appearance.
5. Complete leveling and clean-up prior to final acceptance of the Work.

3.3 TOUCH-UP AND REPAIR

A. Touch up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for final acceptance.

B. Refinish or replace entire surfaces that cannot be touched-up or repaired satisfactorily.

3.4 DEMOBILIZATION

A. Demobilization shall include moving plant and equipment, field trailers, construction materials, debris, and so forth from the Site as well as performing final cleanup.
1. Disturbed areas shall be restored to their original state or better.
2. Permanent improvements damaged during construction operations shall be repaired or replaced at no additional cost to Owner.
3. Remove all equipment, materials, waste, and debris from the site and restore site to original condition upon completion of construction.
4. The work area shall be restored to its original or better condition and shall be inspected and approved by Engineer.

END OF SECTION

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SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Maintain at the Site for Owner, one record copy of the Drawings, Specifications, Operation and Maintenance manuals, coordination drawings, and Shop Drawings that are clearly marked with a red pen to indicate all changes and or revisions resulting from, but not limited to, the following:
   1. Actual Project as constructed.
   2. Addenda.
   3. Change Orders and other modifications.
   4. Engineer's instructions.
   5. Field revisions.
   6. Requests for Information (RFI).
   7. All other changes.

B. Give special attention to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Contract Drawings.

C. Record drawings shall be supplemented by any detailed sketches as necessary or directed to fully indicate the Work, as actually constructed.

D. Section Includes:
   1. Maintenance of Documents and Samples
   2. Marking Devices.
   3. Recording.
   4. Close-out Submittal Delivery.

1.2 RELATED SECTIONS

A. 01 77 00 - Project Closeout

1.3 MAINTENANCE OF DOCUMENTS AND SAMPLES

B. Store documents and samples in field office apart from documents used for construction.

C. Provide files and racks for storage of documents.

D. Provide locked cabinet or secure storage space for storage of samples.

E. Maintain documents in clean, dry, legible condition and in good order. Keep record documents separate from those used for construction.

F. Make documents and samples available at all times for reference by Engineer and Owner.

G. In the case of those drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the record drawings shall be updated by indicating those portions which are superseded by change order drawings or final shop drawings, and by including appropriate reference information describing the change orders by number and the shop drawings by manufacturer, drawing, and revision numbers.

H. During progress meetings, record documents may be reviewed to ascertain that changes have been recorded.

I. Updated Drawings, when provided by Engineer, will be substituted for the hand markups provided Contractor prints the applicable Drawings and inserts them into the record set each month.

J. Copies of the record drawings will be audited regularly by Engineer after the month in which the Notice to Proceed is given as well as on completion of the Work. Failure to properly maintain record drawings in a up-to-date condition may result in the withholding of payments due at the sole discretion of Owner.

1.4 MARKING DEVICES

A. Use a red color pen for recording all information to all documents defined herein.

1.5 RECORDING

A. Label each document "CONFORMING TO CONSTRUCTION RECORD" in neat large red printed letters.

B. Record information concurrently with construction progress, at the time the material or equipment is installed. Do not conceal any work until required information is recorded.

C. Drawings shall be legibly marked to record actual construction per the following:
   1. Record actual depths of various elements of foundations in relation to finish first floor datum.
   2. Record actual as-built depths, horizontal and vertical location, (at every direction change and a maximum of 100 feet intervals on straight runs), of underground pipes, duct banks, and other buried utilities. Reference horizontal location to Project coordinate system and vertical elevations to Project datum.
   3. Identify and record specific details of pipe connections, location of existing buried features and utilities located during excavation, and the final locations of piping, equipment electrical conduits, manholes, and pull boxes (horizontal coordinates and vertical elevation).
   4. Identify and record location of spare conduits including beginning, ending, and routing through pull boxes, and manholes. Record spare conductors, including number and size, within spare conduits, and filled conduits.
   5. Record actual schedules, lists, layout drawings, and wiring diagrams.
   6. Record field changes of dimension and detail.
   7. Record changes made by instruction from Engineer or by Change Order.
   8. Record details not on original Contract Drawings.

D. Specifications and Addenda shall be legibly marked to record:
   1. Manufacturer, trade name, catalog number, and supplier for each product and item of equipment actually installed.
   2. Changes made by instruction from Engineer or by Change Order.

E. Record potholing data and installation of marker balls.

F. All surveying for record documents shall be performed by a licensed surveyor.

1.6 CLOSEOUT SUBMITTALS

A. At Contract closeout, deliver complete record documents to Engineer as required in Section 01 77 00 - Project Closeout. Final payment will not be acted upon until the record drawings have been prepared and delivered to Engineer.

B. The information submitted will be incorporated by Engineer into final drawings to be provided to Owner. Be responsible for the accuracy of submitted construction information. Engineer will assume that the information provided by Contractor is correct and faithfully represents actual construction.

C. This submittal shall include the record paper set along with 2 CDs or 2 USB drives. Each CD or USB shall contain .pdf files and .dwg files of each drawing.

D. Prepare submittal with transmittal letter containing:
   1. Date.
   2. Project title and number.
   3. Contractor's name and address.
   4. Title and number of each record as-built document.
   5. Signature of Contractor's authorized representative and a statement that certifies that the record documents are accurate and reflect what was actually installed during construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 81 10
SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

A. This section Includes seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment and piping.
   2. Seismic design of tanks and anchorage of tanks.
   3. Other structures or items as specified or indicated on the Drawings.

1.2 REFERENCES

A. American Society of Civil Engineers (ASCE) documents as follows:

ASCE 7	Minimum Design Loads for Buildings and Other Structures, 2016 Edition

1.3 SUBMITTALS

A. Shop Drawings and Calculations: Submit shop drawings and structural calculations in accordance with Section 01 33 20 - Submittal Procedures. All drawings and calculations shall be signed and sealed by a licensed Civil or Structural engineer as required below under "Qualifications."

B. ICC-ES reports for concrete anchors.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. Licensed Professionals: Design of items required by this Section and other items not specifically shown in the Contract Documents shall be performed by a Civil or Structural Engineer licensed to practice in the state of Utah.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Design Criteria: Design in accordance with the requirements of the International Building Code and ASCE 7.
   1. Seismic acceleration variables to be used in design are as follows:
      a. The design 5 percent damped spectral response acceleration at short periods, S_{DS} = 0.9g.
      b. The design 5 percent damped spectral response acceleration at a period of 1 second, S_{D1} = 0.41g.
      c. The mapped maximum considered earthquake, 5 percent damped, spectral response acceleration at short periods, S_S = 1.12g.

d. The mapped maximum considered earthquake, 5 percent damped, spectral response acceleration at a period of 1 second, S_1 = 0.41g.
e. Site coefficients:
   1) Fa = 1.2
   2) Fv = 1.5
f. Soil Site Class = C.
g. Seismic Design Category = D.

2. Seismic Importance Factor for Anchorage of Mechanical and Electrical Equipment: 1.50.
3. Seismic Importance Factor for the Design of Tanks and the Anchorage of Tanks: 1.50.
4. Do not use friction to resist sliding due to seismic forces.
5. Use only headed anchor bolts, adhesive anchors, or welded studs for anchors resisting seismic forces. Embedded anchor bolts used to resist seismic forces shall have a standard hex bolt head.
   a. Adhesive anchors must have current ICC-ES reports showing that the anchors meet IBC requirements when installed in cracked substrates.
   b. Do not use other types of anchors unless indicated on the Drawings or approved in writing by Engineer.
   c. Seismic forces must be resisted by direct bearing on the fasteners used to resist seismic forces. Do not use connections which use friction to resist seismic forces.

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 01 81 11
WIND DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

A. This section Includes design criteria for the following when exposed to wind forces:
   1. Anchorage of mechanical and electrical equipment and piping.
   2. Design of tanks and anchorage of tanks.
   3. Other structures or items as specified or indicated on the Drawings.

1.2 REFERENCES

A. American Society of Civil Engineers (ASCE) documents as follows:

ASCE 7	Minimum Design Loads for Buildings and Other Structures, 2016 Edition

1.3 SUBMITTALS

A. Shop Drawings and Calculations: Submit shop drawings and structural calculations in accordance with Section 01 33 20 - Submittal Procedures. All drawings and calculations shall be signed and sealed by a licensed Civil or Structural engineer as required below under "Qualifications."

B. ICC-ES reports for concrete anchors.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. Licensed Professionals: Design of items not specifically shown in the Contract Documents shall be performed by a professional Civil or Structural Engineer licensed to practice in the state of Utah.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Design Criteria: Design in accordance with the requirements of the International Building Code and ASCE 7.
   1. Basic Wind Speed: 115 miles per hour
   2. Risk Category: IV
   3. Exposure: C
   4. Topographic Factor: As calculated per ASCE 7.
   5. Use only headed anchor bolts, adhesive anchors, or welded studs for anchors resisting wind forces. Embedded anchor bolts used to resist seismic forces shall have a standard hex bolt head.

a. Adhesive anchors must have current ICC-ES reports showing that the anchors meet IBC requirements.
b. Do not use other types of anchors unless indicated on the Drawings or approved in writing by the Engineer.
c. Wind forces must be resisted by direct bearing on the fasteners used to resist wind forces.

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01 91 14
EQUIPMENT TESTING AND STARTUP

PART 1 - GENERAL

1.1 SUMMARY

A. Equipment testing and startup are required for satisfactory completion of the Contract and, therefore, shall be completed within the Contract Time.

B. Section Includes:
1. Startup Plan
2. Certificates of Installation and Startup Services
3. Record Keeping
4. Factory Performance Testing
5. Field Performance Testing
6. Special Tools and Lubricating Equipment
7. Startup
8. Lubrication

1.2 DEFINITIONS

A. Component Test and Check Out is the verification that each component of the Work is in compliance with the Contract Documents and is ready to perform its intended function.

B. Subsystem Test and Startup is the verification that a discrete group of related components is functioning as intended within itself and is ready to perform its intended function in the overall system.

C. System End-To-End Test and Startup is the operation and verification that all related components and subsystems are functioning as intended and are ready for final commissioning and operation.

D. Commissioning is placing a complete system or project into service.

1.3 SUBMITTALS

A. Submit startup plan a minimum of 90 days prior to beginning startup procedures.
1. Submit and have an approved detailed and coordinated startup plan for each piece of equipment, subsystem, and the entire system.
2. The Plan and Progress Schedule shall include the following activities:
   a. Manufacturer's services and startup dates.
   b. Submittal dates for certificates of installation and startup services.
   c. Operator training dates for each phase.
   d. Submittal of operation and Maintenance manuals.
   e. Functional test dates.
   f. Operational performance test dates.
   g. Post operational performance test dates.

3. The plan shall include test logs for each item of equipment and each system. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
4. Provide summary of shutdown requirements for existing systems which are necessary to complete startup of new equipment and systems.
5. Revise and update startup plan based upon review comments, actual progress, and to accommodate changes in the sequence of activities.
6. System startup plan shall be coordinated with Owner's operations staff and Engineer to ensure operational intent is achieved.

B. Submit certified copies of factory test reports.

C. Startup Records:
1. Maintain and submit the following records generated during each phase of startup defined above in article titled Definitions:
   a. Daily logs of equipment testing identifying all tests conducted and outcome.
   b. Logs of time spent by manufacturer's representatives performing services on the Site.
   c. Equipment lubrication records.
   d. Electrical phase, voltage, and amperage measurements.
   e. Insulation resistance measurements.
   f. Data sheets of control loop testing, including testing and calibration of instrumentation devices and setpoints.
   g. Detailed, point-by-point, sensor/controlled device/field device to PLC to HMI screen witnessed validation checklist for all telemetry and SCADA tags utilizing a fully functional network or other telemetry system available at the Owner's plant or other Owner-designated facility.

D. Certificates of Installation and Startup Services
1. At completion of installation and functional testing, furnish Certificate of Installation and Startup Services, signed by manufacturer, Contractor, and Owner's authorized representatives. Each form shall be completed for individual pieces of equipment in a timely manner as construction proceeds.
2. Submit 3 original copies of each completed form to Engineer.
3. Certify that:
   a. Equipment has been properly installed, adjusted, aligned, and lubricated.
   b. Equipment is free of any stresses imposed by connecting piping or anchor bolts.
   c. Equipment is suitable for satisfactory full-time operation under full load conditions.
   d. Equipment operates within the allowable limits for vibration.
   e. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
   f. Control logic for startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly functioning.
   g. For remotely monitored and controlled devices, functionality shall not be certified until indication and controls are tested using local and remote SCADA based indications.

4. Sign and submit for acceptance the forms and field manufacturer reports along with the manufacturer's representative prior to proceeding with System End-To-End Test and Startup.

PART 2 - PRODUCTS

2.1 FACTORY PERFORMANCE TESTING

A. Test equipment for proper performance at the point of manufacture or assembly.

B. Demonstrate equipment meets specified performance requirements.

C. Submit certified copies of factory test results to Engineer for review and approval.

D. Do not ship equipment until certified copies of factory test reports have been approved by Engineer. Written acceptance of factory test results does not constitute final acceptance.

2.2 FIELD PERFORMANCE TESTING

A. Furnish the services of an experienced and authorized representative of the manufacturer of each item of equipment indicated in the equipment schedules (excluding manually-operated valves smaller than 24 inches in size, injectors, tanks, batch-type disc meters, and rotameters, and any other minor items of equipment specifically exempted by Engineer in writing), who shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, arrange to have the manufacturer's representative revisit the job site as often as necessary until any and all trouble is corrected and the equipment installation and operation are satisfactory to Engineer.

B. Require that each manufacturer's representative furnish to Engineer a written report addressed to Owner certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts, and has been operated satisfactorily under full-load conditions.

C. Be responsible for scheduling all operations testing, including the End-To-End Testing performed with other contractors associated with the RTU controls and communications. Be advised that Engineer and Owner's operating personnel will witness operations testing and that the manufacturer's representative shall be required to instruct Owner's operating personnel in correct operation and maintenance procedures. Such instruction shall be scheduled at a time arranged with Owner at least two weeks in advance and shall be performed while the respective manufacturer's equipment is fully operational. On-site instruction shall be given by qualified persons who have been made familiar in advance with the equipment and systems. Prior to scheduling any operations testing, furnish *Operations and Maintenance Manuals* required by the Contract Documents.

D. Notify the Engineer at least three Work Days in advance of each equipment test.

E. Furnish all personnel, power, water, chemicals, fuel, oil, grease, and all other necessary equipment, facilities, and services required for conducting the tests.

2.3 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

A. Furnish, according to manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics, including valve keys and stems.

B. Time of Delivery: Submit special tools and lubricating equipment to Engineer when unit is placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.

C. Quality: Provide tools and lubricating equipment of a quality comparable to what the equipment manufacturer uses.

PART 3 - EXECUTION

3.1 STARTUP

A. Startup is a highly complex operation requiring the combined technical expertise of Contractor, manufacturers, subcontractors, Engineer, and Owner. Coordinate all parties necessary for the successful plant startup.

B. Be responsible for the complete test, check out, startup, and commissioning of all elements of the Project. Verify these activities through daily inspection reports, test records, on-site vendor certifications, and by other appropriate means. The test and startup requirements specified in this Section are complementary to those indicated elsewhere in the Contract Documents.

C. Conduct all test, check out, and startup requirements indicated in the Contract Documents and provide documentation of same to Engineer prior to commissioning. Where vendor on-site inspections are required prior to or during startup, require vendor to provide a written statement that the installation and check out is complete and proper and that the item(s) are ready for startup and/or commissioning.

D. It is not the intent of Engineer to instruct Contractor in the startup; however, Engineer will be available prior to and during startup to provide technical support to the Contractor.

E. Perform a 7-day functional test of the facility. The intent of the 7-day functional test is to demonstrate that each and all of the components and systems that have been constructed and installed function individually and collectively in accordance with the Contract Documents. The 7-day functional test shall demonstrate the ability of the entire facility to operate continuously for 7-days without failure. In the event of a failure of any of the facility components, the cause of the failure shall be determined and repaired, and the 7-day functional test shall be restarted from time zero.
    1. Prepare a plan that details the procedures of the 7-day functional test. The plan shall indicate start and stop times of each of the pumping units, capacity to be pumped during each period, the number of pumps to be operated during each period, auxiliary systems that will be needed during each period, and starting and stopping sequences

of each facility subsystem to be operated during each period. Provide adequate detail in the plan to determine personnel needed to operate and monitor all components to be evaluated during each period but the increments of the schedule shall not be greater than 2 hours. In the plan, identify by name all personnel needed to complete the 7-day functional test and identify the shift that each person will work during the test.

2. As part of the plan for the 7-day test, define, subject to Engineer's approval, what will constitute a failing test. At a minimum, a test shall be considered to have failed if any of the following events occur at any time during the 7-day functional test.
   a. Failure of a pumping unit or motor.
   b. Performance of a pumping unit (including pump and motor) outside of its specified acceptable ranges for vibration, noise, temperature, cavitation, efficiency, and capacity.
   c. A failure of any ancillary component or system that cannot be returned to service within 30 minutes of failure.
   d. Three failures of an ancillary component or system regardless of the amount of time it takes to return it to service and regardless of whether or not the failures are due to the same cause.
   e. Three failures of equipment of the same model, regardless of the amount of time it takes to return each to service and regardless of whether or not the failures are due to the same cause.
3. During the performance of the 7-day functional test, it shall not be acceptable to bypass, deactivate, or in any way disable a protective device, alarm, or control to facilitate completion of the test.
4. If variable speed pumps are provided as part of the construction, each pump shall be run under automatic control during the 7-day functional test to verify the ability to operate as required by the Contract Documents provided the communications system is available. If the communication is not available, Engineer will prescribe the method and flow rates at which the 7-day functional test will be performed.
5. Provide adequate staff on Site to operate the facility and make factory personnel available to assist in resolving problems as needed at no additional cost to Owner.
6. Take readings every hour of the 7-day functional test to record equipment operation, operating speeds, flow rates, temperature of equipment components, system pressures, operating voltage, current, power draw of each operating unit, and any problems encountered during the previous hour. Provide readings to Engineer each morning for the previous day's run for evaluation and acceptance of the preceding day as being satisfactorily completed for the 7-day functional test.

F. Furnish operating personnel for the duration of the startup. Additionally, furnish all water, power, chemicals, and other consumables required for the test.

G. Facility startup shall not be commenced until Component Test and Check Out, Subsystem Tests, and System End-To-End Tests, with associated control systems in place and functioning, all have been completed to the satisfaction of Engineer.

H. All defects in materials or workmanship, which appear during this test period, shall be immediately corrected. Time lost for equipment repairs, wiring corrections, control point settings, or other reasons, which actually interrupt the startup may, at the discretion of Engineer, be justifiable cause for extending startup test duration.

I. During startup, furnish the services of authorized representatives of the manufacturers, in addition to those services required under operations testing, as necessary, to correct faulty equipment operation.

J. During startup, keep records of the operations in accordance with the instructions of Engineer.

3.2 LUBRICATION

A. Where lubrication is required for proper operation of equipment, incorporate the necessary provisions in accordance with the manufacturer's requirements. Where possible, make lubrication automated and positive.

B. Upon completion System End-To-End Tests and Startup, a qualified manufacturer's representative shall perform preventive maintenance, such as change break-in lubrication, complying with manufacturer's recommendations.

C. Oil Reservoirs: Where oil is used, provide a reservoir of sufficient capacity to lubricate the unit for a 7-day period.

END OF SECTION

DIVISION 2
EXISTING CONDITIONS

SECTION 02 41 00
DEMOLITION, SALVAGE, AND RECONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall demolish, salvage and reconstruct existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.

1.2 COORDINATION

A. The Contractor shall carefully coordinate the Work in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The Work as indicated is not all inclusive, and the Contractor shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The Contractor shall comply with sequencing requirements in Section 01 14 00 – Work Restrictions.

B. The Contractor shall note that the Drawings used to indicate demolition and reconstruction are based on record drawings of the existing facilities. These record drawings have been reproduced to show existing conditions and to clarify the scope of Work as much as possible. Prior to bidding, the Contractor shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of Work, and the extent of auxiliary utilities. A complete set of record drawings is available for review at the Project site.

C. While demolition and reconstruction are being performed, the Contractor shall provide adequate access for the continued operation and maintenance of equipment and treatment processes. The Contractor shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the Contractor's employees and the Owner's personnel at the plant. The Contractor shall remove such protection when reconstruction activities are complete, or as work progresses, or when directed by the Engineer.

1.3 CONTRACTOR SUBMITTALS

A. Demolition and reconstruction activities and procedures, including operational sequence, shall be submitted to the Engineer for approval. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included.

1.4 DEMOLITION AND ABANDONMENT

A. Existing pavement, concrete, retaining walls, curb and gutter, sidewalks, buildings, yard structures, equipment, piping, valves, ductwork, duct banks, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the Work shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the Contractor.

1.5 SALVAGE

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled and protected on the Site at a location directed by the Engineer. The Contractor shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling.

B. Items to be salvaged include:

Item	Description
Air Valve	Located in the Existing Vault
16” Butterfly Valves	Located in the Existing Vault

1.6 RELOCATION

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be relocated shall be removed without any degradation in condition from that prior to removal. The Contractor shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

B. Items to be relocated include:

Item	Description
Pressure Transmitter	Located in Existing Vault
SCADA Panel, Battery Storage Panel, Junction Panel	Located in Existing Vault

1.7 REHABILITATION

A. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation Work disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.

B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

1.8 DISPOSAL

A. The Contractor shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

A. GENERAL

B. The Contractor shall coordinate demolition and reconstruction Work with the Owner and Engineer. Unless otherwise indicated, the Contractor shall be responsible for the sequence of activities. Work shall be performed in accordance with applicable safety rules and regulations.

C. The Contractor shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.

D. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the Work activities to the extent indicated. If reconstruction beyond the scope indicated is required, the Contractor shall obtain approval from the Engineer prior to commencing.

3.2 PROTECTION OF EXISTING FACILITIES

A. Before beginning any reconstruction, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to reconstruction shall be protected and maintained in accordance with Section 01 76 00 – Protection and Restoration of Existing Facilities. Damaged existing facilities shall be repaired to the previous condition or replaced.

B. Persons shall be afforded safe passages around areas of demolition.

C. Structural elements shall not be overloaded. The Contractor shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of Work performed under this Section. The Contractor shall remove temporary protection when the Work is complete or when so authorized by the Engineer.

D. The Contractor shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment or material.

3.3 DEMOLITION, SALVAGE, AND RELOCATION

A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The Contractor shall verify the scope of the Work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 01 14 00 – Work Restrictions. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:

1. Equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Damage to the existing structure shall be repaired as indicated.
2. Exposed piping including vents, drains, and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2-inches. Resultant openings in the structure shall be repaired as indicated.
3. Electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.
4. Exposed electrical conduits and associated wiring shall be removed. Resultant openings in structures shall be repaired as indicated.
5. Connections to embedded electrical conduits shall be removed a minimum of 2-inches inside the finished surface of the existing structure. Wiring shall be removed and the resulting openings shall be repaired as indicated.
6. Associated instrumentation devices shall be removed.
7. Auxiliary utility support systems shall be removed.
8. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
9. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.
10. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth, which will not interfere with new construction, but not less than 36-inches below existing ground surface or future ground surface, whichever is lower.
11. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 31 23 00 - Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.
12. When existing pipe is removed, the Contractor shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug.
13. When existing piping is removed from existing structures, the Contractor shall fill resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or indicated. In locations where the surface of the grout will be exposed to

view, the grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.

14. Electrical reconstruction shall be conducted by the Contractor in a safe and proper manner to avoid injury from electrical shock to the Owner's and Contractor's personnel. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections, which are energized or could become energized be accessible to Contractor, Owner, or other personnel without suitable protection or warning signs.

B. The Contractor shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during the initial inspection. The Contractor shall inform the Engineer in writing a minimum of 5 Days prior to the functional testing in order for the Owner and Engineer to witness the test. If, in the opinion of the Engineer, the relocated equipment does not function in a satisfactory manner, the Contractor shall make repairs and modifications necessary to restore the equipment to its original operating condition at no additional cost to the Owner.

3.4 ABANDONMENT

A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the Contractor shall remove the abandoned pipe for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inches diameter or greater shall be completely sand-filled prior to closure of the piping ends.

3.5 REHABILITATION

A. Certain areas of existing structures, piping, conduits, and the like will be affected by Work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by its construction activities.

B. Where new rectangular openings are to be installed in concrete or concrete masonry walls or floors, the Contractor shall score the edges of each opening (both sides of wall or floor slab) by saw-cutting clean straight lines to a minimum depth of 1-inch and then chipping out the concrete. Alternately, the sides of the opening (not the corners) may be formed by saw cutting completely through the slab or wall. Saw cuts deeper than 1-inch (or the depth of cover over existing reinforcing steel, whichever is less) shall not be allowed to extend beyond the limits of the opening. Corners shall be made square and true by a combination of core drilling and chipping or grinding. Necessary precautions shall be taken during removal of concrete to prevent debris from falling into or entering adjacent tanks in service or from damaging adjacent equipment or piping. Saw cuts allowed to extend beyond the opening shall be repaired by filling with non-shrink grout. The concrete around any exposed reinforcement steel shall be chipped back and exposed reinforcement steel cut a minimum of 2-inches from the finished face of the new opening and be painted with epoxy paint. The inside face of the new opening shall be grouted with an epoxy cement grout to fill any voids and cover the exposed aggregate and shall be trowel-finished to provide a plumb and square opening.

C. Where new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as indicated or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to provide watertightness around openings so formed. The boxes or cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.

D. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4-inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouted casings shall then be water cured.

E. In locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.

F. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

G. Where existing equipment, piping, and supports, electrical panels and devices, conduits, and associated appurtenances are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Concrete pads, bases associated with equipment, supports, and appurtenances shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2-inches below finished grade and be painted with epoxy paint. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1-1/2 inches, and concrete within the scored lines removed to a depth of 1-1/2 inches (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.

H. Existing reinforcement to remain in place shall be protected, cleaned, and extended into new concrete. Existing reinforcement not to be retained shall be cut-off as follows:

1. Where new concrete joins existing concrete at the removal line, reinforcement shall be cut-off flush with the concrete surface at the removal line.
2. Where the concrete surface at the removal line is the finished surface, the reinforcement shall be cut back 2-inches below the finished concrete surface, the ends painted with epoxy paint and the remaining holes patched with a cement mortar grout.

I. Where existing handrailing is removed, post embedments and anchors shall be removed and post holes shall be filled with non-shrink grout flush to the floor surface. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.

J. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated in accordance with Section 09 90 00 - Protective Coatings and Linings to match the original painting and coating with a compatible system. Surfaces of equipment items that are to be relocated shall be prepared and be coated in accordance with Section 09 90 00 – Protective Coatings and Linings.

3.6 DISPOSAL

A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities, which shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.7 OCCUPANCY AND POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The Contractor shall comply with government regulations pertaining to environmental protection.

B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.8 CLEANING

A. During and upon completion of Work, the Contractor shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by Work in a clean, approved condition.

B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the Engineer or governing authorities, and adjacent areas shall be returned to condition existing prior to start of Work.

END OF SECTION

DIVISION 3
CONCRETE

SECTION 03 11 00
CONCRETE FORMING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish, fabricate, and install concrete formwork, bracing, shoring, supports, and falsework in accordance with Contract Documents.

B. Work shall include installation of form ties, clips, supports and other appurtenances necessary to meet Specifications and produce finished concrete structures.

1.1 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete

1.2 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 317	Standard Tolerances for Concrete Construction and Materials
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Formwork for Concrete

B. National Sanitation Foundation (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects

C. U.S. Department of Commerce, National Institute of Standards and Technology, (NIST) standards, latest editions:

PS 1	Structural Plywood
PS 20	American Softwood Lumber Standard (ASLS)

1.3 SYSTEM DESCRIPTION

A. Be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements specified herein.

B. Design and construct falsework to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework Calculations and Drawings: All falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil or structural engineer, registered in the State of Utah. Always maintain a current copy of the falsework plan or shoring layout on the job site.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Submit detailed drawings of the falsework proposed to be used. Such drawings shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions. Submittals shall include the following:
   1. Form ties and all related accessories, including taper tie plugs, if taper ties are used.
   2. Form gaskets.
   3. Form releasing agent, including NSF certification when applicable.
   4. List of form materials and locations for use.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise expressly accepted by Engineer, all lumber brought on the job site for use as forms, shoring, or bracing shall be new material. All forms shall be smooth surface forms and shall be of the following materials:
   1. Walls: Steel or plywood panel.
   2. Columns: Steel, plywood or fiberglass.
   3. Roof and Floor: Plywood.
   4. All Other Work: Steel panels, plywood or tongue and groove lumber

B. Form materials which may remain or leave residues on or in the concrete that is in contact with potable water shall be classified as acceptable for potable water under NSF 61 within 30 days of application or use.

2.2 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Form ties (general):
      a. Burke Penta-Tie, Burke Company.
      b. Richmond Snap-Tys, Richmond Screw Anchor Company.
      c. Gates Ties, Gates and Sons, Inc.
      d. Engineer approved equal.

2.3 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:
   1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20.
   2. Plywood for concrete formwork shall be new, waterproof, synthetic resin-bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork and shall conform to the requirements of PS 1 for Concrete Forms, Class I, and shall be edge sealed.
   3. Form materials shall be metal, wood, plywood, or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade shown. Metal forms shall be an approved type that will accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

B. Unless otherwise indicated, provide exterior corners in concrete members with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf (minimum). The minimum design load for combined dead and live loads shall be 100 psf.

2.4 FORM TIES

A. Provide form ties with integral waterstops with a plastic cone on both sides of walls, or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming.

B. Form ties for water-retaining structures shall have an integral waterstop that tightly fits the form so that it cannot be moved from the midpoint of the tie. Removable taper ties may be used when approved by Engineer. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.

2.5 FABRICATION

A. Tolerances: The variation from established grade or lines shall not exceed 1/4-inch in 10 feet and there shall be no offsets or visible waviness in the finished surface. All other tolerances shall be within the tolerances of ACI 117.

PART 3 - EXECUTION

3.1 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. Assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the Work and replaced at no increased cost to Owner. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes. Provide sufficient number of forms of each kind to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state and Federal regulations.

B. Install plumb and string lines before concrete placement and maintain during placement. Such lines shall be used by both Contractor and Engineer and shall be in sufficient number and properly installed. During concrete placement, continually monitor plumb and string line form positions and immediately correct deficiencies.

C. Concrete forms shall conform to the shape, lines, and dimensions of members as called for on the Drawings, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

3.2 FORM CONSTRUCTION

A. Construct forms in conformance with ACI 347.

B. All forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Provide suitable and effective means on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the Engineer. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 30 00 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to Engineer.

C. Vertical Surfaces: All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is shown. Not less than 1 inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

D. Construction Joints: Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory affect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

E. Form Ties

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified for finish of concrete surfaces in Section 03 30 00 - Cast-in-Place Concrete. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Do not remove ties in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, provide rubber grommets where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 2 inches back from the formed face or faces of the concrete.
2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, thoroughly clean the hole and roughen for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. Fill the hole completely with nonshrink grout for water bearing and below-grade walls. The hole shall be completely filled with nonshrink or regular cement grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 2 inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

3.3 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this Work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted.

3.4 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture

on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to Engineer.

3.5 MAINTENANCE OF FORMS

A. Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Forms, when in place, shall conform to the established alignment and grades. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the Engineer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the Contractor shall perform the oiling at least 2 weeks in advance of their use. Exercise care to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.6 FALSEWORK

A. Place falsework shall be placed on a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish, fabricate and install reinforcing steel as shown on Contract Documents.

B. Work includes installation of tie wires, clips, supports, and other appurtenances necessary to meet Specifications and produce finished concrete structures.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete

1.3 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 315	Details of Concrete Reinforcement
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures

B. American Welding Society (AWS):

D1.4	Structural Welding Code – Reinforcing Steel

C. ASTM International (ASTM) standards, most recent editions:

ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Standard Specification for Low Alloy Steel Deformed Bars for Concrete Reinforcement
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

D. Concrete Reinforcing Steel Institute (CRSI) standards, most recent editions:

Manual of Standard Practice

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Submit details of the concrete reinforcement steel and concrete inserts at the earliest possible date after receipt of the Notice to Proceed.

C. Include, but not limit to, the following:
   1. Complete bar schedule, bar details and erection drawings to conform to ACI 315.
   2. Each type of bar marked with identification corresponding to identification tag on bar.
   3. Length, type, and location of all splices.
   4. Erection drawings shall be clear, easily legible and to a minimum scale of:
      a. 1/4 inch = 1 foot.
      b. 1/8 inch = 1 foot if bars in each face are shown in separate views.
   5. Size and location of openings.

D. Furnish a certified Affidavit of Compliance issued by steel manufacturer that reinforcing steel furnished for project meets requirements of ASTM standards referenced herein, as applicable.

E. Do not use Contract Documents as erection drawings.

1.5 QUALITY ASSURANCE

A. Qualifications
   1. Welding operators, processes, and procedures to be qualified in accordance with AWS D1.4.
   2. Welding operators to have been qualified during the previous 12 months prior to commencement of welding.

B. Certifications
   1. Submit manufacturer's certification that products submitted meet requirements of standards referenced.

1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Store reinforcing steel on wood supports in a manner that prevents it from coming in contact with the ground.

C. Store only bars with same identifying label in same stack.

D. When handling coated bars, use systems with padded contact areas.

E. Thoroughly inspect coated steel after delivery to the job site and again after installation to ensure that it is not damaged.
   1. Repair damage with patching material meeting manufacturer's requirements.
   2. Promptly patch sheared ends and other cuts or exposed areas before detrimental oxidation occurs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Mechanical Couplers:
      a. Lenton Form Saver by Erico Products.
      b. Dowel Bar Splicer System by Richmond Screw Anchor Company.
      c. Engineer-approved equal.

2.2 REINFORCEMENT STEEL

A. Materials:
   1. Reinforcing bars: ASTM A615, Grade 60.
   2. Reinforcing bars to be welded: ASTM A706.
   3. Smooth dowels: ASTM A615, Grade 60 plain billet steel bars epoxy coated in accordance with ASTM A775. Provide slip dowel sleeves to allow longitudinal movement equal to joint width plus 1/4 inch.
   4. Slip Dowel Sleeve: One or two component Speed Dowel System as manufactured by Greenstreak, inc, to accept 3/4-inch diameter x 12-inch long slip dowels, including epoxy coating when specified herein or shown on Drawings.
   5. Welded wire fabric: ASTM A1064 and the details indicated; provided, that welded wire fabric with longitudinal wire of W4 size wire and smaller shall be either provided in flat sheets or in rolls with a core diameter of not less than 10 inches; and provided further, that welded wire fabric with longitudinal wires larger than W4 size shall be provided in flat sheets only.
   6. Spiral reinforcement: Cold drawn steel wire conforming to the requirements of ASTM A1064.
   7. Welding Electrodes: E90 meeting requirements of AWS D1.4.

B. Fabrication of Bars:
   1. Fabricate with cold bends conforming to recommended dimensions shown in ACI 318.
   2. Field fabrication will be allowed only if Contractor has equipment to properly fabricate steel to same tolerances as for shop fabrications.
   3. Attach identification tags with identifying mark.
   4. Contractor may at his option continue steel reinforcement through openings in walls and slabs, then field cut opening.

2.3 BOLSTERS, CHAIRS AND ACCESSORIES

A. Conform to ACI 315 and CRSI Manual of Standard Practice.

B. Provide spacers, bolsters, chairs, ties and other devices necessary to properly space, place, support, and fasten steel reinforcement in place during concrete placement.

C. Metal accessories shall be stainless steel with plastic coated tips where legs will be exposed in finished concrete surfaces. Color of plastic shall be grey to match concrete color.

D. Do not use rocks, broken bricks, wood blocks, or concrete fragments for support of steel reinforcement.

E. Support between Reinforcing Steel and Formed Exposed Surfaces: Metal bar chairs.

2.4 PRECAST CONCRETE BLOCK BAR SUPPORTS (DOBIES)

A. Supports between Reinforcing Steel for Roof Slabs: Concrete block prohibited.

B. Minimum Compressive Strength of Blocks: 5,000 psi in seven days.

C. Minimum Bearing Area: 9 square inches. Place as required to maintain specified clearances.

D. Wire ties shall be embedded in concrete block bar supports.

2.5 MECHANICAL COUPLERS

A. Provide mechanical couplers where shown and where approved by Engineer and in accordance with ACI building code standards. The couplers shall develop the full tensile strength of the bars being spliced at each splice (Type 2).

B. Where the type of coupler used is composed of more than one component, supply all components required for a complete splice. This shall apply to all mechanical splices, including those splices intended for future connections.

2.6 EPOXY GROUT

A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall meet the requirements found in Section 03315 - Grout.

2.7 FABRICATION

A. Tolerances:
   1. Sheared lengths: plus or minus 1 inch.
   2. Overall dimensions of stirrups, ties, and spirals: plus or minus ½ inch.
   3. All other bends: +0 inch, -½ inch.

B. Minimum diameter of bends measured on the inside of the rebar to be as indicated in ACI 318.

C. Ship all reinforcement to job site with attached plastic or metal tags.
   1. Place on each tag the mark number of the reinforcement corresponding to the mark number indicated on the shop drawings.
   2. Mark numbers on tags to be so placed that the numbers cannot be removed.

2.8 TESTING

A. Perform at mill for each heat.

B. If requested by Engineer, furnish samples of each type of welded splice used in the Work in a quantity and of dimensions adequate for testing.

C. At the discretion of Engineer, radiographic testing of direct butt-welded splices will be performed. Provide assistance necessary to facilitate testing. Repair any weld which fails to meet the requirements of AWS D1.4. The costs of testing will be paid by Owner; except, the costs of all tests which fail to meet specified requirements shall be paid by Contractor at no increase in cost to Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Tolerances:
   1. Rebar Placement:
      a. Clear distance to formed surfaces: plus or minus ¼ inch.
      b. Minimum spacing between bars: ¼ inch.
      c. Top bars in slabs and beams:
         1) Members 8 inches deep or less: plus or minus ¼ inch.
         2) Members between 8 inches and 2 feet deep: plus or minus ¼ inch.
         3) Members more than 2 feet deep: plus or minus ¾ inch.
      d. Crosswise of members: Spaced evenly within plus or minus 1 inch.
      e. Lengthwise of members: plus or minus 2 inches.
   2. Minimum clear distance between rebars:
      a. Beams, walls, and slabs: Distance equal to rebar diameter or 1 inch, whichever is greater.
      b. Columns: Distance equal to 1-1/2 times the rebar diameter or 1½ inch, whichever is greater.
      c. Beam and slab rebars shall be threaded through the column vertical rebars without displacing the column vertical rebars and still maintaining the clear distances required for the beam and slab rebars.

B. Minimum concrete protective covering for reinforcement, unless indicated otherwise on Contract Documents:
   1. Concrete deposited against earth: 3 inches.
   2. Formed surfaces exposed to weather or in contact with earth:
      a. 2 inches for reinforcing bars #6 or larger.
      b. 1½ inch for reinforcing bars less than #6.
   3. Formed surfaces exposed to any liquid: 2 inches for all rebar sizes.
   4. Interior surfaces:
      a. 1½ inch for beams, girders, and columns.
      b. ¾ inch for slabs, walls, and joists.

C. Splice steel to conform to Chapter 12 of ACI 318 or ACI 350 as applicable. Unless indicated otherwise on Contract Documents, provide splices for reinforcing as follows:
   1. Rebar:

a. Lapped splices shall be not less than a Class B splice for reinforcement unless otherwise indicated.
b. Mechanical splices shall be used whenever shown on the Contract Documents and may be used at other locations at Contractor's option. Such locations shall be shown specifically on the rebar shop drawings.
c. Welding:
1) Perform welding of rebars in accordance with requirements of AWS D1.4.
2) Have each welder place an approved identifying mark near each completed weld.

2. Welded wire fabric: Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than 1 spacing of cross wires plus 2 inches, or less than 1.5 times the development length, nor less than 6 inches. Development length shall be as required for the basic development length for the specified fabric yield strength in accordance with Section 12 of ACI 318 or ACI 350.
3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.

D. Placing Rebars
1. Assure that reinforcement at time concrete is placed is free of mud, oil, or other materials that may affect or reduce bond.
2. Reinforcement with rust, mill scale, or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample are not less than required by applicable ASTM specifications that govern the rebar supplied.
3. Rebar support:
a. Support rebars and fasten together to prevent displacement by construction loads or placing of concrete.
b. On ground, provide supporting concrete blocks.
c. Over formwork, provide plastic-coated metal chairs, runners, boosters, spacers, hangers, and other rebar support. Only tips in contact with the forms need to be plastic coated.
d. Bars additional to those shown on the Contract Documents, which may be found necessary or desirable by Contractor for the purpose of securing reinforcement in position, shall be provided by Contractor at his own expense.
e. Tie securely at minimum of 33% of intersections with 16-gage or larger annealed iron wire.
f. Accommodate placement of formed openings.
g. Where parallel horizontal reinforcement in beams in indicated to be placed in two or more layers, rebars in the upper layers shall be placed directly above rebars in the bottom layer with clear distance between layers to be 1 inch. Place spacer rebars at 3 feet maximum centers to maintain the required 1-inch clear distance between layers.
h. Extend reinforcement to within 2 inches of concrete perimeter edges. If perimeter edge is earth formed, extend reinforcement to within 3 inches of the edge.
i. To insure proper placement, furnish templates for all column vertical bars and dowels.

j. Provide splices of reinforcement not specifically indicated or specified subject to Engineer's approval.
k. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer. Do not bend reinforcing by means of heat.
l. Tie wires shall be bent away from form surfaces.
m. Do not tack-weld reinforcement.

E. Ensure that steel reinforcement and embedments do not exceed 160 Degrees F at time of concrete placement.

3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interfaces:
1. Notify Engineer whenever the specified clearances between rebars cannot be met.
2. Do not place any concrete until Engineer submits a solution to rebar congestion problem.
3. Rebars may be moved slightly to avoid interference with other reinforcement steel, conduits, or embedded items.
4. If rebars are moved more than 1 bar diameter, or enough to exceed above tolerances, obtain Engineer's approval of resulting arrangement of rebars.
5. No cutting of rebars shall be done without written approval of Engineer.

B. Employ a testing laboratory to perform and report following:
1. Review and approve Contractor proposed welding procedures and processes for conformance with AWS D1.4.
2. Qualify welders in accord with AWS D1.4.
3. Test three samples of each bar size and each type of weld in accord with AWS D1.4. The tensile strength of each test shall be not less than 125 percent of the required yield strength of the rebar tested.
4. Conduct nondestructive field tests (radiographic or magnetic particle) on not less than one random sample for each 10 welds. In addition, if any welds are found defective, test five previous welds performed by the same welder.
5. Visually inspect each weld for presence of cracks, undercuts, inadequate size, and other visible defects.

3.3 COORDINATION

A. Coordination with placement of formwork, formed openings, embedded items, and other Work.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Provide cast-in-place concrete work as shown on Contract Drawings and as specified herein.

B. Section includes:
1. Concrete Materials.
2. Proportioning and Mixing.
3. Ready Mixed Concrete.
4. Curing Materials.
5. Expansion Joint Filler.
6. Waterstops.
7. Preparing for Concreting.
8. Placing of Concrete.
9. Finishing.
10. Curing.
11. Field Quality Control.

1.2 RELATED SECTIONS

A. Section 03 11 00 – Concrete Forming.

B. Section 03 20 00 – Concrete Reinforcing.

C. Section 03 60 00 – Grouting.

D. Section 07 14 00 – Fluid-Applied Waterproofing.

1.3 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 211	Standard Practice for Selecting Proportions for Concrete
ACI 212	Chemical Admixtures
ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings
ACI 305	Recommended Practice for Hot Weather Concreting
ACI 306	Recommended Practice for Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete

ACI 350	Code Requirements for Environmental Engineering Concrete Structures

B. ASTM International (ASTM) standards, most recent editions:

ASTM C31	Standard Specification Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specifications for Concrete Aggregates
ASTM C39	Test for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Standard Specifications for Ready-Mixed Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specifications for Portland Cement
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C586	Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C 1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

ASTM C1293	Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D412	Test Methods for Rubber Properties in Tension
ASTM D624	Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D747	Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
ASTM D1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2240	Test Method for Rubber Property - Durometer Hardness
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

C. International Concrete Repair Institute (ICRI) standards, latest editions:

Guideline No 310.1R	Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
Guideline No 320.2R	Guide for selecting and specifying Materials for repair of Concrete Surfaces

D. NSF International (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects

E. U. S. Army Corps of Engineers standards, most recent editions:

CRD-C 572	PVC Waterstops

1.4 DEFINITIONS

A. Construction Joints: Fresh concrete placed against a hardened concrete surface; joint between two pours is called a construction joint. Unless otherwise indicated, provide construction joints with a waterstop and sealant groove of the shape indicated.

B. Expansion Joints: To allow concrete to expand freely, space provided between two pours, formed as indicated. Space is made by placing filler joint material against the first pour; acts as a form for the second pour.

C. Control Joints: Provide weakened plane in concrete, where shrinkage cracks will likely occur. A groove, shape and dimensions indicated in Drawings, formed or saw-cut in concrete. Groove is filled with joint sealant material.

D. Laitance: In placement of concrete, accumulation of small inert particles of cement and aggregate on surface, caused by excess of water that, when it evaporates, leaves a thin layer, causing weakened plane for subsequent pour.

E. Alkalies: Term "alkalies" referred to herein is defined as sum of percentage of sodium oxide and 0.658 times percentage of potassium oxide ($Na_20+0.658K_20$). These oxides shall be oxide content determined in accordance with ASTM C114.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product data:
   1. Concrete mix design(s) proposed for use. Proposed concrete mix design submittal to include the following information:
      a. Sieve analysis and source identification of fine and coarse aggregates. Include sand equivalency.
      b. Source test results for aggregate organic impurities.
      c. Source test results for deleterious aggregate per ASTM standards.
      d. Proportioning of all materials.
      e. Type of cement with mill certificate for cement.
      f. Slump.
      g. Air Content.
      h. Brand, type, ASTM designation, and quantity of each admixture proposed for use.
      i. 28-day cylinder compressive test results of trial mixes per ACI 350 and as indicated herein.
      j. Shrinkage test results.
      k. Standard deviation value for concrete production facility.
   2. Manufacturer and type of joint filler, joint sealant, and curing agent.
   3. Waterstops:
      a. Provide manufacturer's current test reports with written material certification.

b. Provide samples of extruded or molded sections of each size or shape to be used in the Work. Samples shall represent in all aspects, the material to be furnished under this Contract.
c. Provide sample of fabricated cross-construction of each size or shape of waterstop to be used. Fabricate samples so that material and workmanship represent the materials to be furnished in the Work.
d. Provide manufacturer's written certification as an integral part of the shipping form, to show that the material shipped to Work meets or exceeds the physical property requirements specified.

4. Manufacturer and type of bonding and patching mortar and bonding adhesive used at construction joints.
5. Pour plan for superplastisized concrete pours.

1.6 QUALITY ASSURANCE

A. Preconstruction Testing: Perform all preliminary and trial batch laboratory tests on cement, aggregates, and concrete.

B. Testing Agencies: The testing laboratory shall meet or exceed the requirements of ASTM C1077.

1.7 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Mixing, transporting, handling, placing, curing and testing of concrete in accordance with applicable ACI and ASTM specifications and as specified.

C. Storage of material:
1. Cement:
a. Protect cement from exposure to moisture until used.
b. Do not use if caked or lumpy.
c. Store sacked cement to permit access for inspection and sampling.
2. Aggregate:
a. Store to prevent segregation and contamination with other sizes or foreign materials.
b. Obtain samples for testing from aggregates at point of batching.
c. Do not use frozen or partially frozen aggregates.
d. Do not use the bottom 6 inches of stockpiles in contact with ground.
e. Allow sand to drain until moisture content is uniform prior to use.
3. Admixtures:
a. Protect from contamination, evaporation, freezing, or damage.
b. Maintain within temperature range recommended by manufacturer.
c. Completely mix solutions and suspensions prior to use.

D. Delivery:
1. Prepare a delivery ticket for each load of ready-mix concrete delivered to the project. Truck operator shall hand ticket to Engineer at time of delivery, which shows the following information for each load:

a. Mix identification mark.
b. Quantity delivered (by volume).
c. Amount of each material in batch.
d. Outdoor temperature in the shade.
e. Time at which cement was added.
f. Amount of water added at jobsite by Contractor.
g. Amount of superplastisizer added where applicable.

1.8 SITE ENVIRONMENTAL REQUIREMENTS

A. When temperature is below 40°F or is likely to fall below 40°F during 24-hour period after placing concrete, heat materials, (not in excess of 140°F) including both water an aggregates and protect concrete so that temperature of the concrete is between 50°F and 90°F for 24-hour period after placing concrete.

B. During hot weather, shade materials from sun and use cool water so temperature of concrete does not exceed 90°F at time of placing concrete.

C. Placing of concrete is not permitted where, in opinion of Engineer, wind, rain or inadequate facilities furnished by Contractor prevents proper finishing or curing of concrete.

1.9 COORDINATION

A. Coordination with placement of reinforcing steel, embedded items, and other Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Expansion joint fillers:
a. Ceramar, WR Meadows, Inc.
b. Rubatex Corporation
c. Williams Products, Inc.
d. Engineer approved equal.
2. Membrane Curing Compound.
a. 1100-Clear, WR Meadows, Inc.
b. Dry-Chem Rez Cure (J-11-W), Dayton Superior.
c. L&M Cure R, L&M Construction Chemicals, Inc
d. Engineer approved equal.
3. Evaporation Retardant:
a. AquaFilm, Dayton Superior.
b. Eucobar, Euclid Chemical Company.
c. MasterKure ER50 by Master Builders.
d. Engineer approved equal.
4. Waterstops, Plastic Serrated Type:
a. Vinylex Corporation.

b. Greenstreak, Inc.
c. W. R. Meadows, Inc.
d. Engineer approved equal.

5. Waterstops, Plastic Adhesive Type:
   a. Synko-Flex, Henry Company.
   b. Engineer approved equal.
6. Waterstops, Hydrophilic Type
   a. Adcor ES, WR Grace,
   b. Hydro-Flex, Henry Company.
   c. Hydrotite, Greenstreak, Inc.
   d. Engineer approved equal.
7. Bonding agent:
   a. Armatek 110 EpoCem, Sika Corporation
   b. Engineer approved equal.
8. Set Controlling Admixtures:
   a. For air temperature at the time of placement over 80°F; set-retarding;
      1) Plastocrete, Sika Corporation
      2) Pozzolith 300R, Master Builders.
      3) Engineer approved equal.
   b. For air temperature at the time of placement under 40°F: Non-corrosive set accelerating;
      1) Plastocrete 161FL by Sika Corporation.
      2) Pozzutec 20 by Master Builders.
9. Air-entraining Agent:
   a. Micro-Air, Master Builders.
   b. Daravair 1000, WR Grace.
   c. Sika AEA-15, Sika Corporation.
   d. Engineer approved equal.
10. Pigments for Underground Conduit Banks:
   a. Arizona Oxides, #1835.
   b. Bayer, Bayferrox #130.
   c. Davis, #117.
   d. As currently approved by governing agency.

2.2 MATERIALS

A. Portland cement: Comply with ASTM C150, Type II or V.
   1. Portland cement shall contain not more than 0.60 percent equivalent alkalies.
   2. Single brand of cement used throughout Work; brand approved by Engineer.

B. Hydraulic Cement: Comply with ASTM C 1157, Type MS.
   1. Single brand of cement used throughout Work; brand approved by Engineer.

C. Fly Ash: ASTM C618, Class F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent
   1. Maximum of 25 percent replacement at 1.0 pounds of fly ash per pound of cement replaced.

D. Coarse Aggregate: Conforming to ASTM C33 and as noted below.

1. Clean, hard, durable gravel, crushed gravel, crushed rock or combination thereof.
2. Reactivity: Non-reactive or below innocuous behavior level.
3. Prepare and handle coarse aggregates in two or more size groups for combined aggregates with maximum size greater than 3/4 inch.
4. When aggregates are proportioned for each batch of concrete, combine the size groups.
5. Obtain coarse aggregates from sources approved by Engineer.

E. Combined Aggregates: Well graded from course to fine sizes; uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradation will be established during the trial batch process.

F. Fine Aggregates: Natural or combination of natural and manufactured sand that is hard and durable.
1. Lightweight Sand for Fine Aggregate: Not permitted.
2. Sand Equivalency: Tested in accordance with ASTM D2419; not less than 80 percent for an average of 3 samples; not less than 80 percent for an individual test.
3. Gradation: In accordance with ASTM C33; 15 to 30 percent passing number 50 screen; 5 to 10 percent passing number 100 screen.
4. Fineness Modulus: Not over 3.00.
5. Reactivity: Non-reactive or below innocuous behavior level.
6. Obtain fine aggregates from sources approved by Engineer

G. Water: Clean and free from objectionable quantities of organic matter, alkali, salts and other impurities, as determined by Engineer.

H. Admixtures:
1. Maximum total water soluble chloride ion content contributed from all ingredients of concrete including water, aggregates, cementitious materials, and admixtures by weight percent of cement:
   a. 0.06 For prestressed concrete.
   b. 0.10 For all other concrete.
2. Do not use calcium chloride.
3. Provide admixtures of same type, manufacturer, and quantity as used in establishing required concrete proportions in the mix design.
4. Air entraining admixtures: ASTM C260.
5. Water reducing admixtures:
   a. Comply with ASTM C494, Type A.
   b. Concrete not to contain more than one water-reducing admixture.
   c. Conform to applicable provisions of ACI 212.3R.
   d. Follow manufacturer's instructions.
   e. Use chloride free admixtures only.
6. Set controlling admixtures with or without water-reducing properties.
   a. ASTM C494, Types B through E.
   b. Conform to applicable provisions of ACI 212.3R.
   c. Do not use retarding or accelerating admixtures unless specifically approved in writing by Engineer and at no additional cost to Owner.
   d. Follow manufacturer's instructions.

e. Use chloride free admixtures only.

7. High Range Water Reducers:
   a. In accordance with ASTM C494, Type F.
   b. Conform to applicable provisions of ACI 212.3R.
   c. Locations for use of high range admixtures shall be as shown on the Contract Drawings. Do not use high range admixtures in other locations unless specifically approved by Engineer and at no additional cost to Owner.
   d. Add to concrete at the jobsite after all other ingredients have been mixed and initial slump has been verified.
   e. Added by a technician certified by manufacturer of the product.
   f. Added at the site unless written permission is given by Engineer to add the product at plant.
   g. Mixing: Minimum 70 revolutions or 5 minutes after addition of high-range water reducer.
   h. Slump before Addition: Maximum 2 inches.
   i. Slump after Addition: Minimum of 6 inches and maximum of 10 inches.
8. Pigments for Underground Conduit Banks: Pigment shall be added to concrete encasing electrical duct banks as required by governing agency.

I. Curing Materials
1. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C156 shall not exceed 0.055 grams per square centimeter of surface.
2. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU B 790A (1) (2). The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.
3. Polyethylene-coated burlap for use as concrete curing blanket shall be 4 mils thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.
4. Membrane Curing Compound (with fugitive dye added): ASTM C309, Type 1-D, Class B. Sodium silicate compounds shall not be allowed.

J. Expansion Joint Filler
1. Provide expansion joints in concrete construction where shown on Contract Drawings.
2. Expansion Joint Filler: Preformed, non-extruding, resilient type, constructed of cellular sponge rubber, extending full thickness of slab, in accordance with ASTM D1751 or ASTM D1752, Type I.

K. Grout: As specified in Section 03 60 00 – Grouting.

L. Waterstop, Plastic Serrated Type:

1. Extruded elastomeric polyvinyl chloride compound; containing plasticizers, resins, stabilizers and other materials necessary to meet requirements of Specifications.
   a. Store waterstops to permit free circulation of air around waterstop material.
   b. Provide special fittings fabricated for splices and joints.
   c. In accordance with Specification CRD-C572.

	VALUE	ASTM STD.
PHYSICAL PROPERTY, SHEET MATERIAL		
Tensile Strength-minimum (psi)	1750	D412, Die C
Ultimate Elongation-minimum (%)	350	D412, Die C
Low Temp. Brittle-maximum (°F)	-35	D746
Stiffness in Flexure-minimum (psi)	400	D747
ACCELERATED EXTRACTION (CRD-C572)		
Tensile Strength-minimum (psi)	1500	D412, Die C
Ultimate Elongation-minimum (%)	300	D412, Die C
EFFECT OF ALKALIES (CRD-C572)		
Change in Weight (%)	+.25/-.10	-----
Change in Durometer, Shore A	+5	D2240
FINISHED WATERSTOP		
Tensile Strength minimum (psi)	1400	D412, Die C
Ultimate Elongation minimum (%)	280	D412, Die C

   d. Style:
      1) Centerbulb, 7/8 inch OD, 6 inches long.
      2) Flat Strip, 6 inches long unless noted otherwise.

M. Waterstop, Plastic Adhesive Type: Non expansive plastic adhesive strip type conformable, manufactured solely for the purpose of preventing water from passing through construction joints.
   1. Primer as recommended by waterstop manufacturer.

N. Waterstop, Hydrophilic Type: Expansive, conformable blended rubber based material.
   1. Primer as recommended by waterstop manufacturer.

O. Elastomeric Bearing Materials:
   1. Rubber bearing pads shall be furnished with the dimensions, material properties, and elastomer grade as required by the Drawings and in accordance with ASTM D2240, Type A, Shore 30 or 40 Durometer.
   2. Prepare concrete support surfaces and adhere pads to concrete per manufacturer's recommendations.

P. Waterproofing: Refer to Section 07 14 00 – Fluid-Applied Waterproofing.

2.3 EQUIPMENT

A. Concrete Pumps:
   1. Provide pumping equipment with two cylinders, designed to operate with only one cylinder in case one is not functioning. In lieu of this requirement, provide a standby pump on the site during pumping.

a. Minimum Diameter of Hose (conduit): 4 inches.
b. Aluminum conduits for conveying the concrete will not be permitted.

B. Vibrators:
1. Internally vibrated, high speed power vibrators of an approved immersion type. In sufficient numbers with standby units as required.

C. Truck Mixers:
1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements as to materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C94, including the following supplementary requirements.
2. Ready-mixed concrete shall be delivered to the site of the Work, and discharge shall be completed within 90 minutes after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first.
3. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
4. Mix each batch of concrete in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
5. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the Work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.
6. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

2.4 REINFORCEMENT STEEL

A. Provide in accordance with Section 03 20 00 – Concrete Reinforcing.

2.5 CONCRETE MIXES

A. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities specified and in accordance with ACI 301 specifications. The exact proportions in which these materials are to be used for different parts of the Work will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the Owner. All changes shall be subject to review by the Engineer.

B. Fine Aggregate Composition:

1. In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table:

Fineness Modulus	Maximum Percent
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

2. In all other concrete, the maximum percentage of fine aggregate of total aggregate, by weight, shall not exceed 50.

C. Concrete compressive strength, aggregate size and slump in accordance with the following:

Type of Construction	Compressive Strength (psi)	Aggregate Gradation (ASTM C33)	Slump in Inches (Max.)	Max W/C Ratio (by Weight)
Structure walls.	4,000	#67 (3/4")	4	0.45
Structure footings; foundations and bottom slabs.	4,000	#467 (1-1/2")	4	0.45
Reinforced concrete encasements; thrust blocks	4,000	#467 (1-1/2")	4	0.50
Site Slabs; Curb and gutter	4,500	#67 (3/4")	4	0.45
Lean Concrete	3,000	#467 (1-1/2")	5	0.60
Site underground conduit banks: Min. 3 lbs. red pigment/sack cement	3,000	#8 (3/8")	5	0.60

1. Compressive Strength: minimum at 28 days of age.
2. Slump as shown above shall be plus or minus 1 inch.

a. Slump to be measured before addition of any plasticizing agents at the job site.
b. Measure at point of discharge of the concrete into the concrete member per ASTM C143.
c. Concrete of lower than maximum slump may be used provided it can be properly placed and consolidated.
d. For pumped concrete, provide additional water at batch plant to allow for slump loss due to pumping. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified above.

3. Minimum cement content:
   a. Reinforced Concrete: Six sacks Portland Cement per cubic yard.
   b. Unreinforced Concrete: Five sacks Portland Cement per cubic yard.
4. Air content: Provide air entrainment resulting in a total air content of 4 to 7 percent for all types of construction.
   a. Air content to be measured in accordance with ASTM C231, ASTM C173, or ASTM C138.
   b. Air may be omitted from interior slabs to be trowel finished.

D. Selection of Proportions:
1. General: Proportion ingredients to produce proper workability, durability, strength, and other required properties. Prevent segregation and collection of excessive free water on the surface.
2. Pan stair fill:
   a. Coarse aggregate: 100 percent passing a 1/2 inch sieve.
   b. Proportions:
      1) One sack cement.
      2) 150 pounds coarse aggregate.
      3) 150 pounds fine aggregate (sand).
      4) Adjust mix to obtain satisfactory finishing.
3. Submit mix design data for approval as required by this specification Section.
4. Proportion mixture to provide desired characteristics using one of the methods described below:
   a. Method 1 (Trial Mix): Per ACI 350, Chapter 5, except as modified herein.
      1) Air content within range specified above.
      2) Record and report the temperature of trial mixes.
      3) Proportion trial mixes per ACI 211.1.
   b. Method 2 (Field Experience): Per ACI 350, Chapter 5, except as modified herein.
      1) Field test records must be acceptable to Engineer to use this method.
      2) Test records shall represent materials, proportions, and conditions similar to those specified herein.
   c. Required average strength to exceed the specified 28-day compressive strength by the amount determined or calculated in accordance with the requirements of ACI 350, using the standard deviation of the proposed concrete production facility.
5. Shrinkage Limitation
   a. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.036 percent or 0.042 percent, respectively per ASTM C157. Use a mix

design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to structural concrete.

2.6 SOURCE QUALITY CONTROL

A. Trial Batch: Based on submitted concrete mixes for each class of concrete.

B. Aggregates:

1. Fine and coarse aggregates shall be tested in accordance with ASTM C1260 or ASTM C1293 to show compliance with ASTM C33 for alkali-silica reactivity and the aggregates shall be non-reactive.
2. Fine and coarse aggregates shall be tested in accordance with ASTM C1260 or ASTM C1293 to show compliance with ASTM C33 for alkali-silica reactivity and shall be non-reactive unless employing the following additional measures:
    a. When the above test results show the aggregates to be reactive, and fly ash or other supplementary cementing material (SCM) is approved for use in order to control alkali-aggregate reactivity, the proposed concrete mixture shall be tested in accordance with ASTM C1567 and produce expansion results of less than 0.10 percent at 14 days.
    b. When a lithium admixture is approved for use in order to control alkali-aggregate reactivity, the proposed concrete mixture shall be tested in accordance with ASTM C1293 and produce expansion results of less than 0.04 percent at one year.
3. The fine and coarse aggregates shall be tested in accordance with ASTM C586 to show compliance with ASTM C33 for alkali-carbonate reactivity and shall be non-reactive.
4. The fine aggregate shall be tested in accordance with ASTM C40 to show compliance ASTM C33 for organic impurities.
5. The fine and coarse aggregate shall be tested in accordance with ASTM C88 to show compliance with ASTM C33.
6. The fine and coarse aggregate shall be tested in accordance with ASTM C142 to show compliance with ASTM C33.
7. The fine and coarse aggregate shall be tested in accordance with ASTM C123 to show compliance with ASTM C33.
8. The fine and coarse aggregate shall be tested in accordance with ASTM C117 to show compliance with ASTM C33.
9. The coarse aggregate shall be tested in accordance with ASTM C131 to show compliance with ASTM C33.
10. In addition to initial aggregate testing, each type of aggregate shall be tested at no increased cost to the Owner for conformance to ASTM C33 under any of the following conditions:
    a. Concrete placement extending longer than six months.
    b. There is a noticeable change in aggregate appearance, consistency, or ease of excavation.
    c. The aggregate supplier changes pits, or locations in the original pit.
11. If the test results fail to meet the requirements of ASTM C33 and this Section, the Engineer may stop the placement of concrete, and may require additional testing of aggregates or field and trail batch testing of concrete to verify conformance to ASTM C33 and the strength and shrinkage requirements of this Section.

12. The Engineer may conduct any additional testing of aggregates at anytime during the concrete placement period. Depending on the test results, testing cost shall be paid by the Contractor or Owner, according to the General Conditions. If test data fails to conform to ASTM C33, the Engineer may stop the placement of concrete or take corrective actions as indicated above.

PART 3 - EXECUTION

3.1 PREPARING FOR CONCRETING

A. Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. Surface shall be free from standing water, mud and debris at the time of placing concrete.

B. Construct forms to the shape, lines and dimensions of members shown on Drawings and sufficiently tight to prevent leakage of mortar. Take special care when forming concrete containing high range water reducing agents. Brace and tie forms to maintain position and shape.
   1. Before placing concrete containing superplastisizing agents, Contractor shall submit a Pour Plan to Engineer for approval. The Engineer may require additional manpower or equipment for these pours as required to limit defects in the concrete. The Pour Plan shall include the following:
      a. Number of crew members and assignment of each.
      b. Number of vibrators to be used.
      c. Number of vibrators in reserve.
      d. Time of day and anticipated duration of pour.
      e. Type and capacity of pumping equipment if used.

C. Provide slabs and beams of minimum indicated depth when sloping foundation base slabs or elevated floor slabs to drains.
   1. For slabs on grade, slope top of subgrade to provide floor slabs of minimum uniform indicated depth.
   2. Do not place floor drains through beams.

D. Unless otherwise indicated, provide exterior corners in concrete members with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

E. Complete all formwork, installation of parts to be embedded, reinforcement and surface preparation prior to placing concrete.
   1. Use setting diagrams, templates, and instructions for locating and setting embedments and attachments.
   2. Prior to placing concrete, position and support pipe, conduit, dowels and other ferrous items required to be embedded, to ensure a 2-inch minimum clearance between items and any part of concrete reinforcement.
   3. Securing such items in position by wiring or welding to reinforcement is prohibited.
   4. Electrical conduits and piping:

a. Install between layers of reinforcement steel in walls and slabs with steel in both faces.
b. Install under reinforcement steel in slabs with only one layer of steel.
c. Conduit outside diameter size shall not exceed 1/3 of the thickness of the concrete. Space conduits at least 3 diameters apart on centers. As a general rule, conduit may not cross other conduit at pipe in concrete members or slabs.

F. Provide openings in formwork to accommodate other trades. Accurately place and securely support all items built into forms.

G. Waterstops:
1. Preparation
a. Uncoil waterstop minimum of 24 hours prior to installation for ease of handling and fabrication.
b. Position waterstop to ensure proper distance from steel reinforcing bars and to prevent rock pockets and honeycomb.
c. Clean concrete joint and waterstop after first pour to remove debris and dirt.
2. Installation
a. Position waterstop across joints as specified herein and as indicated on Drawings.
b. Center waterstops on joint unless shown otherwise.
c. When centerbulb is present at moving joints, ensure that it is not embedded.
d. All waterstops fully continuous for the extent of the joint.
e. Secure plastic serrated waterstop in correct position before concrete placement with hog rings and wire to adjacent reinforcing steel at 12-inch maximum spacing. Center-to-center spacing may be increased upon written request and approval of Engineer.
f. Take suitable precautions and means to support and protect waterstops during the progress of the work.
g. Carefully place concrete without displacing waterstop from proper position.

H. Construction, Expansion, and Contraction Joints:
1. Provide at locations indicated or as approved by Engineer.
2. Install construction joints in beams, slabs, and girders perpendicular to the planes of their surfaces.
3. At least 48 hours shall elapse between placing of adjoining concrete construction.
4. Before new concrete is placed against existing concrete, coat all construction joints with an approved bonding adhesive used and applied in accordance with manufacturer's instructions.

I. Thoroughly clean surfaces of metalwork to be in contact with concrete immediately before concrete is placed.

J. Remove ponded water from the excavation and moisten fill.

K. Remove laitance, tighten forms, roughen, clean, wet and slush hardened concrete with cement grout prior to placing fresh concrete at construction joints. Coat form surfaces with form release agents prior to placing reinforcing bars in forms.

3.2 CYLINDER STORAGE DEVICE

A. Provide and maintain a cylinder storage device at a protected location on the Site, acceptable to Engineer and as follows:
   1. Maintain concrete test cylinders at a temperature range of 60 degrees F to 80 degrees F for the initial 24-hour curing period.
   2. Once placed in the storage device, do not move the cylinders during this period.
   3. Equip the storage device with an automatic 24-hour temperature recorder that continuously records on a time/temperature chart with an accuracy of ±1 degree F.
   4. Have the storage device available at the point of use at least 24 hours before concrete placement.
   5. A 24-hour test run may be required before placement of concrete.

B. Engineer may stop placement of concrete if the storage device cannot accommodate the required number of test cylinders.

C. Use water containing hydrated lime if water is to be in contact with cylinders.

3.3 PLACING OF CONCRETE

A. Notify Engineer not less than 24 hours in advance of the times and places at which Contractor intends to place concrete.

B. Place concrete in compliance with ACI Specifications and requirements of this Section.

C. Place concrete only in presence of duly authorized representative of Engineer.

D. Ready Mix Equipment:
   1. Do not exceed manufacturer's rated capacity of the mixer.
   2. Ensure sufficient mixing time for uniform distribution of materials.
   3. Discharge all concrete from mixer prior to mixing new batch.
   4. In accordance with ASTM C94.

E. Transporting:
   1. Transport concrete from mixer to place of deposit by methods, which prevent segregation or loss of material.
   2. Provide runways when wheelbarrows are used to transport concrete.
   3. Do not wheel conveying equipment over reinforcement or support runways on reinforcement.

F. Placing:
   1. Deposit concrete in continuous manner and as rapidly as possible within planned joints or sections.
   2. Do not use concrete that has attained initial set or contained mixing water for more than 1 hour.
   3. Uniformly distribute concrete during process of depositing and in no case move deposited concrete in forms more than 6 feet in horizontal direction.
   4. Do not drop freely more than 5 feet in unexposed work or more than 3 feet in exposed work; where greater drops are required, use duct or other approved method.

5. Do not place concrete against icy or frost covered earth surfaces.

G. Compacting:
1. Compact by internal type vibrators supplemented by rodding and tamping as necessary, to maximum practicable density, free from pockets of coarse aggregate in such a manner that surfaces are smooth and free from voids.
2. Avoid excessive vibration of concrete; avoid segregation of aggregates.
3. Avoid disturbance of previous lifts where initial set has taken place.
4. Use of form vibrators or tapping of forms is prohibited.

H. Protection:
1. Protect all concrete against physical injury until final acceptance by Owner.
2. Protect concrete from reduced strength due to weather extremes.
3. When the temperature is below 40 Degrees F, or is likely to fall below 40 Degrees F during the 24-hour period after placing the concrete, follow the recommendations of ACI 306R, except as modified herein.
   a. Do not place concrete on frozen ground or in contact with forms or reinforcing bars coated with frost, ice, or snow.

Outdoor Temperature at Placement (In shade)	Concrete Temperature (At mixing)
Below 30 Degrees F	65 Degrees F
Between 30 and 45 Degrees F	60 Degrees F
Above 45 Degrees F	50 Degrees F

   b. Minimum concrete temperature at the time of mixing:
   c. Do not place heated concrete that is warmer than 80 Degrees F.
   d. If freezing temperatures are expected during curing, maintain the concrete temperature at or above 50 Degrees F for 72 hours, with additional requirements listed under Article 3.3 - Curing below.
   e. Do not allow concrete to cool suddenly.
   f. Calcium chloride will not be permitted as a concrete accelerator or to thaw frozen subgrade prior to concrete placement.
4. When the temperature is 90 Degrees F or above, or is likely to rise above 90 Degrees F within the 24-hour period after concrete placement; or when there is any combination of high air temperature, low relative humidity, and wind velocity which would impair concrete strength or quality, follow the recommendations of ACI 305R and the following:
   a. Keep concrete as cool as possible during placement and curing.
   b. Do not allow concrete temperature to exceed 90 Degrees F at placement.
   c. Prevent plastic shrinkage cracking due to rapid evaporation of moisture.
   d. Dampen subgrade and forms with cool water immediately prior to placement of concrete.
   e. Apply an evaporation retardant per manufacturer's instructions between placement and finishing operations.
   f. Protect the concrete with temporary wet covering during any appreciable delay between placement and finishing.

g. Take appropriate precautions per ACI 305R when the actual or anticipated evaporation rate equals or exceeds 0.2 LBS/SF/HR as determined from ACI 305R.

3.4 CURING

A. Cure concrete for not less than 14 days after placing.

B. Leave forms in place at least 14 days, or until concrete has attained specified 28-day strength, unless otherwise approved by Engineer. If forms are allowed to be removed within 14 days of placing concrete, continue curing in accordance with other methods specified herein or as directed by Engineer.

C. Strictly follow careful procedures for the removal of forms and perform with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted.

D. Keep encasement concrete, concrete cradles and anchor blocks moist until covered. The surface shall be covered with moist earth not less than 4 hours, or more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

E. Concrete slabs may be cured by either of the following two methods:
   1. Method 1:
      a. After finishing slab, wet surface with a fine spray of water and cover with polyethylene-bonded waterproof paper sheeting.
      b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
      c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
      d. Repair or replace sheets immediately if damage occurs.
   2. Method 2:
      a. Cover concrete with water-saturated polyethylene-coated burlap curing mats and keep continuously wet for curing period.
      b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
      c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
      d. Repair or replace sheets immediately if damage occurs.

F. As an alternate to above referenced curing methods for formed and slab concrete, spray surface with liquid curing compound that does not affect bond of paint to concrete surface.
   1. Apply curing compound in accordance with manufacturer's instructions as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after completion of finish or stripping of forms, if stripped in less than 14 days.
      a. Maximum coverage rate of 200 square feet per gallon, applied in such a manner as to cover surface with a uniform film to seal thoroughly.
   2. Curing vertical surfaces with a curing compound:
      a. Cover vertical surfaces with a minimum of two coats of the curing compound.

b. Apply the first coat of curing compound immediately after form removal. Vertical surface at the time of receiving the first coat shall be damp with no free water on the surface.
c. Allow the preceding coat to completely dry prior to applying the next coat.
d. Vertical surface is defined as any surface steeper than 1 vertical to 4 horizontal.

3. Curing Compound: As specified herein.
4. Take care to avoid damage to seal during curing period.
5. Repair broken or damaged seals occurring before expiration of curing period by application of additional curing compound over damaged portion.
6. Do not use curing film method where construction joints are to be made.
7. In hot weather, follow curing procedures outlined in ACI 305R and the following:
   a. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of application and maintenance of water saturated material to all exposed surfaces; horizontal, vertical, and otherwise. After 24-hour interval, continue curing, using one of the following methods:
      1) Moist cure for six more days.
      2) Application of curing compound as specified above.
   b. Begin curing formed concrete immediately after placing. Curing shall consist of keeping forms continuously wet for 24 hours. Thereafter, continue curing, using one of the following methods:
      1) Loosen forms and position soaker hose so that water runs down along concrete surfaces. Continue for six more days.
      2) Strip forms and apply during compound as specified for vertical surfaces above. Do not allow concrete surfaces to dry prior to application of curing compound.
8. In Cold Weather, following curing procedures outlined in ACI 306R and the following:
   a. Water curing of concrete may be reduced to 6 days during periods when the mean daily temperature in the vicinity of the worksite is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.
   b. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 Degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 Degrees F. Concrete cured by water curing shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 Degrees F.
   c. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 Degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 Degrees F for more than 3 successive days, the specified 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 Degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

d. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

3.5 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein specified shall be promptly executed by the Contractor at its own expense.

B. All repairs shall be performed in accordance with the manufacturer's recommendations and with ICRI Guideline No 310.1R and Guideline No 320.2R. These guidelines shall be followed for removal geometry, exposing and undercutting of reinforcing steel, cleaning and repair of reinforcing steel, and edge and surface condition of concrete and shall be followed regardless of the amount of corrosion present or not present in the reinforcing steel.

1. Remove unsound deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16-inch. Remove to provide for minimum thickness specified for mortar. If reinforcing is exposed in this process, then additional concrete shall be removed until the surface is a minimum of 1-inch or 1 bar diameter behind the exposed reinforcing.
2. Clean exposed reinforcing bars of rust and other deleterious materials which may prevent bonding of the repair product.
3. Keep surface at saturated surface dry (SSD) condition for a minimum of 24-hours prior to placement of repair material.
4. Place and cure repair grout as specified in Section 03 60 00 – Grouting and in accordance with manufacturer's written recommendations.
5. For exposed walls, the cement shall contain such a proportion of white Portland cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout specified in Section 03 60 00 - Grouting. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout specified in Section 03 60 00 - Grouting.

D. All repairs shall be built up and shaped in such a manner that the completed Work will conform to the requirements of this Section, as applicable, using approved methods which

will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

E. Prior to filling any structure with water, all cracks that may have developed shall be "vee'd" as shown on the Drawings and filled with sealant conforming to the requirements of Section 07 92 00 – Joint Sealants. This repair method shall be done on the water bearing face of members. Prior to backfilling, faces of members in contact with fill, which are not covered with a waterproofing membrane, shall also have cracks repaired as specified herein.

3.6 PATCHING HOLES IN CONCRETE

A. Patching Small Holes
1. Holes which are less than 12 inches in their least dimension and extend completely through concrete members, shall be filled as specified herein.
2. Small holes in members which are water-bearing or in contact with soil or other fill material, shall be filled with nonshrink grout specified in Section 03 60 00 - Grouting. Where a face of the member is exposed to view, the nonshrink grout shall be held back 2 inches from the finished surface. The remaining 2 inches shall then be patched according to the paragraph in Part 3 entitled "Treatment of Surface Defects."
3. Small holes through all other concrete members shall be filled with nonshrink grout, with exposed faces treated as above.

B. Patching Large Holes
1. Holes which are larger than 12 inches in their least dimension, shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as specified herein.
2. Holes which are larger than 24 inches in their least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in drilled holes and epoxy grout as specified in Section 03 60 00 – Grouting. The reinforcing added shall match the reinforcing in the existing wall unless shown.
3. Large holes in members which are water bearing or in contact with soil or other fill, shall have either a hydrophilic type or a plastic adhesive type waterstop material placed around the perimeter of the hole as specified herein, unless there is an existing waterstop in place.

3.7 CONCRETE FINISH

A. General: Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions shown are defined as tolerances and are specified herein. These tolerances are to be distinguished from irregularities in finish as described herein.

B. Aluminum finishing tools shall not be used.

C. Formed Surfaces:
1. Exterior buried surfaces require no treatment after form removal except for curing, repair of defective concrete, and treatment of surface defects.

2. Surfaces exposed to view shall be finished as specified under "Architectural Concrete Finish" below.

D. Surface holes larger than 1/2 inch in diameter or deeper than 1/4-inch are defined as surface defects in basins and exposed walls.

E. Unformed Surfaces: After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each Work operation as necessary to prevent drying shrinkage cracks. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:

1. Finish U1 – Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8 inch. No further special finish is required.
2. Finish U2 After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where shown or as determined by the Engineer.
3. Finish U3 After the floated surface (as specified for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.
4. Finish U4 Steel trowel finish (as specified for Finish U3) without local depressions or high points. In addition, the surface shall be given a light broom finish with broom lines perpendicular to drainage unless otherwise shown. The resulting surface shall be rough enough to provide a nonskid finish.

3.8 ARCHITECTURAL CONCRETE FINISH

A. General: Architectural finish shall be required for permanently exposed concrete surfaces and in other locations where specifically called out on the Drawings.

1. Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and all form-tie holes filled as indicated herein.
2. Architectural finishes shall not be applied until the concrete surface has been repaired as required and the concrete has cured at least 14 days.
3. All architecturally treated concrete surfaces shall conform to the accepted sample required herein in texture, color, and quality. It shall be the Contractor's responsibility to maintain and protect the concrete finish.

B. Smooth Concrete Finish

1. The concrete surface shall be wetted, and a grout shall be applied with a brush. The grout shall be made by mixing one part Portland cement and one part of fine sand that will pass a No. 16 sieve with sufficient water to give it the consistency of thick paint. The cement used in said grout shall be 1/2 gray and 1/2 white Portland cement, as

determined by the Engineer. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling all small air holes. After all the surface grout had been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely all surface grout so that there is no visible paint-like film of grout on the concrete. The entire cleaning operation for any area shall be completed the day it is started, and no grout shall be left on the surface overnight.

2. Cleaning operations for any given day shall be terminated at panel joints. It is essential that the various operations be carefully timed to secure the desired effect which is a light-colored concrete surface of uniform color and texture without any appearance of a paint or grout film.
3. In the event that improper manipulation results in an inferior finish, rub such inferior areas with carborundum bricks.
4. Before beginning any of the final treatment on exposed surfaces, treat in a satisfactory manner a trial area of at least 200 square feet in some inconspicuous place selected by the Engineer and shall preserve said trial area undisturbed until the completion of the job.

3.9 WATERPROOFING

A. Apply waterproofing to exterior surface of all buried roof slabs and walls of underground concrete structures.

B. Refer to Section 07 14 00 – Fluid-Applied Waterproofing.

3.10 TOLERANCES:

A. Construction Tolerances: Set and maintain concrete forms and perform finishing operations so as to ensure that the completed Work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117.

1. The following non-cumulative construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10 feet: 1/4 inch In 20 feet or more: 1/2 inch
Variation from the level or from the grades shown.	In 10 feet: 1/4 inch In 20 feet or more: 1/2 inch
Variation from plumb.	In 10 feet: 1/4 inch In 20 feet or more: 1/2 inch
Variation in the thickness of slabs and walls.	Minus 1/4 inch Plus 1/2 inch
Variation in the locations and sizes of slabs and wall openings.	Plus or minus 1/4 inch

3.11 FIELD QUALITY CONTROL

A. General
   1. Tests on component materials and for slump, temperature, air content, compressive strength and shrinkage of concrete will be performed as specified herein.
   2. The cost of all laboratory tests for qualification of mix designs on cement, aggregates, and concrete, including strength and shrinkage testing will be borne by Contractor. The cost of all field testing during construction, including slump, temperature, air, strength and shrinkage will also be borne by Owner. However, Contractor will be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications.
   3. Provide access for Engineer to aggregate stockpiles for concurrent sampling during construction.
   4. Provide access for Engineer to batch plant for monitoring batching procedures during construction.
   5. Concrete for testing shall be supplied by Contractor at no additional cost to Owner, and Contractor shall provide assistance to Engineer in obtaining samples, and disposal and cleanup of excess material.
   6. Composite samples of concrete placed in the Work shall be taken in accordance with ASTM C172 from the first placement of each class of concrete and at the following minimum frequency for each class:
      a. Not less than one sample per day on which concrete it placed.
      b. Not less than one sample for each 100 cubic yards of concrete placed.
      c. Not less than one sample for each 5,000 square feet of surface area for slabs or walls.
      d. Not less than 5 samples from randomly selected batches for the Work.

B. Slump Tests
   1. Perform in accordance with requirements of ASTM C143 at frequency indicated for sampling above.

C. Temperature Tests
   1. Test concrete temperature per ASTM C1064 at frequency indicated for sampling above.

D. Air Content Tests
   1. Test air content per ASTM C231 at frequency indicated for sampling above.

E. Shrinkage Tests
   1. Drying shrinkage tests will be made for the first placement of each class of structural concrete, and during construction every 3 months to insure continued compliance with these Specifications. A minimum of 1 test per structure shall be made regardless of the timing.
   2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10 inches, fabricated, cured, dried and measured in accordance with ASTM C157.
   3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage test value by more than 25 percent.

a. If the required shrinkage limitation is not met during construction, take any or all of the following actions, at no additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include changing the source or aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

F. Field Compression Tests
1. Field compression test specimens will be made at the frequency indicated for sampling above.
2. Each set of test specimens will be a minimum of five cylinders.
3. Compression test specimens for concrete shall be made in accordance with ASTM C31. Specimens shall be 6-inch diameter by 12-inch high cylinders.
4. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and two at 28 days. The remaining cylinders will be held to verify test results, if needed.

G. Evaluation and Acceptance of Concrete
1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 350 and as specified herein.
2. A statistical analysis of compression test results will be performed according to the requirements of ACI 214. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.
3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.
4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any three consecutive tests being below the specified compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard of deviation.
5. All concrete which fails to meet the ACI requirements and these Specifications, is subject to removal and replacement at no increase in cost to the Owner.

3.12 APPLICATION OF LOADS

A. Do not allow traffic, construction equipment, or materials of any kind to be placed on elevated concrete slabs until the concrete has attained a minimum age of 7 days and 80% of the minimum specified 28-day strength as proven by concrete strength tests.

B. Do not place backfill against cantilevered walls until the concrete has attained a minimum age of 7 days and 100% of the minimum specified 28-day concrete strength as proven by concrete strength tests.

C. Do not place backfill against walls that are tied to elevated slabs or decks until the both the slabs and walls have attained a minimum age of 7 days and 80% of the minimum specified 28-day strength as proven by concrete strength tests.

3.13 SCHEDULES

A. Grout: As specified in Section 03 60 00 – Grouting.

B. Unformed Concrete Surfaces: Apply finish as follows.

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and finished floors, without architectural finishes	U4
Interior slabs and finished floors with architectural finishes	U3
Top surface of walls	U3

END OF SECTION

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SECTION 03 60 00
GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes various types of cementitious grout to be provided and installed per the Contract Documents

B. Section includes the following types of grout:
1. Cement grout.
2. Nonshrink grout.
3. Epoxy grout.
4. Grout for repair of concrete.
5. Pump and motor grout.
6. Concrete topping gout and concrete fill.

1.2 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 318	Building Code Requirements for Reinforced Concrete
ACI 308	Standard Practice for Curing Concrete

B. American Society for Testing and Materials (ASTM) standards, most recent editions:

ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94	Standard Specifications for Ready-Mixed Concrete
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C348	Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars
ASTM C469	Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
ASTM C884	Standard Test Method for Thermal Compatibility Between Concrete and an Epoxy-Resin Overlay
ASTM C939	Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C1090	Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
ASTM C1107	Packaged Dry, Hydraulic Cement Grout (Nonshrink)
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts
ASTM C1202	Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1339	Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D696	Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

C. International Concrete Repair Institute (ICRI) standards, latest editions:

Guideline No 310.1R	Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
Guideline No 320.2R	Guide for selecting and specifying Materials for repair of Concrete Surfaces

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data:
   1. Submit certified test results verifying the compressive strength, shrinkage, and expansion requirements indicated herein.
   2. Submit manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of nonshrink and epoxy grout used in the Work.

C. Certification:
   1. Provide manufacturer's independent certification of compliance with ASTM C1107 without modification to the standard methods certifying that the Class B or C grout's post-hardening non-shrink properties are not based on gas expansion.
   2. Provide Manufacturer's certification that grouts have strengths of 3500 psi at 1 day, 6500 psi at 3 days and 7500 psi at 28 days when cured at 72 degrees F as well as meeting the 3, 7, and 28-day strengths when tested and cured at the 45 degree F and 95 degree F limits and all other requirements of ASTM C1107.
   3. The Contractor shall engage an independent testing laboratory to run a 24-hour grout evaluation in accordance with ASTM C1107 of each grout submitted for approval showing compliance with all aspects of the evaluation. Submit results to the Engineer for review.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.
   1. Store non-shrink grout materials in temperature controlled environments above 40 degrees F and below 90 degrees F.
   2. Store epoxy grout components in temperature controlled environments above 60 degrees F and below 90 degrees F.

C. Deliver epoxy resin, hardener, and aggregate in sealed pre-measured containers, palletized and shrink-wrapped to prevent shipping damage.

D. Immediately remove from the Project site any cement-based grout material which becomes damp or otherwise defective.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Nonshrink, nonmetallic grout:
      a. 5 Star Grout, Five Star Products, Inc.

b. Masterflow 928, BASF Building Systems, Inc.
c. NS Grout, Euclid Chemical Company.
d. Sika Grout 212, Sika Corporation.
e. Engineer approved equal.

2. Epoxy grout:
a. HP Epoxy Grout, Five Star Products, Inc.
b. Masterflow 648 CP Plus, BASF Building Systems, Inc.
c. E^3-Flowable, Euclid Chemical Company.
d. Sikadur 42 Grout-Pak, Sika Corporation.
e. Engineer approved equal.

3. Grout for pumps and motors:
a. Escoweld, ITW Polymer Technologies.
b. Chockfast Red, ITW Polymer Technologies.
c. DP Epoxy Grout, Five Star Products, Inc.
d. Engineer approved equal.

2.2 CEMENT GROUT

A. Cement grout shall be composed of one-part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 4,500 psi.

B. Cement grout materials shall be as specified in Section 03300 – Cast-in-Place Concrete.

2.3 NONSHRINK GROUT

A. Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water.

B. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

C. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout herein shall be that recommended by the manufacturer for the particular application. All grouts (Grade B or C) shall be tested for height change of the hardened grout at 1, 3, 14, and 28 days in accordance with ASTM C1090 and shall be tested for compression at 1, 3, 7, and 28 days in accordance with the modified ASTM C109 testing procedure.

D. Class A non-shrink grouts: Not used.

E. Class B or C high precision, fluid, extended working time, non-shrink grouts:
1. Minimum 28-day compressive strength of 7500 PSI.
2. No shrinkage (0.0 percent) and a maximum of 4.0 percent expansion in the plastic state when tested in accordance with ASTM C827.
3. No shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state
4. When mixed to a fluid consistency of 20 to 30 seconds per ASTM C939 at temperature extremes of 45 to 90 degrees F shall have an extended working time of 30 minutes when tested in accordance with ASTM C1107.

F. Application:

1. Class B or C non-shrink grout shall be used for grouting under all base plates for structural steel members, grouting under all equipment base plates except for pumps and motors, and at all locations where grout is required by the Contract Documents except where epoxy grout or grout for pumps and motors is specifically required. Class B or C non-shrink grout shall be used in place of Class A non-shrink grout for all applications. Class B or C non-shrink grout shall not be used for dry packing applications or repair of concrete.

2.4 EPOXY GROUT

A. Epoxy grout shall be a pourable, nonshrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any nonreactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.

B. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F.

C. The epoxy grout shall develop a compressive strength of 5,000 psi in 24 hours and 10,000 psi in 7 days when tested in accordance with ASTM C579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C827.

D. The epoxy grout shall exhibit a minimum effective bearing area of 95 percent. This shall be determined by testing in accordance with ASTM C1339, for bearing area and flow.

E. The peak exotherm of a 2-inch diameter by 4-inch high cylinder shall not exceed 95 degrees F when tested with 75 degree F material at laboratory temperature. The epoxy grout shall exhibit a maximum thermal coefficient of 30 x 10-6 inches/inch/degree F when tested according to ASTM C531 or ASTM D696.

F. Application:

1. Epoxy grout shall be used to embed all anchor bolts and reinforcing steel required to be set in grout and for all other applications in the Contract Documents where grout type is not specifically indicated.

2.5 GROUT FOR REPAIR OF CONCRETE

A. Vertical, overhead, and shotcrete applications:

1. Shall not produce a vapor barrier.
2. One component, reoplastic, cement based, shrinkage compensated, non-expansive, gray concrete product.
3. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.

4. Free of chlorides and other chemicals causing corrosion with the following properties:
    a. Minimum Slant Shear Bond Strength: 2500 PSI at 28 days when tested in accordance with ASTM C882.
    b. Minimum Compressive strength: 6,500 PSI at 28 days when tested in accordance with ASTM C109.
    c. Minimum Tensile Bond Strength: 200 PSI at 28 days per ASTM C307.
    d. Minimum Flexural Strength: 1,200 PSI when tested in accordance with ASTM C348.
    e. Modulus of Elasticity: 3.6E6 PSI when tested in accordance with ASTM C469.
    f. Maximum Rapid Chloride Permeability: 772 coulombs when tested in accordance with ASTM C1202.

B. Horizontal and formed applications:
1. Shall not produce a vapor barrier.
2. One component, reoplastic, cement-based, shrinkage compensated, non-expansive, gray concrete product.
3. Flowable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.
4. Free of chlorides and other chemicals causing corrosion with the following properties:
    a. Minimum Shear Bond Strength: 2150 PSI at 7 days.
    b. Minimum Compressive Strength: 6000 PSI at 7 days when tested in accordance with ASTM C109.
    c. Minimum Flexural Strength: 770 PSI at 28 days when tested in accordance with ASTM C78.
    d. Maximum Chloride Permeability: 1,000 coulombs when tested in accordance with ASTM C1202.
    e. Modulus of Elasticity: 4.8E6 PSI when tested in accordance with ASTM C469.

2.6 GROUT FOR PUMPS AND MOTORS

A. Grout for pumps and motors shall be epoxy grouts meeting the following minimum requirements:
1. Creep shall be less than 0.005 in/in when tested by ASTM C1181 method. The test shall be at 70 degrees F and 140 degrees F with a load of 400 PSI.
2. Linear shrinkage shall be less than 0.080 percent and thermal expansion less than 17E-6 in/in/degree F when tested by ASTM C531.
3. The compressive strength shall be a minimum of 12,000 PSI in 7 days when tested by ASTM C579 Method B, modified.
4. Bond strength of grout to Portland cement concrete shall be greater than 2,000 PSI when using ASTM C882 test method.
5. Grout shall pass the thermal compatibility test when overlaid on Portland cement concrete using test method ASTM C884.
6. Tensile strength and modulus of elasticity shall be determined by ASTM D638. The tensile strength shall not be less than 1,700 PSI and the modulus of elasticity shall not be less than 1.8E6 PSI.
7. Peak exothermic temperature shall not exceed 110 degrees F when a specimen 6 inches in diameter by 12 inches high is used. Gel time shall be at least 150 minutes.

8. The grout shall be suitable for supporting precision machinery subject to high impact and shock loading in industrial environments while exposed to elevated temperatures as high as 150 degrees F, with a load of 2,000 PSI.

B. Primer, if required, shall conform to the written recommendations of the grout manufacturer.

C. Surface preparations shall conform to the written recommendations of the grout manufacturer.

D. Placement and Curing
1. Placement and curing procedures shall be in accordance with the written recommendations of the grout manufacturer.
2. A grouting performance demonstration/training session shall be conducted by the grout manufacturer's representative prior to foundation and baseplate preparation and the first grouting on site. This training session shall demonstrate proper preparation and installation methods and that the grouting material meets the strength requirements.

2.7 CONCRETE TOPPING GROUT AND CONCRETE FILL

A. Grout for topping of slabs and concrete fill for built up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures as necessary, with strength as specified above.

B. Where concrete topping is deeper than 6 inches, it will be considered "Concrete Fill" and may be placed using either grout as specified herein or "lean concrete", as specified in Section 03300 – Cast-In-Place Concrete, when approved by Engineer.

2.8 CURING MATERIALS

A. Curing materials shall be as specified in Section 03300 – Cast-In-Place Concrete for cement grout and as recommended by the grout manufacturer for prepackaged grouts.

2.9 CONSISTENCY

A. Use grouts with the consistency necessary to completely fill space to be grouted for the particular application. Where "dry pack" is called for in the Contract Documents, use grout with a consistency such that the grout is plastic and moldable but will not flow.

B. Regardless of consistency called for on the Contract Documents, the type of grout to be used shall be as indicated herein for the particular application.

2.10 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement will not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the grout manufacturer.

PART 3 - EXECUTION

3.1 PERPARATION

A. All surface preparation, curing, and protection of cement grout shall be as indicated in Section 03300 – Cast-In-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete.

B. Do not place grout on concrete or masonry substrates until those substrate materials have attained 28-day design strength unless authorized by Engineer.

3.2 MANUFACTURER'S SERVICES

A. The manufacturer of nonshrink grout and epoxy grout shall provide onsite technical assistance upon request.

B. Coordinate with the manufacturer all demonstrations, training sessions, and applicable site visits. The grout manufacturer shall conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurements, cube testing, application, and curing for each category and type of grout.

C. Training by the manufacturer is required for all types of grout installations. Grout manufacturer's representative shall train Contractor to perform the grout Work including mixing of grouts to required consistency, testing, placing, and curing on actual project base plates, tie holes, rock pockets, and other applications.

3.3 GROUTING PROCEDURES

A. Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Base Plate Grouting:
   1. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a 1 inch thickness of grout or a thickness as indicated on the Contract Drawings.
   2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout. The mixture shall be of a trowelable consistency and tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop shall be provided at the back side of the space to be filled with grout. Where this method of placement is not practical or where required by Engineer, alternate grouting methods shall be submitted for acceptance by Engineer.

C. Concrete Topping Grout:
   1. All mechanical, electrical, and finish Work shall be completed prior to placement of concrete topping or concrete fill. The base slab shall be given a roughened textured surface by sandblasting or hydroblasting exposing the aggregates to ensure bonding to the base slab.

2. The minimum thickness of grout topping and concrete fill shall be one inch. Where the finished surface of concrete fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 6-inches wide by 1-1/2 inches deep.
3. The base slab shall be thoroughly cleaned and wetted prior to placing topping and fill. No topping concrete shall be placed until the slab is complete free from standing pools or ponds of water. A thin coat of neat Type II cement grout shall be broomed into the surface of the slab just before topping of fill placement. The topping and fill shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade.
4. Concrete topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping and fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

D. Grout for Repair of Concrete
1. All repairs shall be performed in accordance with the manufacturer's recommendations and with ICRI Guideline No 310.1R and Guideline No 320.2R. These guidelines shall be followed for removal geometry, exposing and undercutting of reinforcing steel, cleaning and repair of reinforcing steel, and edge and surface condition of concrete and shall be followed regardless of the amount of corrosion present or not present in the reinforcing steel.
2. Remove unsound deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16-inch. Remove to provide for minimum thickness specified for mortar. If reinforcing is exposed in this process, then additional concrete shall be removed until the surface is a minimum of 1-inch or 1 bar diameter behind the exposed reinforcing.
3. Clean exposed reinforcing bars of rust and other deleterious materials which may prevent bonding of the repair product.
4. Keep surface at saturated surface dry (SSD) condition for a minimum of 24-hours prior to placement of repair material.
5. Place material in accordance with Manufacturer's written recommendations.
6. Cure material continuously for 7-days with water fog nozzles or other applications which provide a continuous wet curing of the repaired area in accordance with ACI 308.

E. CONSOLIDATION
1. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

END OF SECTION

DIVISION 4
MASONRY

SECTION 04 01 20
MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes cleaning exposed masonry surfaces.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Provide a letter stating that Contractor has a minimum of 5 years' experience in this type of masonry cleaning.

C. Product Data:

1. Manufacturer's instructions, including application rates.
2. Manufacturer's recommendations for neutralizing rinse after cleaning.

D. Samples for Verification:

1. Prior to erecting mock-up, procure and clean two samples of each type of masonry used in Work. Cleaned samples shall be submitted to Engineer for review of aesthetics and effectiveness.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Engaged in producing masonry cleaners that have been used for similar applications with successful results for a minimum or five years, and with factory-trained representatives who are available for consultation and site inspection and assistance at no additional cost to the Owner.
2. Applicator: Trained, approved, and accepted by the cleaning compound manufacturer. Application personnel shall have at least two years of experience with the particular materials being applied.

B. Mock-ups:

1. Clean an area approximately 10 to 20 square feet or larger as required to demonstrate effectiveness of cleaner on each type of masonry unit used. Upon approval of Engineer, cleaner may be applied to mock-up panels constructed in Section 04800 Reinforced Masonry Assemblies.
   a. Prepare mock-ups on existing walls under same weather conditions to be expected during remainder of Work.

b. Test cleaners and methods on samples of adjacent non-masonry materials for possible adverse reactions. Samples of tested materials shall be available for Engineer's review upon request.
c. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Deliver materials in manufacturer's original, unopened containers, labeled with manufacturer's name, batch number, and type of materials

C. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

D. Do not store in areas where temperature will fall below 20 degrees F or rise above 100 degrees F.

1.5 PROJECT CONDITIONS

A. Schedule application of products such that temperature and humidity levels conform to manufacturer's requirements during and after application.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Cleaning solution: Detergent type.
   a. Diedrich Technologies, Inc.; "202 New Masonry Detergent."
   b. Elgene; "Florok 700 Masonry Detergent."
   c. PROSOCO, Inc.; "Sure Klean #600 Detergent."
   d. Engineer approved equal.
2. Cleaning solution for manganese and vanadium stained masonry:
   a. Diedrich Technologies, Inc.; "202V Vana-Stop Mew Masonry."
   b. Elgene "960 Masonry Cleaner."
   c. PROSOCO "Ferrous Stain Remover."
   d. Engineer approved equal.

2.2 MATERIALS

A. Water for Cleaning: Potable

B. Detergent Type Cleaning Solution:
1. Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from new masonry without

discoloring or damaging masonry surfaces. Use products expressly approved for intended use by cleaning solution manufacturer and manufacturer of masonry units being cleaned.

2. Cleaner shall be a solution of blended liquid acids, heavily inhibited and emulsified and in combination with special wetting systems.
3. Specific product selection shall be dependent upon substrate as recommended by the cleaning solution manufacturer.
4. Muratic acid will not be acceptable as a cleaning solution for new masonry.

C. Cleaning Solution for Manganese or Vanadium Stained Masonry:
1. Manufacturer's standard-strength cleaner designed for removing vanadium, manganese, and other metallic stains without discoloring or damaging masonry surfaces. Use products expressly approved for intended use by cleaning solution manufacturer and manufacturer of masonry units being cleaned.
2. Cleaner shall be a solution of blended liquid acids, heavily inhibited and emulsified and in combination with special wetting systems.
3. Specific product selection shall be dependent upon substrate as recommended by the cleaning solution manufacturer.
4. Muratic acid will not be acceptable as a cleaning solution for new masonry.

D. Neutralizing rinse: Rinse to be as required by the manufacturer of the cleaners used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Allow 7 to 28 days after completion of masonry work before start of cleaning.

B. Protection:
1. Protect surrounding surfaces and installed Work from run-off, overspray, and splashing. Erect temporary protective covers and walkways at points of pedestrian and vehicular entrance and exit that must remain in service during course of cleaning.
2. Comply with cleaning solution manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent cleaning solutions from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
    a. Cover adjacent surfaces with materials that are proven to resist the cleaning solutions used. Use materials that contain only waterproof, UV-resistant adhesives. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. Promptly remove masking after cleaner application to prevent adhesive staining.
    b. Keep wall wet below area being cleaned to prevent streaking from runoff.
    c. Do not clean masonry during winds of sufficient force to spread cleaning solutions to unprotected surfaces.
    d. Dispose of runoff from cleaning operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Surface Preparation:
1. Prepare surfaces in strict accordance with manufacturer's printed instructions.
2. Remove excess mortar using wooden paddles and scrapers. Do not scratch or chip masonry surface.
3. Point up cracks, other than hairline cracks
4. Defective mortar joints shall be routed out, pointed with mortar, and tooled.
5. Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used. Extraneous substances include paint, calking, asphalt, and tar.
6. Remove paint and calking with approved alkaline or solvent paint remover.
   a. Comply with requirements for paint removal
   b. Repeat application up to two times if needed.
7. Remove asphalt and tar with approved asphalt and tar remover solution.
   a. Apply only to asphalt and tar by brush without prewetting.
   b. Allow asphalt and tar remover to remain on surface for 10 to 30 minutes.
   c. Rinse off with water using low pressure spray.
   d. Repeat application if needed.

3.2 CLEANER APPLICATION

A. Apply cleaner in strict accordance with manufacturer's printed instructions.
1. Do not use wire brushes or brushes that are not resistant to cleaning solution being used.
2. Use spray equipment that provides controlled application at volume and pressure recommended by manufacturer, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
3. Cleaning solution application:
   a. In accordance with manufacturer's instructions, apply cleaning solution to masonry surfaces using brush or spray application methods, at Contractor's option.
   b. Use low-pressure tank or chemical pump suitable for cleaner indicated, equipped with cone-shaped spray tip.
   c. Do not spray apply at pressures exceeding 50 psi.
   d. Do not allow solution to remain on surface for periods longer than those indicated or recommended by manufacturer.
   e. Reapply cleaner as recommended by manufacturer prior to removing excess mortar.
4. Water application:
   a. Water soak application:
      1) Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles.
      2) Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
   b. Spray Applications:
      1) Use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.

2) Unless otherwise indicated, hold spray nozzle at least six inches from surface of masonry and apply water in horizontal back and forth weeping motion, overlapping previous strokes to produce uniform coverage.

5. High-pressure water spray application:
   a. Use fan-shaped spray tip that disperses water at an angle of at least 40 degrees.

B. Perform cleaning method indicated in a manner that results in uniform coverage for all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.

C. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that cleaning solution is completely removed. Apply neutralizing agent and repeat rinse, if necessary, to produce tested pH of between 6.7 and 7.5.

D. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

3.3 FINAL CLEANING

A. Wash adjacent woodwork and other nonmasonry surfaces. Use detergent and soft brushes or cloths.

B. Clean mortar and debris from roof. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

C. Sweep and rake adjacent pavement and grounds to remove mortar and debris. Where necessary, pressure wash surfaces to remove mortar, dust, dirt, and stains.

END OF SECTION

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SECTION 04 05 12
MORTAR AND GROUT

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install mortar and grout for masonry construction in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 04 22 00 – Concrete Unit Masonry

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C5	Standard Specification for Quicklime for Structural Purposes
ASTM C109	Compressive Strength of Hydraulic Cement Mortars
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C207	Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C270	Standard Specification for Mortar for Unit Masonry
ASTM C404	Standard Specification for Aggregates for Masonry Grout
ASTM C476	Standard Specification for Grout for Masonry
ASTM C1019	Standard Test Method for Sampling and Testing Grout
ASTM E514	Standard Test Method for Water Penetration and Leakage Through Masonry

1.4 DEFINITIONS

A. Coarse grout and fine grout are defined by the aggregate size used in accordance with ASTM C476.

B. Coarse aggregate and fine aggregate are defined in ASTM C404, Table 1.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Submit proposed grout mix design including aggregate data to show conformance to these specifications, including cement data to show conformance to these specifications and ASTM C150. Submit the proposed method of placing grout.

C. Submit proposed mortar mix design including aggregate data to show conformance to these specifications, including cement data to show conformance to these specifications and ASTM C150.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.

C. Store sand only on smooth, well-drained ground free from dust, mud and debris.

D. Do not use bottom 6 inches of pile in mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Integral mortar water repellent:
      a. ACM Chemistries, Inc.: RainBloc.
      b. BASF/Master Builders; MasterPel 240MA.
      c. Grace Construction Products; Dry Block.
      d. Krete Industries, Inc.; Gard Mortar Mix.
      e. Engineer approved equal.
   2. Admixtures for grout
      a. BASF/Master Builders; Pozzolith.
      b. Sika Corporation; SikaGrout Aid Type II.
      c. Engineer approved equal.

2.2 MATERIALS

A. Portland Cement: ASTM C150, Type II, natural color.

B. Mortar Aggregate: ASTM C144, standard masonry type.

C. Hydrated Lime: ASTM C207, Type S.

D. Quicklime: ASTM C5, non-hydraulic type.

E. Grout Aggregate: ASTM C404.

F. Mixing Water: Potable.

G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units that also contain integral water repellent by same manufacturer.

H. Admixtures for Mortar:
   1. Admixtures may be used to obtain the desired or required workability and may be used instead of lime.
   2. The admixture shall not be detrimental to bonding characteristics nor increase the efflorescence.

I. Admixtures for Grout:
   1. Admixtures for grout may be used only when approved by Engineer. If used, they shall be used in accordance with the manufacturer's published recommendations and included in the proposed grout mix submittal.

J. Color: When colored masonry is specified, mortar for use with colored masonry units shall have integral color as approved by Engineer. Color shall match block color.

2.3 MORTAR MIXES

A. ASTM C270, Type M or S mortar mix shall be used. Use the Property Method.

B. Whenever a fire-resistance classification or rating is shown for unit masonry construction, provide mortar of type which has been tested and listed by UL for construction indicated.

C. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C270.

D. Mix materials a minimum of 3 minutes.

E. Do not use masonry cement.

F. Do not use anti-freeze compounds to lower the freezing point of mortar.

G. Provide water repellant treated mortar per water repellant manufacturer's recommended rate. When tested as a wall assembly made with CMU containing integral water repellent manufacturer’s block additive according to ASTM E514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.

2.4 GROUT MIXES

A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C476.

B. Grout strength: For regular masonry units, 2000 psi strength at 28 days and for Hi-R masonry units, 2000 psi strength at 28 days when tested in accordance with ASTM C1019, 8-10 inches slump.

C. Do not use anti-freeze compounds to lower the freezing point of grout.

D. Mix materials a minimum of 5 minutes.

2.5 SOURCE QUALITY CONTROL

A. Perform laboratory test on mortar and grout in accordance with ASTM C109 using the same mix design as proposed for the Work.

PART 3 - EXECUTION

3.1 PREPARATION

A. Plug cleanout holes with block masonry units to prevent leakage of grout materials. Brace masonry for wet grout pressure.

3.2 INSTALLATION

A. Install mortar and grout per requirements of Section 04 22 00 – Concrete Unit Masonry.

B. Use coarse grout in spaces with least dimension over 2 inches.

C. Use fine grout for grouting door and window frames in masonry.

D. Remove excess mortar from grout spaces.

E. Work grout into masonry cores and cavities to eliminate voids.

F. Do not displace reinforcement while placing grout.

3.3 FIELD QUALITY CONTROL

A. Field quality control for masonry mortar and grout will be performed in conjunction with masonry prism testing specified in Section 04 22 00 – Concrete Unit Masonry. Separate tests for grout and mortar will not be required.

B. If Mortar begins to stiffen within 2½ hours, it may be retempered by adding water and remixing

C. Do not use mortar after it has begun to set. No mortar shall be used beyond 2½ hours after initial mixing.

D. Use grout within 2 hours after initial mixing. Use no grout after it has begun to set.

END OF SECTION

SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install concrete masonry in accordance with Contract Documents.

B. Work shall include installation of ties, spacers, supports and other appurtenances necessary to meet Specifications and produce finished masonry structures.

1.2 RELATED SECTIONS

A. Section 03 20 00 – Concrete Reinforcing.

B. Section 04 05 12 – Mortar and Grout.

C. Section 04 01 20 – Masonry Cleaning.

D. Section 07 92 00 – Joint Sealants.

1.3 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions.

ACI SP-66	ACI Detailing Manual
ACI 530	Building Code Requirements for Masonry Structures

B. ASTM International (ASTM) standards, most recent editions:

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM C55	Concrete Building Brick
ASTM C90	Loadbearing Concrete Masonry Units
ASTM C140	Sampling and Testing Concrete Masonry Units and Related Units
ASTM C150	Standard Specification for Portland Cement

ASTM C1314	Standard Test Method for Compressive Strength of Masonry Prisms
ASTM D1056	Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
ASTM D1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM E514	Standard Test Method for Water Penetration and Leakage Through Masonry
ASTM C 578	Specification for Rigid Cellular Polystyrene Thermal Insulation
ASTM C 272	Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
ASTM E 84	Flame Spread Characteristics
ASTM C 303	Test Method for Density of Preformed Block-type Thermal Insulation
ASTM E 119	Standard Methods of Fire Tests of Building Construction and Materials

C. International Code Council (ICC)

IBC	International Building Code, 2012 edition
ICC-ES	Report ESR-3508 (For Hi-R Block and Insulation Inserts)

D. Underwriters Laboratories Inc. (UL):

Building Materials Directory

1.4 SYSTEM DESCRIPTION

A. Provide masonry with a compressive strength, f'm, of 1500 psi minimum at 28 days of age.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data
   1. Submit masonry accessory product data.
   2. Submit Hi-R Masonry Data.

C. Shop Drawings: Include, but not limit to, the following:
   1. Complete bar schedule, bar details and erection drawings to conform to ACI SP-66.
   2. Each type of bar marked with identification corresponding to identification tag on bar.
   3. Length, type, and location of all splices.
   4. Erection drawings shall be clear, easily legible and to a minimum scale of:
      a. 1/4 inch = 1 foot.
      b. 1/8 inch = 1 foot if bars in each face are shown in separate views.
   5. Size and location of openings.
   6. Contract Documents shall not be used as erection drawings.
   7. Block layout details at corners and openings for the Hi-R Block showing how the reinforcement and insulation is continuous at these locations.

D. Samples
   1. Submit samples of concrete masonry unit colors with texture ranges for selection of color. Full size samples of the blocks selected shall be submitted for final approval by the Engineer after color selection, if requested. If the material specified is a colored and textured unit, the samples submitted shall be colored and textured units. Samples of mortar colors shall be submitted for color selection by the Engineer.

E. Test Reports
   1. Submit test reports from testing proposed concrete block masonry units showing compliance with ASTM C90 and IBC Table 2105.2.2.1.2, including aggregate data to show conformance to these specifications and cement data to show conformance to ASTM C 150.
   2. Submit test reports from testing masonry prisms.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Concrete masonry shall conform to the International Building Code and ACI 530 (ASCE 5) and other applicable codes and standards of the governing authorities.

1.7 WARRANTY

A. Warrant that Hi-R inserts are free of defects and are manufactured to meet physical properties and material specifications.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.

C. Store masonry units on pallets and protect from contamination and staining. Keep masonry units covered at all times.

1.9 PROJECT ENVIRONMENTAL REQUIREMENTS

A. General:
1. Protect masonry from excessive loading during construction. Provide shoring as necessary.
2. At the end of each day, or at shutdown, cover tops of all walls not enclosed or otherwise sheltered to protect masonry from weather.

B. Temporary Facilities:
1. Construct and maintain temporary protection required to permit continuous and orderly progress of the Work.
2. In cold weather, provide and maintain heat sufficient to assure temperature above 32 degrees F within the protected areas.
3. In hot weather, provide and maintain shade to protect materials and mixing equipment from direct sunlight.
4. Remove all temporary facilities after completion of the Work.

C. Cold Weather Construction:
1. Procedures prior to and during installation:
a. Air temperature: 30 to 40 degrees F.
1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 degrees F at the time of mixing.
b. Air temperature: 25 to 30 degrees F.
1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 degrees F at time of mixing.
2) Maintain mortar temperatures above freezing until used.
3) Heat grout water and aggregate to produce grout temperatures between 70 and 120 degrees F at the time of mixing.
4) Maintain grout temperatures above 70 degrees F until placed.
c. Air temperature: Below 25 degrees F.
1) Do not place masonry.
2. Procedures after installation:
a. Air temperature: 32 to 40 degrees F.
1) Protect from rain or snow for not less than 24 hours by covering with weather-resistant membrane.
b. Air temperature: 25 to 32 degrees F.
1) Completely cover with weather-resistant covering for not less than 48 hours.
c. Air temperature: 20 to 25 degrees F.
1) Completely cover with weather-resistant insulating blankets for not less than 48 hours or provide other protection approved by Engineer.
d. Air temperature: Below 20 degrees F.
1) Provide enclosed shelters and heating to maintain air temperature on each side of wall above 32 degrees F. for 48 hours.
2) Do not allow rapid drop in temperature after removal of heat.

D. Hot Weather Construction:
   1. Procedures prior to and during installation:
      a. Air temperature: Above 100 degrees F or above 90 degrees F with a wind velocity greater than 8 mph.
         1) Maintain aggregate piles in damp and loose condition.
         2) Produce mortar having a temperature below 120 degrees F.
         3) Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar.
         4) Retemper mortar with cool water to maintain proper consistency.
         5) Use mortar within 2 hours of initial mixing.
      b. Air temperature: Above 115 degrees F or above 105 degrees F with a wind velocity greater than 8 mph.
         1) Implement requirements above plus provide shade for materials and mixing equipment to protect from direct sunlight.
      c. Air temperature: Above 120 degrees F.
         1) Do not place masonry.
   2. Procedures after installation:
      a. Air temperature: Above 100 degrees F or above 90 degrees F with a wind velocity greater than 8 mph.
         1) Fog spray newly constructed masonry until damp, at least three times each day until the masonry is three days old.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Integral masonry water repellent:
      a. ACM Chemistries, Inc.; RainBloc.
      b. BASF/Master Builders; MasterPel 240.
      c. Grace Construction Products; Dry Block.
      d. Krete Industries, Inc.; Krete HQ (S) Plus
      e. Engineer approved equal.
   2. Masonry accessories and horizontal joint reinforcing:
      a. AA Wire Products Co.
      b. Dayton Superior; Dur-O-Wall.
      c. Heckman Building Products, Inc.
      d. Hohmann & Barnard, Inc.
      e. Engineer approved equal.

2.2 MATERIALS

A. Hollow Load Bearing Concrete Masonry Unit (CMU): ASTM C90, medium weight, color and face as shown on Drawings.
   1. Sizes and shapes as indicated on Drawings or as required for conditions.
   2. Face shell and web thickness: ASTM C90, Table 1.
   3. Water Absorption: ASTM C90, Table 2.

4. Fire resistive units: UL rated.
5. Special shapes and faces:
    a. For insulated block use Hi-R Masonry Units
    b. Closed cell bond beam units over openings.
    c. Deep knock-out blocks for bond beams in field of the wall.
    d. Sash units for control joints
    e. Architectural faces as shown on the Drawings.

B. Concrete Brick Units:
1. ASTM C55, of same type and weight as Hollow Load Bearing CMU.

C. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water repellent manufacturer's mortar additive according to ASTM E514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.

D. Mortar and Grout: Refer to Section 04 05 12 – Mortar and Grout.

E. Steel Reinforcement: Refer to Section 03 20 00 – Concrete Reinforcing, and as indicated on Drawings.

F. Hi-R® Concrete Masonry Insulation
1. Description: Inserts complying with ASTM C 578; Standard Type X.
2. Performance Requirements:
    a. Moisture Absorption: ASTM C 272 – < 1.0% by volume
    b. Flame Spread Characteristics: ASTM E 84 – Flame Spread < 5
    c. Thermal Resistance (R) per inch of thickness at 75° = 5.00
    d. Drainage: Allows full drainage of water in cores of masonry units.
    e. Rot & Vermin Resistance: Produced from expanded polystyrene – fully resistant to rot; does not attract vermin, termites or rodents.
    f. Density: ASTM C 303 – 1.3 lb./cu. Ft.
    g. Components: Insulation shall contain no fluorocarbons and no formaldehyde.
    h. Hourly Rating: ASTM E 119 Insert shall cause no reduction in hourly rating.
    i. Shape: Two-piece, interlocking insert shall overlap at both head & bed joints with edges of adjacent inserts of the same type. Keyway shall be provided for butt welded cross-rods of 400 mm (16") o.c. ladder type horizontal wall reinforcement.
3. Product: Hi-R® inserts manufactured by Concrete Block Insulating Systems & available exclusively from Concrete Masonry Block Producers.

G. Sealants: Refer to Section 07 92 00 – Joint Sealants.

H. Bond Breaker Strips: 15-pound asphalt saturated felt.

I. Compressible Joint Filler:
1. Oversized 50 percent to joint width.
2. Closed Cell foam confirming to ASTM D1752, Type I.

J. Back-up Rod:
   1. 30 to 50 percent larger than joint width.
   2. Conform to ASTM D1056, round, closed cell foam.

K. Control Joints:
   1. Solid rubber section 5/8 inch thick with 5/16 inch flange conforming to ASTM D2000.
   2. Durometer hardness of 80 when tested in accordance with ASTM D2240.
   3. Fit neatly, without forcing, in masonry jamb sash grooves.

L. Embedded Flashing Materials: Reinforced plastic flashing of manufacturer's standard composite plastic flashing as described below.
   1. Metal foil, 0.33 mil thick, encapsulated between polyester film and bonded to fiberglass scrim reinforcement, with a total thickness of 7 mil, Dur-O-Wal, “FiberWeb 300", or equal.
   2. Joint tape: Reinforced plastic flashing manufacturer's standard polyester tape, 2 inches (50 mm) wide by 2.0 mils thick.
   3. Application: Use where flashing is fully concealed in masonry.
   4. Adhesive for flashings: Of type recommended by manufacturer of flashing material for use indicated.

M. Steel Lintels, Shelf Angles, and Miscellaneous Steel Shapes:
   1. Steel shapes used in masonry construction shall conform to ASTM A36. Lintels and shelf angles shall be provided when shown on the Drawings. These steel members shall be hot-dip galvanized in accordance with ASTM A123.

PART 3 - EXECUTION

3.1 PREPARATION

A. For Hi-R® block, examine conditions, with installer present, for compliance with requirements, for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry.

B. Verify that anchors and flashings are correct and in proper location for roughing into masonry work. Beginning of installation means that mason accepts existing conditions.

C. Lay out walls in advance for uniform and accurate spacing of bond patterns and joints. Properly locate openings, embedded items, movement type joints, returns, and offsets.

D. Verify that built-in items are in proper location and ready for roughing into masonry work.

E. Provide temporary bracing during installation of masonry work as required. Maintain in place until building structure provides permanent bracing for the walls.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:

1. Build walls to thickness indicated on Drawings.
2. Build single-wythe walls to actual thickness of masonry units.
3. Build in flashing, reinforcing, weeps, and related items.
4. Perform all cutting with masonry saws.
5. Drill holes with power drills when required for piping, conduit, etc.
6. Install all block in running bond. Protect from displacement.
7. Cut as required to maintain bond pattern.
8. Avoid use of less than half-size units, whenever possible.
9. Do not use chipped, cracked, spalled, stained, or otherwise imperfect units exposed in finish work.
10. Build chases and recesses as indicated and required for work of other trades. Provide not less than 8 inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

C. For Hi-R® Concrete Masonry Insulation Inserts:
1. General: Inserts shall be pre-installed by CMU manufacturer prior to delivery to jobsite.
2. Unless otherwise indicated on Construction Documents, inserts shall be left in place when grouting.

D. Concrete Masonry Lintels and Sills:
1. For openings which do not show precast concrete or steel lintels, use concrete masonry lintel units and reinforced concrete fill as shown on Drawings.

E. Laying and Tooling:
1. Lay masonry units with face shells in completely filled bed and head joints.
   a. Butter ends with sufficient mortar to fill head joints and shove into place.
   b. Do not slush head joints.
2. Head joints in lintels shall be mortared solid for full thickness of the wall.
3. Maintain nominal 3/8 inch joint widths.
   a. Tool all joints concave.
   b. During tooling of joints, enlarge any voids or holes and completely fill with mortar.
4. Point-up all joints at corners, openings, and adjacent work to provide neat and uniform appearance.
5. Remove any masonry that is disturbed after laying.
   a. Clean and relay in fresh mortar.
   b. Do not pound units to fit.
   c. If adjustments are required, remove units, clean, and reset in fresh mortar.
6. Toothing of masonry units will not be permitted.
7. Where work is stopped and later resumed, rack back 1/2 masonry unit length in each course.
   a. Remove loose units and mortar prior to laying fresh masonry.
8. As work progresses, build in items indicated on Drawings and specified.
   a. Fill in solidly with mortar around built-in items.
   b. Grout-fill space between door frames and masonry.

F. Reinforcing:
1. Provide continuous horizontal joint reinforcing where indicated on Drawings.

a. Embed longitudinal side rods in mortar for entire length with minimum cover of 5/8 inch on exterior side of walls and 1/2" at other locations.
b. Lap reinforcement minimum 12 inches at ends.
c. Do not bridge control and expansion joints with joint reinforcing.
d. Make corners and wall intersections by use of prefabricated "L" and "T" sections.
e. Cut and bend as required.
f. Install joint reinforcing at 16 inches on center vertically unless noted otherwise on Drawings.
g. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 24-inches each side of opening, unless otherwise shown on Drawings.

2. Install vertical and horizontal reinforcing bars where indicated on Drawings.
   a. Support and secure reinforcing bars from displacement.
      1) Retain vertical reinforcement in position at top and bottom of each bar and at intervals not exceeding 160 bar diameters.
   b. Unless otherwise shown on the Drawings, the reinforcing bars shall be located as follows:
      1) Single vertical bar; centered in cell.
      2) Double vertical bars; 2-3/4 inches from face of masonry.
      3) Horizontal bars; 4 inches above the bottom of the masonry unit.
   c. Reinforce horizontal bond beams with 2-#4 bars unless otherwise shown on the Drawings.
   d. Lap splices a minimum of 54 bar diameters unless otherwise shown on the Drawings.
3. Bar clearances:
   a. The clear distance between the surface of a bar and any surface of a masonry unit shall not be less than ¼-inch for fine grout and ½-inch for coarse grout. Cross webs of hollow units may be used as support for horizontal reinforcement. All reinforcing bars, except joint reinforcing, shall be completely embedded in mortar or grout and have a minimum cover, including the masonry unit, of at least ¾-inch when not exposed to weather or soil, 1½-inches of cover when exposed to weather, and 2-inches of cover when exposed to soil.

G. Grout Placement:
1. For masonry grout lifts 4 feet and higher, cure all masonry for a minimum or 24 hours after placement before beginning grouting operations. Grout lifts less than 4 feet may be placed immediately after setting masonry.
2. Grout spaces less than 2 inches in width with fine grout using low lift grouting techniques.
3. Grout spaces 2 inches or greater in width with coarse grout using high or low lift grouting techniques.
4. When grouting is stopped for more than one hour, terminate grout 1-1/2 inch below top of upper masonry unit to form a positive key for subsequent grout placement.
5. Low lift grouting:
   a. Place first lift of grout to a height of 16 inches and rod for grout consolidation.
   b. Place subsequent lifts in 8 inch increments and rod for grout consolidation.
6. High lift grouting:

a. Clean out masonry cells and cavities.
b. Pump grout into spaces. Maintain water content in grout to intended slump without aggregate segregation.
c. Limit grout lift to 48 inches and vibrate or rod for grout consolidation.
d. Wait 60 minutes before placing next lift.

7. Fill all cells and cavities for solid grout construction.

H. Lintels, Control Joints, and Sealants.
1. Provide vertical expansion, control, and isolation joints where indicated on the Drawings.
2. Refer to Section 07 92 00 – Joint Sealants, for sealant installation requirements.
a. Seal all control and expansion joints.
b. Provide reinforced masonry lintels whenever openings more than 12 inches wide are indicated on the Drawings without other structural support or other supporting lintels.
1) Allow masonry lintels to attain specified strength before removing temporary supports.

3.3 SITE TOLERANCES

A. Maximum variation from plumb in vertical lines and surfaces of columns, walls, and arises:
1. 1/4 inch in 10 feet.
2. 3/8 inch in a story height not to exceed 20 feet.
3. 1/2 inch in 40 feet or more.

B. Maximum variation from plumb for external corners, expansion joints, and other conspicuous lines:
1. 1/4 inch in any story or 20 feet maximum.
2. 1/2 inch in 40 feet or more.

C. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
1. 1/4 inch in any bay or 20 feet.
2. 1/2 inch in 40 feet or more.

D. Maximum variation from plan location of related portions of columns, walls, and partitions:
1. 1/2 inch in any bay or 20 feet.
2. 3/4 inch in 40 feet or more.

E. Maximum variation in cross-sectional dimensions of columns and thicknesses of walls from dimensions shown on the Drawings:
1. Minus 1/4 inch.
2. Plus 1/2 inch.

3.4 FIELD QUALITY CONTROL

A. Inspection:
1. Masonry construction shall be inspected by a Special Inspector selected by Engineer and approved by the local Building Official having jurisdiction. Items subject to Special Inspection shall be inspected in accordance with Chapter 17 of the

International Building Code (IBC) at the specific frequency listed on the Drawings. The Special Inspector shall work under the direct supervision of Engineer. All costs of such inspection will be borne by Owner.

2. The Special Inspector will observe the Work for conformance with the design drawings and specifications in accordance with Paragraph 1705.4 of the IBC.

B. Site Tests:

1. Concrete block masonry units shall be sampled and tested in accordance with ASTM C140.
   a. Provide test results minimum of 5 days prior to start of masonry construction.
   b. Remove CMU immediately from site if CMU fails test requirements.
2. Testing of masonry prisms:
   a. Testing of Masonry Prisms: Engineer shall have masonry prisms tested to assure compliance with the Specifications and the governing codes by a recognized testing laboratory.
      1) Tests shall be made in accordance with IBC Section 2105 at the following times:
         a) At the time of the construction of the sample panel, at least 5 masonry prisms shall be made for each type of block indicated herein; except, separate prisms are not required for block which only varies by texture.
         b) At any change in materials during construction, at least 5 masonry prisms shall be made for each type of block affected.
         c) Minimum of one set of at least 5 masonry prisms shall be made for each masonry structure, besides the structure that the sample panel is part of, or for each week in which block is laid, for each type of block involved; whichever occurs first.
         d) Additional sets of at least 5 masonry prisms may be required whenever, in the judgment of Engineer, additional tests are necessary to determine the quality of the materials.
      2) The prisms shall be constructed by Contractor in the presence of Engineer or Engineer's representative. The same personnel who are laying the block in the structure shall construct the masonry prism.
      3) The masonry prisms shall be constructed and tested as specified in ASTM C1314. The prism shall be grouted after the required 24 hour minimum cure period, using the same grout used in the walls.
      4) Compression tests made on sets of specimens made during construction shall include 2 prisms tested at 7 days after grouting and 3 prisms tested at 28 days after grouting.
      5) The average compressive strength of prisms tested at 28 days after grouting, shall not be less than the specified masonry compressive strength.
3. Corrective Actions: If the compressive strength of the prisms, made during construction of the sample panel and tested as indicated, fails to meet or exceed the strength required, adjustments shall be made to the mix designs for the mortar, or grout, or both, as needed to produce the specified strength. The masonry units shall also be retested to verify compliance to the requirements of ASTM C 90.
4. If the compressive strength of the prism, made during construction and tested as indicated, fails to meet or exceed that required, prisms or cores shall be cut from the

walls constructed in sufficient numbers and in sufficient locations to adequately determine the strength of the walls in accordance with IBC Section 2105. Those portions of the walls represented by specimens failing to meet the required compressive strength are subject to being removed and replaced. Corrective actions as indicated above shall be taken.

5. The costs of tests and test reports except for additional tests requested by Engineer shall be paid by Owner. The costs of the additional tests and reports, when reports verify compliance with the Contract Documents will also be paid by Owner. When tests or reports do not verify compliance, the cost of all additional tests and reports shall be paid by Contractor at no increased cost to Owner.
6. Test samples shall be stored in a moist environment until tested, unless directed otherwise by Engineer or the testing laboratory.

3.5 PROTECTION

A. Protect the exposed faces of the masonry from staining by mortar, grout, weather, or other conditions and materials.

B. When moisture protection is required, use light fog spray nozzles to cure mortar.

C. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain is imminent and when Work is discontinued.

D. Adequately brace walls until walls and roof are completed. Below grade walls shall not be backfilled until top decks and roofs are in place

E. Provide sufficient bracing to protect walls against damage from elements, including wind and rain.

F. Protect masonry against freezing for a minimum of 72 hours after being laid.

G. Protect masonry from damage until final acceptance of Work. Damaged units will not be accepted.

3.6 CLEANING

A. Clean masonry in accordance with section 04 01 20 Masonry Cleaning.

END OF SECTION

DIVISION 5
METAL FABRICATION

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide structural steel framing and appurtenant metal parts required for permanent connection of structural steel, complete, in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 03 60 00 – Grouting

B. Section 05 50 00 – Metal Fabrications

C. Section 09 90 00 – Painting and Coating

1.3 REFERENCES

A. American Institute of Steel Construction (AISC) standards, most recent editions:

Manual of Steel Construction, 15th Edition.

Code of Standard Practice for Steel Buildings and Bridges.

Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design.

Structural Joints	Allowable Stress Design Specifications for Structural Joints Using ASTM A325 and A490 Bolts, approved by the Research Council on Structural Connections of the Engineering Foundation.

B. ASTM International (ASTM) standards, most recent editions:

ASTM A6	Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
ASTM A36	Specification for Structural Steel.
ASTM A53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

ASTM A325	Specification for Structural Bolts, Steel Heat Treated, 120/105 ksi Minimum Tensile Strength.
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A992	Standard Specification for Steel for Structural Shapes for Use in Building Framing
ASTM A593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM A594	Standard Specification for Stainless Steel Nuts
ASTM A1085	Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

C. American Welding Society (AWS) standards, most recent editions:

D1.1	Structural Welding Code-Steel

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop drawings:
1. Conform to AISC recommendations and specifications.
2. Show all holes required for other Work.
3. Include complete erection drawings and details showing all members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing sequence of erection.
4. Fabricator's drawings shall not include reproductions from Contract Drawings.

C. Test reports:
1. Certified copies of mill tests for material supplied.

D. Surveys:
1. Submit certified copies of each survey conducted by a registered professional engineer or surveyor, showing elevations and locations of base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Steel fabricator: Minimum of 10 years of experience in fabrication of structural steel and be certified under AISC Quality Certification Program, Category BU at time of bid.
   2. Steel erector: Minimum of 10 years' experience in erection of structural steel and be certified under AISC Quality Certification Program, Category CSE at time of bid.
   3. Welders: Use welders with current certifications (previous 12 months at time of bid) for the material, type, and position of welding used. Certify in accordance with AWS Specifications according to AWS D1.1, Structural Welding Code – Steel.
      a. All weld procedures and welder qualifications shall be available in the Contractor's field office for review.
      b. All welding shall be inspected by a Contractor-furnished inspector qualified in accordance with AWS requirements and approved by the Engineer

B. Shop inspection may be required by Owner at Owner's own expense.
   1. Furnish ample notice to Engineer prior to the beginning of fabrication work so that inspection may be provided.
   2. Furnish all facilities for the inspection of materials and workmanship in the shop and allow inspectors free access to the necessary parts of the Work.
   3. Inspectors shall have the authority to reject materials and Work that does not meet Specifications.
   4. Inspection at the shop is intended to facilitate the Work and avoid errors, but will in no way relieve Contractor from the responsibility for providing proper materials and workmanship under this Specification.

C. Owner may engage inspectors to inspect welded connections and high-strength bolted connections, and to perform tests and prepare test reports.
   1. Ten percent of all butt and bevel welds that extend continuously for 24 inches or less will be completely tested in accordance with AWS D1.1, Part B, Radiographic Testing of Welds, Chapter 6. Butt and bevel welds that extend continuously for more than 24 inches will be spot tested at intervals not exceeding 36 inches.
   2. Welds required by Engineer to be corrected shall be corrected or redone and retested as directed, at no additional cost to Owner.
   3. Have tested to failure, three bolts from each heat lot of bolts supplied to the job to verify compliance with Specifications.
      a. Testing laboratory: Approved by Engineer.
      b. Submit test reports to Engineer in accordance with 01 33 20 – Contractor Submittals.
      c. Inspect high-strength bolts using one of the methods set forth in the AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

D. Costs for initial testing will be paid for by Owner. Pay costs for additional testing and investigation on Work that does not meet Specifications.
   1. Supply material for testing at no additional cost to Owner.
   2. Provide assistance to Engineer in obtaining material for test samples.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Structural members shall be loaded in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

C. Protect structural steel members and packaged materials from corrosion and deterioration.

D. Store material in a dry area and do not place in direct contact with the ground.
   1. Do not place materials on the structure in a manner that might cause distortion or damage to the members or supporting structures.
   2. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Welded anchor studs.
      a. Nelson Stud Welding Company.
      b. Omark Industries, KSM Fastening Systems Division.
      c. Stud Welding Products, Inc.
      d. Engineer approved equal.

2.2 MATERIALS

A. Wide Flange Steel Shapes: ASTM A992.

B. Other Steel Shapes, Plates, and Bars: ASTM A6 and ASTM A36, unless otherwise shown.

C. Structural Steel Pipe: ASTM A53, Type E or S, Grade B.

D. Structural Tubing: ASTM A500, Grade C or ASTM A1085.

E. Bolts for Connections: ASTM A325, in bearing type connections with threads included in the shear plane (A325N), with standard washers unless noted otherwise. Bolts and nuts used to connect dissimilar metals shall be ASTM F593 and F594, Type 316 stainless steel.

F. Welded Anchor Studs: Headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated in the Contract Documents.

G. Non-shrink grout: Refer to 03 60 00 – Grouting.

H. Drill-in anchors: Refer to Section 05 50 00 – Metal Fabrications.

I. Cast-in-place anchor bolts: Provide anchor bolts of size and configuration shown on the Drawings and conforming to ASTM F1554, Grade 36.

J. Galvanizing: ASTM A123 or A653 with minimum coating of 1.5 ounces per square foot.

2.3 FABRICATION

A. Structural steel shall be fabricated in accordance with Contract Drawings, AISC Specifications, and as indicated on shop drawings.

B. Minimize the amount of field welding. Shop assemble components into largest size practical commensurate with transportation and handling limitations.
   1. Shop connections: Bolted with high-strength A325N bolts or welded.

C. One-sided or other types of eccentric connections not indicated in the Contract Documents will not be permitted without prior approval.

D. Accurately mill bearing surfaces to true plane.

E. Cut, drill, or punch holes at right angles to surface of metal.
   1. Do not make or enlarge holes by burning.
   2. Make holes clean cut, without torn or ragged edges.
   3. Remove outside burrs resulting from drilling or reaming operations with a tool making 1/16 inch bevel.
   4. Provide holes in members to permit connection of work of other trades.

F. Headed studs and deformed bar anchors:
   1. Automatically end weld in accordance with AWS code and manufacturer's recommendation.
   2. Fillet welding of headed studs and deformed bar anchors will not be allowed.

G. Cope at 45 degrees, corners of stiffener plates at junction of member flanges with webs.

H. Materials shall be properly marked and match marked for field assembly.

I. Furnish structural members full length without splices unless otherwise indicated.

J. Where finishing is required, assembly shall be completed, including bolting and welding of units, before start of finishing operations.

K. Steel members in contact with dissimilar metals shall be protected from galvanic action by coating contact areas in accordance with Section 05 50 00 – Metal Fabrications, unless indicated otherwise.

L. Clean and coat structural steel in accordance with Section 09 90 00 – Painting and Coating

2.4 WELDING

A. Requirements of this paragraph apply to both shop welding and field welding.

B. Comply with AWS D1.1 and other requirements indicated for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.

C. Test and qualify welders, welding operators, and tackers in compliance with AWS D1.1 for position and type of welding to which they will be assigned.

D. Do not perform welding when ambient temperature is lower than 0 degrees F or where surfaces are wet and exposed to rain, snow, or high wind, or where operators are exposed to inclement conditions.

E. When headed stud type shear connectors are to be field applied, clean surface of members to receive studs in shop to remove oil, scale, rust, dirt, and other deleterious materials. Do not shop paint or galvanize metal surfaces to receive field applied studs.

F. Test in-place studs in accordance with requirements of AWS D1.1 qualification procedures to ensure adequate welding of studs to members.

2.5 SHOP PAINT PRIMER

A. Apply shop paint primer in accordance with Section 09 90 00 – Painting and Coating.

B. Provide suitable methods of handling and transporting painted steel to avoid damage to coating.

C. Anchor Bolts:
   1. Anchor bolts in exterior locations shall be hot-dip galvanized to a depth of 1 inch below finished concrete surface.

D. Omit shop applied primer in the following cases:
   1. At field weld locations.
   2. For the portion of a member to be embedded in concrete.
   3. Where galvanizing with no further coating is required.

E. Clean all surfaces thoroughly not coated before shipping. Remove loose mill scale, rust, dirt, oil, and grease. Protect machined surfaces.

2.6 GALVANIZING

A. When specified elsewhere in the Contract Documents, structural steel shall be hot-dip galvanized after fabrication.
   1. Galvanizing: ASTM A123 or A653 with minimum coating of 1.5 ounce per square foot.

B. Provide suitable methods of handling and transporting coated steel to avoid damage to coating.

PART 3 - EXECUTION

3.1 GENERAL

A. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing are installed.

B. Plumb, align, and set structural steel members to tolerances listed in the AISC Code of Standard Practice for the type of Work being installed. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and level and in proper alignment until permanent connections are made, the succeeding Work is in place, and temporary measures are no longer necessary. Use temporary guys, bracing, shoring, and other work to prevent damage to adjacent work and existing structures or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind. Remove and dispose of all temporary Work and facilities off-site.

3.2 EXAMINATION

A. Verify dimensions and elevations, make field measurements necessary, and be fully responsible for accuracy and layout of Work.
   1. Specifically check the elevations of all finished footings or foundations to receive steel framing and the alignment of all anchor bolts before starting erection. Notify Engineer of any deviations found by such checking.

B. Review Drawings and report discrepancies to Engineer for clarification prior to starting fabrication.

3.3 FIELD CONNECTIONS

A. Provide bolts for all field connections except where shown otherwise on the Contract Drawings.
   1. Use high-strength A325N bolts unless specifically shown otherwise.
   2. Conform to "Specifications for Structural Joints Using ASTM A325 or A490 bolts."
   3. Standard A307 bolts may be used for attaching steel stair treads to steel stringers.

B. Shop and field connections shall be bolted or welded as indicated. Connections shall develop full strength of members joined and shall conform to AISC standard connections.

3.4 WELDED CONSTRUCTION

A. Comply with current AWS D1.1 Code for procedures, appearance, quality of welds and welders, and methods used in correcting welding Work.
   1. Welded architectural metal Work exposed to view shall have welds ground smooth.
   2. Use shielded metal arc welding method or gas metal arc welding methods for structural steel welding.

B. Unless otherwise indicated, all butt and bevel welds shall be complete penetration.

3.5 HOLES FOR OTHER WORK

A. Provide holes as necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.

B. No torch cut holes will be permitted.

3.6 ERECTION

A. Comply with AISC Specifications and Code of Standard Practice.

B. Install high strength bolts in accordance with the AISC Specification for Structural Joints Using ASTM A325N bolts. Connections shall be bearing type (threads excluded from shear planes) unless indicated otherwise.

C. Provide anchor bolts and other connectors required for securing structural steel to in-place Work and templates and other devices for presetting bolts and other anchors to accurate locations.

3.7 SETTING BASES AND BEARING PLATES

A. Prior to placement of non-shrink grout beneath base and bearing plates, clean bottom surface of plates of all bond reducing materials, and clean concrete and masonry bearing surface of all bond reducing materials and roughen to improve bonding.

B. Loose and attached base plates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

C. Tighten anchor bolts after supported members have been positioned and plumbed and non-shrink grout has attained its indicated strength.

D. Grout base plates with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

3.8 FIELD ASSEMBLY

A. Set structural frames accurately to the lines and elevations indicated.
   1. Align and adjust various members to form a part of a complete frame or structure before permanently fastening.
   2. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact.
   3. Perform necessary adjustments to compensate for discrepancies in elevations and alignments.

B. Level and plumb individual members of structure within specified AISC tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of structure.

3.9 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, immediately notify Engineer.
   1. Propose a method to remedy the misfit for review by Engineer.
   2. Engineer will determine whether remedy is acceptable or if the member must be refabricated.

B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by use of drift pins.

C. Pay costs associated with repair of misfits at no increased cost to Owner.

3.10 GAS CUTTING

A. Gas cutting torches shall not be used in the field for correcting fabrication errors in structural framing, except when approved by Engineer.

B. Gas cut sections shall be finished equal to a sheared appearance.

3.11 TOUCH-UP COATING

A. Clean field welds, bolted connections, and abraded areas of shop paint primer immediately after erection.
   1. Apply touchup paint primer by brush or spray at the same thickness and of the same material used for shop paint.
   2. Repair galvanized surfaces that have been field welded or damaged in accordance with Section 05 50 00 – Metal Fabrications.

B. Finish painting of all structural steel shall be as indicated in Section 09 90 00 – Painting and Coating.

END OF SECTION

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish, fabricate, and install metal fabrications in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 05 12 00 – Structural Steel Framing

B. Section 07 72 00 – Roof Accessories

C. Section 09 90 00 – Painting and Coating

D. Section 09 97 01 – Pipeline Coatings and Linings

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36	Specification for Structural Steel
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Gray Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A197	Standard Specification for Cupola Malleable Iron
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	Specification for Structural Bolts, Steel Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A536	Standard Specification for Ductile Iron Castings

ASTM A563	Specification for Carbons and Alloy Steel Nuts
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTMA668	Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992	Standard Specification for Steel for Structural Shapes for Use in Building Framing
ASTM A1085	Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B211	Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B308	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429	Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

B. American National Standards Institute (ANSI) standards, most recent editions:

ANSI A14.3	Standard for Ladders - Fixed - Safety Requirements

C. American Welding Society (AWS) Standards, most recent editions:

AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel
AWS QC1	Specification for AWS Certification of Welding Inspectors
AWS Welding Handbook	

D. American Water Works Association (AWWA) standards, most recent editions:

AWWA C105	American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines

E. National Sanitation Foundation (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects.

F. Federal Specifications:

MIL-A-907E	Anti-seize Thread Compound, High Temperature

G. Occupational Safety and Health Administration (OSHA), most recent editions:

OSHA 1910.27	Fixed Ladders

H. Society for Protective Coatings (SSPC):

SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel

1.4 DEFINITIONS

A. Metal Fabrications: Defined as items to be fabricated from metal shapes, plates, or bars and their products.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Submit shop drawings of all metal fabrications to the Engineer for review.
   1. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

2. Submit layout drawings for grating showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners. Submit load and deflection tables for each style and depth of grating used.

C. Submit ICC-ES report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor submitted. Submit manufacturer's recommended installation instructions and procedures for adhesive anchors. Upon review, by Engineer, these instructions shall be followed specifically.

D. No substitution for the indicated adhesive anchors will be considered unless accompanied by an ICC-ES report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

1.6 QUALITY ASSURANCE

A. All weld procedures and welder qualifications shall be available in the Contractor's field office for review.

B. Qualification of Welders: Use welders with current certifications (previous 12 months) for the material, type, and position of welding used. Certify in accordance with AWS Specifications according to the following:
1. AWS D1.1, Structural Welding Code – Steel.
2. AWS D1.2, Structural Welding Code – Aluminum.
3. AWS D1.6, Structural Welding Code – Stainless Steel.

C. All welding shall be inspected by a Contractor-furnished inspector qualified in accordance with AWS requirements and approved by the Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Metal fabrications shall be loaded for transport in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

C. Protect metal fabrications from corrosion and deterioration.

D. Store material in a dry area and do not place in direct contact with the ground.
1. Do not place materials on the structure in a manner that might cause distortion or damage to the members or supporting structures.
2. Repair or replace damaged materials or structures as directed.

1.8 PROJECT CONDITIONS

A. Check actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Concrete and masonry anchors:
      a. Hilti, Inc.
      b. ITW Ramset/Redhead.
      c. Simpson Strong Tie Company, Inc.
      d. Engineer approved equal.
   2. Castings, trench covers, and accessories:
      a. D&L Foundry and Supply
      b. Deeter Foundry company.
      c. Neenah Foundry Company.
      d. Engineer approved equal.
   3. All purpose metal framing
      a. Allied Tube and conduit.
      b. B-Line Systems.
      c. Unistrut Building Systems.
      d. Engineer approved equal.
   4. Steel Ladder Rungs:
      a. Perforated “Traction Tread”; McNichols, Co.
      b. Engineer approved equal.
   5. Floor hatches:
      a. Babcock Davis Associates.
      b. Bilco Company.
      c. Dur-Red Products.
      d. Engineer approved equal.
   6. Anti-seize lubricant:
      a. AS-470 by Dixon Ticonderoga
      b. PURE WHITE by Anti-Seize Technology
      c. Engineer approved equal.

2.2 MATERIALS

A. Steel: Refer to Section 05 12 00 – Structural Steel Framing.

B. Steel:
   1. Wide flange steel shapes shall be ASTM A992. Other steel shapes, plates, and bars shall be in accordance with ASTM A6 and ASTM A36, unless otherwise shown.
   2. Structural steel pipe shall be ASTM A53, Type E or S, Grade B.

3. Structural tubing shall be ASTM A1085. Furnish members full length without splices unless otherwise noted or approved by Engineer.
4. Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated in the Contract Documents.

C. Steel Forgings: ASTM A668.

D. Stainless steel: ASTM A666 and ASTM A276, Type 316 or 316L

E. Aluminum: Refer to Section 05 14 00 – Structural Aluminum.

F. Aluminum: Alloy 6061 – T6 conforming to the following specifications:
1. Sheet and plate: ASTM B209.
2. Rolled Bars and Rods: ASTM B211.
3. Extruded bars, rods, shapes, and tubes: ASTM B221.
4. Rolled or extruded structural shapes: ASTM B308.
5. Extruded structural pipe and tube: ASTM B429.

G. Iron:
1. Ductile iron: ASTM A536.
2. Gray cast iron: ASTM A48.
3. Malleable iron: ASTM A47, A197.

H. Bolts and Anchors:
1. Standard Service (non-corrosive applications): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following:
   a. Anchor bolts: ASTM F1554, Grade 36, of dimensions indicated, with nuts conforming to ASTM A563 and flat washers where indicated.
   b. Install high-strength structural connections using ASTM A325 bolts and nuts per ASTM A563, coated to match material being connected.
2. Corrosive Service: All bolts, nuts, and washers in the locations listed below shall be stainless steel.
   a. All buried locations except as noted below for pipe flange, fitting and coupling connections.
   b. All submerged locations.
   c. Inside hydraulic structures, below the top of the structure.
   d. Inside buried vaults, manholes, and structures that do not have a forced-air ventilation system and either a gravity drain or a sump with a sump pump.
   e. All chemical handling areas.
   f. Other locations indicated by the Contract Documents or designated by the Engineer to be provided with stainless steel bolts.
3. Stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, conforming to ASTM F593F for bolts and to ASTM F594 for nuts. Protect all threads on stainless steel bolts with an anti-seize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E and classified as acceptable

for potable water use by NSF. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

4. Pipe Flange, Fitting and Coupling Connection Applications: Unless otherwise noted, all pipe flange, fitting and coupling connection bolts shall be carbon steel per ASTM A307, Grade A hex bolts, with nuts per ASTM A563. All bolts, nuts and washers shall be zinc plated. Protect all threads on bolts and nuts with anti-seize lubricant.
   a. Exposed Connections: For exposed pipe connections in buried vaults, manholes, and structures with forced-air ventilation and which drain through a gravity sewer or to a sump with a pump, prepare and coat bolts and nuts after installation with the same system as the adjacent flanged piping, in accordance with Section 09 90 00 – Painting and Coating.
   b. Buried Connections: Coat all buried connections in accordance with Section 09 97 01 – Pipeline Coatings and Linings. Provide wax tape coating per AWWA C217 for steel pipe connections, including sleeve couplings and restrained sleeve couplings. For other pipe materials, grease and wrap connections per AWWA C105.
5. Bolt Requirements:
   a. The bolt and nut material shall be free-cutting steel.
   b. The nuts shall be capable of developing the full strength of the bolts.
   c. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.
   d. Provide bolts with hexagon heads. Provide nuts conforming to Heavy Hexagon Series.
   e. Install all bolts and nuts with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification.
   f. Install lock washers with washers where indicated and fabricated of material matching the bolts.

I. Provide bolts of length such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.

J. Epoxy Anchors: Unless otherwise indicated, all drilled concrete or masonry anchors shall be epoxy anchors. No substitutions will be considered unless accompanied with ICC-ES reports verifying strength and material equivalency.
   1. Epoxy anchors are required for drilled anchors where exposed to weather, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails, pumps, mechanical equipment, and reinforcing bars. Provide threaded stainless steel rod, Type 316.
   2. Unless otherwise indicated, epoxy anchors will also be permitted in locations not indicated above.
   3. Products for concrete anchorage:
      a. HIT-RE 500-V3, Hilti.
      b. HIT-HY 200.
      c. Set XP, Simpson Strong-Tie.
      d. Red Head C6+, ITW Ramset/Redhead.
      e. Engineer approved equal.
   4. Products for masonry anchorage:
      a. HIT-HY 270, Hilti.

b. Set XP, Simpson Strong-Tie.
c. Red Head C6+, ITW Ramset/Redhead.
d. Engineer approved equal.

K. Expansion Anchors: Expansion anchors will only be permitted when specifically approved by the Engineer. Expansion anchors that are to be fully encased in grout may be carbon steel. For non-encased buried or submerged anchors, provide stainless steel anchors. When expansion anchors are indicated or permitted, provide the following:
1. Kwik-Bolt TZ, Hilti.
2. Strong-Bolt 2, Simpson Strong-Tie.
3. Trubolt, ITW Ramset/Redhead.
4. Engineer approved equal.

L. Corrosion Protection:
1. Hot-dip galvanize all miscellaneous steel metalwork after fabrication.
a. Galvanizing: ASTM A123 or A653 with minimum coating of 1.5 ounce per square foot.

2.3 MANUFACTURED UNITS

A. Handrails and Guardrails: Refer to Section 05 52 13 – Pipe and Tube Railings.

B. Bollards:
1. Standard weight steel pipe, diameter as shown on Drawings.
2. Minimum 48 inches projection above finish grade.
3. Minimum 42 inches embedment in concrete.
4. Fabricate sleeves for removable bollards from steel pipe with 1/4-inch thick steel plate welded to bottom of sleeve.

C. Ladders:
1. Ladders shall be of stainless steel or galvanized steel as shown on the Contract Documents. When material is not specifically noted, material shall be stainless steel.
2. Design to support minimum 300-pound concentrated vertical load with 150-pound concentrated horizontal load.
a. Maximum allowable stresses per AISC manual.
b. Maximum lateral deflection: Side rail span/300.
c. Design in accordance with OSHA standards.
3. Fabricate ladders for the locations shown, with dimensions, spacings, details, and anchorages as indicated. Comply with requirements of ANSI A14.3.
4. Side rails, minimum sizes: Continuous, 1 1/2-inch nominal diameter pipe. Fabricate with eased edges, spaced 18 inches apart.
5. Rungs: 1-1/8 inch by 1-5/8 inch by 14 gage perforated “traction tread” rungs.
a. Top rung level with top platform.
6. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
7. Support each ladder at top and bottom and at intermediate points spaced not more than 4 feet on center with welded or bolted steel brackets.
8. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 9 inches.

9. When required by Drawings, every ladder that does not have an exterior handhold shall be equipped with a pop-up extension. Pop-up extension device shall be manufactured of the same material and finish as the ladder with telescoping tubular section that locks automatically when fully extended. Upward and downward improvement shall be controlled by stainless steel spring balancing mechanisms. Units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.

D. Metal Grating:
1. Metal grating shall be of the design, sizes, and types indicated. Completely band at all edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Support grating at bearings by support members. Where grating is supported on concrete, embedded support angles matching grating material shall be used unless indicated otherwise. Such angles shall be mitered and welded at corners.
2. Bearing Bars:
   a. Type: Rectangular bar.
   b. Thickness: 3/16 inch minimum.
   c. Depth: 1-1/2 inch unless otherwise indicated on Contract Documents.
   d. Spacing: 1 3/16 inch maximum.
   e. Configuration of top surface: Plain unless otherwise indicated on Contract Documents.
3. Cross Bars:
   a. Cross bars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.
   b. Spacing: 4 inches maximum.
4. All pieces of grating shall be fastened in at least two locations to each support.
5. Where grating forms the landing at the top of a stairway, the edge of the grating, which forms the top riser, shall have an integral non-slip nosing, width equal to that of the stairway.
6. Where grating depth is not given, grating shall be provided which will be within allowable stress levels, and which shall not exceed a deflection of ¼-inch or the span divided by 180, whichever is less. For standard duty plank, and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater or a concentrated moving load of 1000 pounds.
7. Material:
   a. Galvanized Steel: Except where indicated otherwise, bar grating shall be fabricated entirely of hot-dip galvanized carbon steel.
   b. Aluminum: Bearing and banding bars, alloy 6063-T5.
   c. Grating which may be partially or wholly submerged shall be fabricated entirely of stainless steel.
8. No single piece of grating shall weigh more than 80 pounds or be wider than 3 feet, unless indicated otherwise on Contract Documents.

E. Floor Hatches:
1. Where floor access hatches are called for on the Contract Documents to be mounted on a floor slab (including top slabs which are not covered with a roofing membrane) or on a concrete curb, the hatch shall be a flush type as indicated herein.

2. Material: Aluminum alloy 6061-T6 unless otherwise indicated. Provide Type 316 stainless steel hardware.
3. Design Live Load: Minimum 150 psf.
4. Provide hatch opening sizes, number and directional swing of door leaves, and locations as indicated on the Drawings. Sizes given are for the clear opening. Where the number of leaves is not indicated, provide double-leaf doors for openings larger than 42 inches in either direction. Unless indicated otherwise, locate hinges on the longer dimension side. Unless indicated otherwise, ladder hatches shall be a minimum of 36 inches wide by 36 inches long, with the door hinge opposite the ladder.
5. Hatch shall have oversized recessed padlock clip that can accommodate a lock with a 2.5" shackle length.
6. Hatch shall be equipped with recesses safety grating for fall protection.
7. Door leaves shall be a minimum of 1/4-inch checkered pattern plate. Channel frames shall be a minimum of 1/4-inch material with an anchor flange around the perimeter. Hatches shall be provided with an automatic hold-open arm with release handle. Hatches shall be designed for easy opening from both inside and outside.
8. Aluminum surfaces in contact with other metals or concrete shall be painted for aluminum metal isolation. Caulk the mounting flange of access hatches for water tightness when mounted to concrete curbs.
9. Products:
    a. Type "APS" or "APD," Babcock Davis Associates.
    b. Type "J" or "JD", Bilco.
    c. Type "SLG" or "DLG," Dur-Red Products.
    d. Engineer approved equal.

F. Roof Hatches:
1. Where indicated on Contract Drawings, hatches mounted on a roof surface of whatever material shall be the integral raised curb type as indicated in Section 07 72 00 – Roof Accessories.

G. Iron Castings:
1. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shot blasting. Castings shall be prefabricated, conforming to ASTM A48 or A536.
2. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finished surface and so that the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.
3. Covers and grates with matching frames shall be designed to support the following loadings:
    a. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no floor loading is given, a minimum of 300 pounds per square foot.
    b. Exterior covers and grates shall be designed for AASHTO HS-20 loading unless indicated otherwise.

H. All Purpose Metal Framing:
1. Material: Carbon Steel.
2. Channels and inserts:

a. Minimum 12 gage.
b. Channels to have one side with a continuous slot and inturned lips.

3. Fittings: Hot-rolled steel strip and plate.
4. Nuts: Steel, ASTM A563, with toothed grooves in top of nuts to engage the inturned lips of channels.
5. Finish: Epoxy coated. Galvanize items which cannot be epoxy coated.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

C. Form exposed work true to line and level with accurate angles and surfaces straight and sharp edges.

D. Drill and punch holes with smooth edges.

E. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

1. Temperature Range: 0 degrees F minimum to 110 degrees F maximum ambient temperature.

F. Shear and punch metals cleanly and accurately. Remove burrs.

G. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

H. Remove sharp or rough areas on exposed traffic surfaces.

I. Welding

1. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
2. In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.
3. Weld corners and seams continuously to comply with the following:

a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
b. Obtain fusion without undercut or overlap.
c. Remove welding flux immediately.
d. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners whenever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

K. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

L. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

M. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

N. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.5 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of the required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Hot-dip galvanize after fabrication.

2.6 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel studs for embedding into concrete.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. Provide steel framing and supports for applications indicated that are not a part of structural steel framework as required to complete the Work.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive other adjacent construction retained by framing and supports.

C. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection.

D. Cut, drill, and tap units to receive hardware, hangers, and similar items.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

B. Inspect and verify condition of substrate. Correct any surface defects or conditions which might interfere with or prevent a satisfactory installation.

C. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.

B. In fabrication and erection of structural steel, conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

C. Shim and grout as necessary.

D. To the maximum extent possible, use bolted field connections. Where practicable, conceal the fastenings. When field welding is warranted, comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish/grind exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

E. Unless notes or specified otherwise:
   1. Connect steel members to steel members with 3/4-inch diameter high strength bolts.
   2. Connect aluminum to aluminum with 3/4-inch diameter aluminum bolts.
   3. Connect aluminum to structural steel using 3/4-inch diameter stainless steel bolts.
   4. Connect aluminum and steel members to concrete and masonry using 3/4-inch stainless steel epoxy anchors. Provide a minimum of 5 1/2 inches of embedment into concrete or masonry.

F. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing. Provide fully welded splices where continuity is required.

G. Provide each fabricated item complete with attachment devices as indicated or required to install.

H. Anchor metal items so that items will not be distorted nor fasteners overstressed from expansion and contraction.

I. Install bollards in concrete as detailed. Fill pipe with concrete and round off at top of pipe.

J. Center abrasive stair nosings in stair.

K. Attach grating to end and intermediate supports with grating saddle clips and bolts.
   1. Maximum spacing: 2 feet on center with a minimum of two attachments per support.
   2. Attach individual units of grating together with clips or attachments at 2 feet on center maximum with a minimum of two clips per side.

L. Coat ferrous metals in accordance with Section 09 90 00 – Painting and Coating.

M. Coat surfaces of aluminum that will come in contact with grout, concrete, masonry, wood or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

3.3 DRILLED ANCHORS

A. Drilled-in anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, cleaned and dried. Drilled anchors shall not be installed until the concrete has reached the specified 28-day compressive strength. Epoxy anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

3.4 SETTING LOOSE PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

B. Set loose level and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
   1. Use non-shrink grout in concealed locations where not exposed to moisture.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780

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DIVISION 6
WOOD AND PLASTICS

SECTION 06 10 53
MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Provide and install miscellaneous rough carpentry as shown on the Contract Drawings and as specified herein.

B. Section Includes:
1. Framing with dimension lumber.
2. Rooftop equipment bases and support curbs.
3. Wood blocking, cants, and nailers.
4. Interior wood trim

C. Related Sections
1. Section 05 50 00 – Metal Fabrications.
2. Section 06 16 00 – Sheathing.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME) standards, most recent editions:

ASME B18.2.1	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.6.1	Wood Screws (Inch Series)

B. ASTM International (ASTM) standards, most recent editions:

ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

ASTM C954	Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM D3498	Standard Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems
ASTM D5664	Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber
ASTM F1667	Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

C. American Wood Council (AWC) standards, most recent editions:

Details for Conventional Wood Frame Construction

National Design Specification (NDS) for Wood Construction with Commentary

D. American Wood Protection Association (AWPA) standards, most recent editions:

AWPA U1	Use Category System: User Specification for Treated Wood
AWPA M4	Standard for the Care of Preservative-Treated Wood Products

E. International Code Council

IBC	International Building Code, current for the Project per Drawings, General Structural Notes.

F. U.S. Department of Commerce, National Institute of Standards and Technology, (NIST) standards, latest editions:

PS 1	Structural Plywood
PS 20	American Softwood Lumber Standard (ASLS)

1.3 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   1. ALSC: American Lumber Standard Committee.
   2. WCLIB: West Coast Lumber Inspection Bureau.
   3. WWPA: Western Wood Products Association.

C. ICC-ESR: International Code Council Evaluation Service Report.

D. S4S: Surfaced four sides.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Contractor Submittals.

B. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

C. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

D. Research/Evaluation Reports: ICC-ESR reports for the following, showing compliance with building code in effect for Project:
   1. Wood preservative treated wood.
   2. Power driven fasteners.
   3. Powder actuated fasteners.
   4. Expansion anchors.
   5. Metal framing anchors.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Stack and store lumber products flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

C. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproofed, wet work other than painting is dry, and HVAC systems are operating and maintaining temperature and humidity at occupancy levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Metal Framing Anchors:
      a. Simpson Strong-Tie Co., Inc.
      b. Engineer approved equal

2.2 WOOD PRODUCTS, GENERAL

A. Lumber: Document PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

B. Factory mark each piece of lumber with grade stamp of grading agency.

C. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.

D. Where nominal sizes are indicated, provide actual sizes required by document PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

E. Provide dressed lumber, S4S, unless otherwise indicated.

2.3 WOOD PRESERVATIVE TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1, Use Category 2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA U1, Use Category 1 with inorganic boron (SBX).

B. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

C. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

D. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

E. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

F. Application: Treat items indicated on Drawings, and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
   3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   4. Wood framing members that are less than 18 inches above the ground in crawl spaces or unexcavated areas.
   5. Wood floor plates that are installed over concrete slabs-on-grade.

2.4 DIMENSIONAL LUMBER FRAMING

A. Maximum Moisture Content: 19 percent.

B. Wall Studs: Stud or No. 2 grade, Douglas Fir – Larch, WCLIB or WWPA grading rules.

C. Wall Plates: No. 2 or Construction grade, Douglas Fir – Larch, WCLIB or WWPA grading rules.

D. Framing Other Than Noted Above: No. 2 grade or better, Douglas Fir – Larch, WCLIB or WWPA grading rules.

E. Exposed Framing: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
   1. Species: As indicated above for load-bearing construction of same type.
   2. Grade: No. 1.

2.5 SHEATHING

A. Refer to Section 06 16 00 – Sheathing.

2.6 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.
   3. Cants.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber, Douglas Fir – Larch, 19 percent maximum moisture content.

C. For exposed and concealed boards, provide lumber with 19 percent maximum moisture content, Spruce Pine Fir species, Construction or No. 2 Common grade, WCLIB or WWPA grading rules.

D. For blocking not used for attachment of other construction, provide lumber with 19 percent maximum moisture content, Douglas Fir – Larch species, Utility, Stud, or No. 3 grade, WCLIB or WWPA grading rules. Select pieces and cut to eliminate defects that will interfere with attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.7 INTERIOR WOOD TRIM

A. General: Provide kiln-dried finish (surfaced) material without finger jointing, unless otherwise indicated on Drawings.

B. Softwood Lumber Trim for Transparent (Stain or Clear) Finish: Provide Grade Superior or C & Better finish, Douglas Fir-larch, WCLIB or WWPA grading rules.

C. Hardwood Lumber Trim for Transparent (Stain or Clear) Finish: Clear red oak species, selected for compatible grain and color.

D. Lumber Trim for Opaque (Painted Finish: Solid lumber, Grade 1 Common, Idaho white, lodgepole, ponderosa, or sugar pine species, WWPA grading rules.

E. Moldings: Made to patterns indicated in WMMPA WM7 and graded according to WMMPA WM4.
   1. Moldings for Transparent (Stain or Clear) Finish: N-grade, red oak species, selected for compatible grain and color.
   2. Moldings for Opaque (Painted) Finish P-grade Idaho white, lodgepole, ponderosa, or sugar pine species.

2.8 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: ICC ESR 1539.

D. Wood Screws: ASME B18.6.1.

E. Screws for fastening to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Lag Bolts: ASME B18.2.1.

G. Bolts: Steel bolts complying with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers.

H. Concrete and Masonry Anchors: Refer to Section 05 50 00 – Metal Fabrications.

2.9 METAL FRAMING ANCHORS

A. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated on Drawings. Design is based on products of Simpson Strong-Tie Co., Inc. Substitutions from other manufacturers must include ICC-ESR evaluation reports with test capacities that equal or exceed those of the Simpson product indicated.

B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653, G60 coating designation.
   1. Use for interior locations where stainless steel is not indicated.

C. Stainless-Steel Sheet: ASTM A666, Type 304.
   1. Use for exterior locations and where specifically indicated.

2.10 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

B. Flexible Flashing Separator Between Preservative-Treated Wood and Metal Decking: Self-adhesive, rubberized-asphalt compound, bonded to a high-density, polyethylene film to produce an overall thickness of not less than 0.025 inch.

C. Adhesives for Gluing Wood to Wood, Concrete, or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

D. Water-Repellent Preservative for Ends of Exposed Posts and Beams: NWWDA-tested and accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Where wood preservative treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

C. Framing Standard: Comply with AWC's "Details for Conventional Wood Frame Construction," unless otherwise indicated.

D. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.

E. Do not splice structural members between supports, unless otherwise indicated.

F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening plywood, gypsum board, or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches on center.

G. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

H. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   1. Use inorganic boron for items that are continuously protected from liquid water.
   2. Use copper naphthenate for items not continuously protected from liquid water.

I. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. ICC-ESR 1539 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

J. Use sinker or common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

K. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

A. Install where indicated on Drawings and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 WOOD TRIM INSTALLATION

A. Install with minimum number of joints practical, using full length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches long except where absolutely necessary. Stagger joints in adjacent and related standing and running trim. Cope at interior returns and miter at exterior corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints.
   1. Match color and grain pattern across joints for clear and stained finish.
   2. Install trim after wall sheathing operations are completed.
   3. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads and fill holes.
   4. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.

3.4 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

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SECTION 06 16 00
SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide and install wood sheathing panels as shown on the Contract Drawings and as specified herein.

B. Section Includes:
1. Roof Sheathing.
2. Flexible flashing at openings in sheathing.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME) standards, most recent editions:

ASME B18.6.1	Wood Screws (Inch Series)

B. ASTM International (ASTM) standards, most recent editions:

ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C79	Standard Specification for Gypsum Sheathing Board
ASTM C954	Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM C1002	Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C1396	Standard Specification for Gypsum Board
ASTM D226	Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D3498	Standard Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems
ASTM E1677	Standard Specification for Air Barrier (AB) Material or System for Low-Rise Framed Building Walls

ASTM F1667	Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

C. American Wood Protection Association (AWPA) standards, most recent editions:

AWPA U1	Use Category System: User Specification for Treated Wood

D. International Code Council:

IBC	International Building Code, current for the Project per Drawings, General Structural Notes.

E. Underwriters Laboratories (UL) standards, most recent editions:

Fire Resistance Directory

F. U.S. Department of Commerce, National Institute of Standards and Technology, (NIST) standards, latest editions:

PS 1	Structural Plywood
PS 2	Performance Standard for Wood-Based Structural-Use Panels

1.3 DEFINITIONS

A. ICC-ESR: International Code Council Evaluation Service Report.

B. S1S: Surfaced 1 side.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Contractor Submittals.

B. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
   4. For building wrap, include data on air/moisture infiltration protection based on testing according to referenced standards.

C. Research/Evaluation Reports: ICC-ESR reports for the following, showing compliance with building code in effect for Project:
   1. Preservative treated plywood.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Stack and store plywood and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Paper Surfaced Gypsum Wall Sheathing:
      a. G-P Gypsum Corporation.
      b. National Gypsum Corporation.
      c. United States Gypsum Company.
      d. Engineer approved equal.

2.2 WOOD PANEL PRODUCTS, GENERAL

A. Plywood: Either document PS 1 or document PS 2, unless otherwise indicated.

B. Oriented Strand Board: Document PS 2.

C. Thickness: As needed to comply with requirements specified, but not less than thickness indicated on the Drawings.

D. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE TREATED PLYWOOOD

A. Preservative Treatment by Pressure Process: AWPA U1, Use Category UC2.

B. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

C. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

D. Select first option in paragraph below and delete others if total treatment is required; otherwise, select second option with or without third option.

E. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete.

2.4 ROOF SHEATHING

A. Plywood Roof Sheathing: Exposure 1, Structural I.

1. Span Rating: As required to suit joist or truss spacing indicated on Drawings.
2. Nominal Thickness: Not less than 19/32 inch unless noted otherwise on Drawings.

B. Oriented-Strand-Board Roof Sheathing: Exposure 1, Structural I .
1. Span Rating: As required to suit joist or truss spacing indicated on Drawings.
2. Nominal Thickness: Not less than 19/32inch unless noted otherwise on Drawings.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: ICC ESR 1539.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
1. For wall and roof sheathing panels, provide screws with organic polymer or other corrosion protective coating having a salt spray resistance of more than 800 hours according to ASTM B117.

F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic polymer or other corrosion protective coating having a salt spray resistance of more than 800 hours according to ASTM B117.
1. For steel framing less than 0.0329 inch thick, attach sheathing to comply with ASTM C1002.
2. For steel framing from 0.033 to 0.112 inch thick, attach sheathing to comply with ASTM C954.

2.6 WEATHER RESISTANT SHEATHING PAPER

A. Building Paper: ASTM D226, Type 1 (No. 15 asphalt-saturated organic felt), unperforated.

B. Building Wrap: ASTM E 1677, Type I air retarder; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E84; UV stabilized; and acceptable to authorities having jurisdiction.
1. Allowable UV Exposure Time: Not less than three months.

C. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.7 MISCELLANEOUS MATERIAL

A. Adhesives for Field Gluing Panels to Framing: Formulation complying with ASTM D3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch.
   1. Primer for Flexible Flashing: Product recommended by manufacturer of flexible flashing for substrate.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. ICC ESR 1539 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

D. Use sinker or common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

A. Fastening Methods: Fasten panels as indicated below:
   1. Roof Sheathing:
      a. Nail to wood framing.
      b. Screw to cold-formed metal framing.
      c. Space panels 1/8 inch apart at edges and ends.

3.3 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to wood framing with screws.
   2. Fasten gypsum sheathing to cold-formed metal framing with screws.
   3. Install boards with a 3/8-inch gap where non load-bearing construction abuts structural elements.
   4. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.

C. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.

D. Space fasteners approximately 8 inches on center and set back a minimum of 3/8 inch from edges and ends of boards.

3.4 WEATHER RESISTANT SHEATHING PAPER INSTALLATION

A. General: Cover sheathing with weather-resistant sheathing paper as follows:
   1. Cut back barrier 1/2 inch on each side of the break in supporting members at expansion- or control-joint locations.
   2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap, unless otherwise indicated.

B. Building Paper: Apply horizontally with a 2-inch overlap and a 6-inch end lap; fasten to sheathing with galvanized staples or roofing nails.

C. Building Wrap: Comply with manufacturer's written instructions.
   1. Seal seams, edges, fasteners, and penetrations with tape.
   2. Extend into jambs of openings and seal corners with tape.

3.5 FLEXIBLE FLASHING INSTALLATION

A. Apply flexible flashing where indicated to comply with manufacturers written instructions.
   1. Prime substrates as recommended by flashing manufacturer.
   2. Lap seams and junctures with other materials at least 4 inches, except that at flashing flanges of other construction, laps need not exceed flange width.
   3. Lap flashing over weather-resistant building paper at bottom and sides of openings.
   4. Lap weather-resistant building paper over flashing at heads of openings.
   5. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

3.6 PROTECTION

A. Paper-Surfaced Gypsum Sheathing: Protect sheathing by covering exposed exterior surface of sheathing with weather-resistant sheathing paper securely fastened to framing. Apply covering immediately after sheathing is installed.

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SECTION 06 17 53
SHOP-FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide and install wood trusses as shown on the Contract Drawings and as specified herein.

B. Section Includes:
1. Wood roof trusses.
2. Wood girder trusses.
3. Wood truss bracing.
4. Metal truss accessories.

C. Related Sections
1. Section 05 50 00 – Metal Fabrications
2. Section 06 10 00 – Rough Carpentry
3. Section 06 10 53 – Miscellaneous Rough Carpentry

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME) standards, most recent editions:

ASME B18.2.1	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.6.1	Wood Screws (Inch Series)

B. ASTM International (ASTM) standards, most recent editions:

ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM D5664	Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber
ASTM F1667	Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

C. American Wood Council (AWC) standards, most recent editions:

National Design Specification (NDS) for Wood Construction with Commentary

D. American Wood Protection Association (AWPA) standards, most recent editions:

AWPA U1	Use Category System: User Specification for Treated Wood

E. Society For Protection of (SSPC) standards, latest editions:

SSPC Paint 20	SSPC-Paint 20, Zinc-Rich Coating (Type I Inorganic and Type II Organic)

F. Truss Plate Institute (TPI) standards, most recent editions

TPI 1	National Design Standard for Metal Plate Connected Wood Truss Construction
TPI DSB	Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses
TPI HIB	Commentary and Recommendations for Handling, Installing and Bracing Metal Plate Connected Wood Trusses

G. U.S. Department of Commerce, National Institute of Standards and Technology, (NIST) standards, latest editions:

PS 20	American Softwood Lumber Standard (ASLS)

1.3 DEFINITIONS

A. Fabricated wood Trusses: Planar structural units consisting of metal plate connected members fabricated from dimensional lumber and cut and assembled before delivery to Project site.

B. TPI: Truss Plate Institute, Inc.

C. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   1. ALSC: American Lumber Standard Committee.

2. WCLIB: West Coast Lumber Inspection Bureau.
3. WWPA: Western Wood Products Association.

E. ICC-ESR: International Code Council Evaluation Service Report.

F. S4S: Surfaced four sides.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Contractor Submittals.

B. Product Data: For wood preservative treated lumber, fire-retardant treated lumber, metal-plate connectors, metal truss accessories, and fasteners.
1. Include data for wood preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to truss fabricator.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

C. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer. Show fabrication and installation details for trusses.
1. Prepare shop drawings at the minimum scale shown on the Contract Drawings.
2. Prepare shop drawings which are not reproductions of the Contract Drawings.
3. Include individual truss drawings, signed and sealed by a professional engineer licensed to practice in the state of Utah, verifying accordance with the building code and design requirements shown on the Contract Drawings. As a minimum, include the following information.
    a. Description of design criteria
    b. Engineering analysis depicting member forces/stresses and truss deflection.
    c. Truss member grades and sizes and connections at truss joints.
    d. Truss support reactions for each load case.
    e. Top chord, bottom chord, and web bracing requirements.
    f. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
    g. Show splice details and bearing details.
4. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.

5. Plan and details for the type and location of all permanent lateral and diagonal bracing and/or blocking required in the top chord, bottom chord, and web planes – diaphragms excluded.
6. Provide templates or location drawings for installation of any required anchor bolts.
7. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer licensed to practice in Utah, and responsible for their preparation.

D. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

E. Qualification Data: For metal-plate manufacturer and truss fabricator.

F. Research/Evaluation Reports: ICC-ESR reports for the following, showing compliance with building code in effect for Project:
1. Wood-preservative-treated lumber.
2. Fire-retardant-treated wood.
3. Metal-plate connectors.
4. Metal truss accessories.

1.5 QUALITY ASSURANCE

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.
1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

C. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to Engineer.

D. Source Limitations for Connector Plates: Obtain metal connector plates from a single manufacturer.

E. Comply with applicable requirements and recommendations of TPI 1, TPI DSB, and TPI HIB.

F. Wood Structural Design Standard: Comply with applicable requirements in AWC's "National Design Specifications for Wood Construction" and its "Supplement."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Handle and store trusses to comply with recommendations of TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."
   1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
   2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
   3. Provide for air circulation around stacks and under coverings.
   4. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.
   5. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable.
   1. Metal Connector Plates
      a. Alpine Engineered Products, Inc.
      b. CompuTrus, Inc.
      c. Eagle Metal Products.
      d. MiTek Industries, Inc.; a subsidiary of Berkshire Hathaway, Inc.
      e. Engineer approved equal.
   2. Metal Truss Accessories
      a. Simpson Strong-Tie Co., Inc.
      b. Engineer approved equal.

2.2 DESIGN CRITERIA

A. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.

B. Design Loads: As indicated on Drawings.

C. Connector Plate Design
   1. Proportion for full member design loads without considering wood-to-wood bearing.
   2. Stress increase for the value of a connector will not be allowed in any circumstance.
   3. Increase net area of connector plates by 25 percent above that required by calculated stresses. Increase area of connector plate by increasing the plate dimension in each direction.
   4. Design for a single connection per joint per side.
   5. Minimum size of any plate connector is 15 square inches.
   6. Minimum bite of any connector on a truss member is 2-1/2 inches.

D. Maximum Deflection Under Design Loads
   1. Roof Trusses: Live load vertical deflection of 1/360 of span.
   2. Floor Trusses: Live load vertical deflection of 1/480 of span.

2.3 DIMENSION LUMBER

A. Lumber: Document PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
   3. Where nominal sizes are indicated, provide actual sizes required by document PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   4. Provide dressed lumber, S4S, unless otherwise indicated.
   5. Provide dry lumber with 19 percent maximum moisture content at time of dressing.

B. Grade and Species: Provide dimension lumber of any species for truss chord and web members, graded as follows and of the following minimum design values for size of member required according to AWC's "National Design Specifications for Wood Construction" and its "Supplement;"
   1. Grading Method: Visual or mechanical.
   2. Design Values: Modulus of elasticity of at least 1,400,000 psi and an extreme fiber stress in bending of at least 700 psi

C. Minimum Chord Size for Roof Trusses: 2 by 6 inches nominal for both top and bottom chords.

D. Minimum Web Size for Roof Trusses: 2 by 4 inches nominal.

E. Permanent Bracing: Provide wood bracing that complies with requirements of truss manufacturer and as specified in Section 06 10 00 – Rough Carpentry or Section 06 10 53 – Miscellaneous Rough Carpentry.

2.4 METAL CONNECTOR PLATES

A. General: Fabricate connector plates to comply with TPI 1.

B. Hot-Dip Galvanized Steel Sheet: ASTM A653; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 coating designation; and not less than 0.036 inch thick.

C. Use for all trusses unless otherwise indicated on the Drawings.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   1. Where trusses are exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: ICC ESR 1539.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1.

F. Bolts: Steel bolts complying with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers.

G. Concrete and Masonry Anchors: Refer to Section 05 50 00 – Metal Fabrications.

2.6 METAL TRUSS ACCESSORIES

A. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated on Drawings. Design is based on products of Simpson Strong-Tie Co., Inc. Substitutions from other manufacturers must include ICC-ESR evaluation reports with test capacities that equal or exceed those of the Simpson product indicated.

B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653, G60 coating designation.
   1. Use for all trusses unless otherwise indicated on the Drawings.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-aPaint 20, with dry film containing a minimum of 94 percent zinc dust by weight.

2.8 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close fitting joints.

B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details shown on the Contractor's submittal drawings.

C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.

D. Fabricate wood trusses within manufacturing tolerances in TPI 1.

E. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.

F. Space trusses as indicated on the Drawings; adjust and align trusses in location before permanently fastening.

G. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in truss accessories according to manufacturer's fastening schedules and written instructions.

H. Securely connect each truss ply as shown on Contractor's submittal drawings when required for forming built-up girder trusses.

I. Support trusses at girder trusses as indicated on the Drawings.

J. Install and fasten temporary and permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

K. When floor trusses are required, install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.

L. Install wood trusses within installation tolerances in TPI 1.

M. Do not cut or remove truss members.

N. Replace wood trusses that are damaged or do not meet requirements.

O. Do not alter trusses in field.

3.2 REPAIRS AND PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

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SECTION 06 60 00
FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install fiberglass reinforced plastic fabrications, complete and serviceable as shown on the Drawings and as specified herein.

B. Section Includes:
1. Structural shapes.
2. Grating.
3. Fixed ladders.

1.2 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM D256	Standard Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D696	Standard Test Method for Coefficient for Coefficient of Linear Thermal Expansion of Plastics Between -30 Degrees C and 30 Degrees C with a Vitreous Silica Dilatometer
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D2344	Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM D2583	Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

ASTM E84	Surface Burning Characteristics of Building Material

B. American Water Works Association (AWWA) standards, most recent editions:

AWWA F101	Contact-Molded, Fiberglass-Reinforced Plastic Wash-Water Troughs and Launders
AWWA F102	Matched Die Molded, Fiberglass Reinforced Plastic Weir Plates, Scum Baffles, & Mounting Brackets

C. National Sanitation Foundation (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects

D. Occupational Safety and Health Administration (OSHA), most recent editions:

OSHA 1910.27	Fixed Ladders

1.3 DEFINITIONS

A. FRP: Fiberglass reinforced plastic.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Contractor Submittals.

B. Product Data: Submit manufacturer's published literature including material specifications, structural design data, structural properties and load and deflection tables for each style and type of fabrication used, corrosion resistance tables and anchoring systems and allowable load tables as applicable.

C. Shop Drawings: Submit shop drawings of all FRP fabrications and accessories.
   1. For grating, show direction of span, type and depth of grating, size and shape of individual panels, seat angle details, and details of grating clip fasteners.

D. Structural Calculations: Provide design calculations for items and systems not sized or designed in the Contract Documents.

E. Samples: The Engineer may require sample pieces of any item specified herein for acceptance as to quality and color. When required, submit samples manufactured by the method to be used in the Work.

F. Certified Test Reports: Provide when requested by Engineer.

G. Qualification Statements: Provide qualification documents for manufacturer's experience history.

H. Warranty Documentation: Provide certificate of warrantees specified herein.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer having a minimum of 10 years' experience in design and manufacture of similar products and systems to those specified herein. When requested, provide evidence of at least 5 previous successful installations in the past 5 years.

B. Maintain a continuous quality control program and provide Engineer with certified test reports of physical tests on samples when requested.

C. Provide only new FRP material for the fabrications specified.

D. Licensed Professional Engineer: When design calculations are required, they must be signed and sealed by an engineer licensed to practice in the state of Utah.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Delivery and Acceptance Requirements: Deliver manufactured materials in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Package adhesives, resins, and their catalysts and hardeners separately and not such to facilitate movement to a dry indoor storage area.

C. Storage and Handling Requirements: Store all materials carefully to prevent them from damage. Store adhesives, resins, and their catalysts in dry indoor facilities between 70 degrees F and 85 degrees F until they are required.

1.7 WARRANTY

A. Provide manufacturer's written 3-year warranty on all FRP products against defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable.
   1. Grating and Treads
      a. Fibergrate Composite Structures, Inc. (Safe-T-Span).
      b. CorGrate Fiberglass Systems (CorGrate FW).
      c. Strongwell (Duradek).
      d. Engineer approved equal.
   2. Fixed Ladders
      a. CorGrate Fiberglass Systems.
      b. Fibergrate Composite Structures, Inc. (Dynarail)
      c. Strongwell.
      d. Engineer approved equal.

2.2 GENERAL

A. FRP items shall be composed of fiberglass reinforcement and resin in quantities, qualities, properties, arrangements, and dimensions as necessary to meet the design requirements and dimensions indicated.

B. Provide FRP products with tested flame spread rating of 25 or less per ASTM E84.

C. Resins for FRP products shall be vinyl ester with chemical formulation necessary to provide the corrosion resistance, strength, and other physical properties as required.

D. Finish
   1. Provide all finished surfaces of fiberglass items and fabrications smooth, resin-rich, free of voids, and without dry spots, crazes, or unreinforced areas.
   2. Provide for corrosion resistance and weathering.
   3. Outer surfaces with no glass fibers exposed.

E. Supports and Fasteners: Provide all bolts, anchor bolts, washers, nuts, and supports as required for FRP items specified in this Section, in accordance with the requirements of the manufacturers of the FRP items.
   1. Unless specified otherwise, provide connectors of Type 316 stainless steel.

F. Include an ultraviolet (UV) inhibitor in all FRP items. Additionally, provide an extra 1-mil UV coating on all FRP products located in exterior locations, exposed to the weather, or in UV facilities.

G. Design and install fiberglass items providing accommodation for expansion and contraction. Prevent shearing of bolts, screws, and other fastenings, and provide close fitting of sections. Design joints exposed to weather to exclude water.

H. Fabricate FRP products free from warps, twists, or other defects with affect appearance and serviceability.

2.3 STRUCTURAL SHAPES

A. Manufacture all structural shapes by the pultrusion process with a glass content minimum of 45 percent and a maximum of 55 percent by weight.

B. Minimum longitudinal mechanical properties are as follows.

Property	ASTM Method	Minimum Value	Units
Tensile Strength	D638	30,000	psi
Tensile Modulus	D638	2.5×10^{6}	psi
Flexural Strength	D790	30,000	psi
Flexural Modulus	D790	1.8×10^{6}	psi
Short Beam Shear	D2344	4,500	psi
Shear Modulus	N/A	4.5×10^{5}	psi
Coefficient of Thermal Expansion	D696	4.4×10^{-6}	In/in/deg F

2.4 GRATING

A. Furnish and install FRP grating in areas shown on the Drawings, including FRP angle supports and embeds, fasteners, and accessories.

B. Manufacture
   1. Depth: As shown on Drawings.
   2. Bearing bars and cross-rods manufactured by the pultrusion process having a maximum of 70 percent and a minimum of 60 percent continuous glass content (by weight).
   3. Interlock bearing bars and bond to cross-rods to provide a panel that resists twisting forces and prevents internal movement of the bearing bars.
   4. Non-slip Surface: Provide grating with quartz grit bonded and baked to the top surface of the finished grating product.
   5. Color: Yellow

C. Load/Deflection Requirements: Provide grating capable of spanning the distances indicated without exceeding a deflection of span divided by 240 or 3/8 inch maximum when loaded at 100 psf.

D. Penetrations: Provide cutouts where needed for utility penetrations through the grating. Reinforce around such cutouts where necessary to meet the load/deflection requirements.

E. Fabricate individual grating panels into easily removable sections as large as possible up to 80 pounds.

F. Grating Clips: Install mechanical grating clips manufactured from Type 316 stainless steel and coated with epoxy coating. Provide a minimum of 4 clips per panel at a maximum of 4 feet on center.

2.5 FIXED LADDERS

A. Furnish and install FRP fixed ladder systems with all safety cages, landings, mounting clips, fasteners, and necessary appurtenances as shown on the Drawings.

B. Design Criteria
   1. Conform to OSHA requirements.
   2. Design to support a 1200-pound load applied at any point.

C. Fabricate side rails from square tube, minimum 2 inches square (nominal) by 1/4 inch thick. Anchor with FRP standoff clips manufactured of vinyl ester resin. Place clips as shown on the Drawings at maximum spacing of 4 feet.

D. Rungs
   1. Uniformly spaced at 12 inches maximum
   2. Attach to rails by both mechanical attachment and epoxy bond.

E. When required, furnish and install fall prevention system and anti-climb guards in accordance with OSHA regulations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Field verify all dimensions before fabrication of products and indicate such measurements on shop drawing layouts. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

3.2 INSTALLATION

A. General
   1. Install FRP structures in accordance with manufacturer's assembly shop drawings. Field cut and drill FRP products with carbide or diamond tipped bits and blades only. Seal cut or drilled surfaces in accordance with manufacturer's instructions.
   2. Bond FRP items with epoxy adhesive recommended by the manufacturer of the particular items. Use solvent and abrasives to sufficiently remove the surface gloss and to remove any mold release agent or other contaminants which may interfere with proper bonding. Follow adhesive manufacturer's instructions and do not stress bonded items for a minimum of 48 hours after bonding.

B. Structural Shapes
   1. Mark materials for field assembly per shop drawing layouts. When finishing is required, complete field assemblies in final position before starting finishing operations.
   2. Connections: Make shop and field connections by bonded or bolted as indicated.
   3. Holes for Other Work: Provide holes as necessary or as indicated for securing other Work to FRP framing, and for the passage of other Work through FRP members.
   4. Seal all field cuts and drilled edges sealed with a resin compatible with the original resin and recommended by the manufacturer to prevent premature fraying at the field cut edges.
   5. Furnish anchor bolts and other connectors required for securing structural FRP to in-place Work and templates and other devices for presetting bolts and other anchors to accurate locations
   6. Setting Bases and Bearing Plates: Prior to the placement of nonshrink grout beneath base and bearing plates, clean the bottom surface of the plates of all bond-reducing materials. Clean and roughen concrete and masonry bearing surface to remove bond-reducing materials improve bonding.
      a. Set loose and attached base plates and bearing plates for structural members on wedges, leveling nuts, or other adjustable devices.
      b. Tighten anchor bolts after the supported members have been positioned and plumbed and the nonshrink grout has attained its required strength.
      c. Grout base plates with nonshrink grout to assure full uniform bearing. Complete grouting prior to placing loads on the structure.
   7. Field Assembly: Set structural frames accurately to the lines and elevations indicated. Align and adjust members to form a part of a complete frame or structure before permanent fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Plumb and level individual members of the structure within required tolerances.

8. Misfits at Bolted Connections: Where misfits in bolting are encountered, the immediately notify the Engineer. Submit a method to remedy the misfit for review by the Engineer. Engineer will determine whether the remedy is acceptable or if the member must be refabricated. Methods of remedy may include, but are not limited to the following:
    a. Reaming holes that must be enlarged to admit oversized bolts.
    b. Drilling additional holes in the connection, to conform to manufacturer's standards for bolt spacing, end, and edge distances, and adding additional bolts.
    c. Rejecting the improperly fabricated member and fabricating a new member to ensure proper fit.
    d. Mid-sized or misaligned holes in members shall not be enlarged by burning of by the use of drift pins.

C. Grating
1. Layout: Each grating section shall be readily removable, except where indicated. As much as possible, provide openings and holes where indicated on the Contract Drawings. Make grating openings which fit around protrusions (pipes, cables, machinery, etc.) discontinuous at approximately the centerline of opening so each section of grating is readily removable.
2. Install the grating with a minimum 1.5-inch bearing surface at the support ends.
3. Tolerances Between Sections: Not more than ¼-inch clearance between adjacent sections or between grating and frames. Assemble adjacent sections to line up forming an uninterrupted straight line, where possible.
4. Provide grating free from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles, and pits. Except for non-slip surfaces provide a smooth finish.
5. Miter and bond seat angles corners to produce smooth, even, level seating surface.
6. Install grating so that the top surface is level and even with adjacent walking surfaces. There shall be no protrusions above the top surface.
7. Fasten all grating to supports as specified herein.

D. Ladders
1. Install FRP ladders per manufacturer's instructions in locations shown on the Drawings. Install safety devices when shown on the drawings or specified herein.

END OF SECTION

DIVISION 7
THERMAL AND MOISTURE PROTECTION

SECTION 07 14 00
FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide and apply single-component, fluid-applied liquid waterproofing system to below grade concrete slabs, walls, and footings, including surface preparation.

1.2 RELATED SECTIONS

A. Section 03 30 00 Cast-in-Place Concrete

B. Section 04 22 00 Concrete Unit Masonry

C. Section 07 92 00 - Joint Sealants.

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C836	Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
ASTM D41	Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
ASTM D1644	Standard Test Methods for Nonvolatile Content of Varnishes
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data: For each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

C. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions which may be required.

D. Qualification Data: For qualified Installer.

E. Product Test Reports: For waterproofing, based on evaluation of comprehensive tests performed by a qualified testing agency.

F. Field quality-control reports.

G. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that is approved or licensed by manufacturer for installation of waterproofing required for this Project and is eligible to receive special warranties specified.

B. Source Limitations: Obtain waterproofing materials from single source from single manufacturer.

C. Preinstallation Conference: Conduct conference at Project site.
   1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, installation procedures, testing and inspection procedures, and protection and repairs.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below 0 Degrees F.
   1. Do not apply membrane when air, material, or surface temperatures are expected to fall below 30 Degrees F within four hours of completed application.
   2. Do not apply membrane if rainfall is forecast or imminent within 12 hours.
   3. Do not apply waterproofing membrane to any surfaces containing frost.
   4. Consult manufacturer for applications to green concrete.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.8 WARRANTY

A. Special Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents, and shall be in addition to, and run concurrent with, other warranties made under requirements of the Contract Documents.

B. Provide written warranty signed by waterproofing manufacturer and installer agreeing to repair or replace waterproofing that does not meet requirements or that does not remain watertight within the specified warranty period.

C. Warranty Period: 3 years after date of Substantial Completion.

D. Warranty does not include failure of waterproofing due to failure of substrate or formation of new joints and cracks in substrate that exceed 1/16 inch in width.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers and products are acceptable:
   1. Fluid Applied Waterproofing:
      a. Epro Services, Inc., Ecobase Waterproofing Membrane.
      b. Tremco Barrier Solutions, Tuff-N-Dri H8 Waterproofing.
      c. Engineer approved equal.

2.2 PERFORMANCE CRITERIA

A. Waterproofing Membrane:
   1. Single-component, polymer-enhanced liquid-applied membrane with the following minimum properties:
      a. Solids content, ASTM D1644, 60% minimum.
      b. Tensile Strength, ASTM D412: 15 psi, minimum.
      c. Elongation, ASTM D412: 1100%, minimum.
      d. Water Vapor Transmission, ASTM E96: 1 perms maximum (40 mil dry coat).
      e. Hydrostatic Pressure Resistance, 8 feet water head, minimum.
      f. Adhesion, ASTM C836, minimum 11 lb/inch to peel from concrete and masonry.

B. Sealants and Accessories: Manufacturer's recommended sealants and accessories.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
   2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.

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

3.2 PREPARATION

A. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

E. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

3.3 JOINTS, CRACKS, AND TERMINATIONS

A. Prepare and treat substrates to receive waterproofing membrane, including expansion joints, construction joints, cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.

3.4 MEMBRANE APPLICATION

A. Apply using appropriate equipment and nozzles, per manufacturer’s recommendations. Start application with manufacturer's authorized representative present.

B. Membrane: Spray apply asphalt emulsion membrane to substrates and adjoining surfaces indicated. Spread to a minimum wet thickness per manufacturer’s specification to achieve listed hydrostatic resistance, minimum of 60 mils.

C. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.

D. Allow product to cure prior to backfilling.

E. When buried surfaces that have been waterproofed are not backfilled within 30 days of membrane applications, membrane shall be coated with whitewash. Any formula for mixing the whitewash may be used which is not detrimental to the membrane and produces a uniformly coated white surface which remains until backfill is placed.

3.5 FIELD QUALITY CONTROL

A. Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions; surface preparation; and application of the membrane, flashings, protection, and drainage components; furnish daily reports to Engineer.

3.6 CLEANING AND PROTECTION

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

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SECTION 07 19 00
WATER REPELLENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes exterior water repellent coatings for concrete unit masonry (unpainted and unglazed).
   1. Silicone Water Repellents

B. Related Sections
   1. Section 04 22 01 – Hi-R Concrete Unit Masonry

1.2 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM D3278	Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
ASTM D5095	Standard Test Method for Determination of the Nonvolatile Content in Silanes, Siloxanes and Silane-Siloxane Blends Used in Masonry Water Repellent Treatments

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: Manufacturer's technical data to include the following:
   1. Detailed installation instructions.
   2. Protection and cleaning instructions.
   3. Certified test reports indicating compliance with requirements specified herein.
   4. Data substantiating that materials are recommended by manufacturer for applications included in this Work.

C. Samples: Provide samples of each substrate indicated to receive water repellent, 8 inches square, with specified repellent treatment applied to half of the sample.

D. Applicator Certificates: Provide letter on Manufacturer's letterhead certifying that the applicator is approved to apply products supplied.

E. Test and Evaluation Reports: Results of rilem tube testing and application rates determined therefrom.

F. Warranty Documentation.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturers: Use products from manufacturer with not less than 5 years' experience.
   2. Applicators: Firm experienced in application of systems similar in complexity to those required for this Project, plus the following:
      a. Acceptable to, or licensed by manufacturer.
      b. Not less than 3 years' experience with systems.
      c. Successfully completed not less than 5 comparable scale projects using the same system.

B. Test Area: Test a minimum 4 feet by 4 feet area on each type of masonry surface in the Work.
   1. Use the manufacturer's application instructions.
   2. Let test area protective treatment cure before inspection.
   3. Perform rilem tube testing to determine coverage rate to be used.
   4. Obtain Engineer's approval of test areas and resulting application rates to be used before proceeding with full scale application.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Packaging and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.

C. Storage and Handling Requirements: Comply with manufacturer's instructions.

1.6 SITE CONDITIONS

A. Maintain surface and ambient temperature above 40 degrees F during, and 24 hours after application.

B. Do not proceed with application on materials where ice and snow exist.

C. Do not proceed with application if surface temperature exceeds 100 degrees F.

D. Do not proceed with application when windy conditions exist that may cause water repellent to be blown onto vegetation or surfaces not intended to be coated.

E. Do not proceed with the application of materials in rainy conditions or when rain is anticipated within 6 hours after application.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty, executed by the applicator and water repellent manufacturer, covering materials and labor, agreeing to repair or replace materials that fail to provide water repellency within the specified warranty period. Warranty does not include deterioration or failure of coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new joints and cracks in excess of 1/16 inch wide, fire, vandalism, or abuse by maintenance equipment.

C. Warranty Period: 5 years from date of Substantial Completion.

D. Retreat all defective areas as identified by the Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Silicone Water Repellent:
      a. Weather Seal Blok-Guard & Graffiti Control II; ProSoCo, Inc.
      b. Engineer approved equal

2.2 MATERIALS

A. Masonry: Refer to Section 04 22 01 – Hi-R Concrete Unit Masonry.

B. Silicone Sealer:
   1. Silicone emulsion water repellent for dense substrates.
   2. Water-based solution containing not less than 6% solids per ASTM D5095.
   3. Flash Point: Greater than 212 degrees F per ASTM D3278.
   4. Freeze Point: 32 degrees F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine system components, substrate, and conditions where water repellents are to be installed. If unsatisfactory conditions exist, notify Engineer in writing of unsatisfactory conditions and do not begin this Work until such conditions have been corrected.

B. Commencing installation of this Work constitutes acceptance of conditions.

3.2 PREPARATION

A. Clean substrate of substances that might interfere with penetration or performance of water repellents.

B. Test for moisture content, according to repellent manufacturer's written instructions, to ensure surface is sufficiently dry.

C. Test for pH level, according to water repellent manufacturer's written instructions, to ensure chemical bond to silicate minerals.

D. Protect adjoining work, including sealant bond surfaces, from spillage or blow over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live plants and grass.

E. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water repellent treatment have been installed and cured.

3.3 APPLICATION

A. Apply product as supplied by the manufacturer without dilution or alteration unless dilution is specifically included in the manufacturer's instructions.
   1. Apply using low pressure spray equipment (<50 psi).
   2. Saturate the surface in a "wet-on-wet" application from the bottom up, creating a 6 inch to 8 inch rundown below the spray contact point.
   3. Avoid excessive overlapping.
   4. Allow the application to penetrate the masonry surface and immediately brush out runs and drips to prevent build-up.

B. Brush apply water repellent only at locations where overspray would affect adjacent materials and where not practicable for spray application.

C. Apply 2 coats at rate determined by the manufacturer as a result of the test panel evaluations. Comply with manufacturer's written instructions on limitations on drying time between coats.

3.4 RESTORATION

A. Repair, restore, or replace to the satisfaction of Engineer, any materials, landscaping, and nonmasonry surfaces damaged by exposure to water repellents.

3.5 FIELD QUALITY CONTROL

A. Manufacturer Services: Provide services of a manufacturer-authorized technical service representative to approve the substrate before application and to instruct the applicator on the application rates and methods.

3.6 CLEANING

A. While Work Progresses: Clean spillage and overspray from adjacent surfaces using materials and methods as recommended by water repellent manufacturer.

B. Remove and dispose of all materials used to protect surrounding areas and nonmasonry surfaces, following completion of the work of this Section.

C. Clean site of all unused water repellents, residues, rinse water, wastes, and effluents in accordance with environmental regulations.

3.7 EXTERIOR SCHEDULE

A. Provide water repellent to exterior masonry surfaces of the following structures:
   1. Pump Station
   2. Generator Enclosure

END OF SECTION

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[COMMENTS]

SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install building insulation as shown on the Contract Drawings in the following locations:
   1. Foundation wall insulation (supporting backfill)
   2. Concealed building insulation
   3. Radiant barriers
   4. Safing insulation

1.2 REFERENCES

ASTM International (ASTM) standards, most recent editions:

ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E136	Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 deg C.
ASTM C578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C612	Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C665	Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C1029	Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Manufacturer's Certificate: For each product, provide written letter, signed by manufacturer, certifying that products provided meet or exceed specified requirements.

C. Test Reports: Provide test report, produced by an independent laboratory, showing test results that indicate physical properties of the products provided meet or exceed the requirements of this Section.

D. Manufacturer's Instructions: Submit the following:
   1. General installation/application instructions.
   2. Environmental conditions required for installation and installation techniques.
   3. Safety requirements for application of product.

E. Product Data
   1. Product test reports from and based on tests performed by a qualified independent testing agency evidencing compliance of insulation products with specified requirements including those for thermal resistance, fire test response characteristics, water vapor transmission, water absorption, and other properties, based on comprehensive testing of current products.
   2. Manufacturer's installation instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

C. Protect plastic insulation as follows:
   1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.5 QUALITY ASSURANCE

A. Single Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products complying with requirements indicated without delaying the Work.

B. Fire Test Response Characteristics: Provide insulation and related materials with the fire test response characteristics indicated on Contract Drawings or specified elsewhere in this Section as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency. Conform to the following standards:
   1. Surface Burning Characteristics: ASTM E84.
   2. Fire Resistance Ratings: ASTM E119.
   3. Combustion Characteristics: ASTM E136.

[COMMENTS]

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Extruded Polystyrene Board Insulation:
      a. Amoco Foam Products Company
      b. DiversiFoam Products
      c. Dow Chemical Company
      d. UC Industries, Inc.; Owens Corning Company
      e. Engineer approved equal
   2. Closed-Cell Polyurethane Spray Foam Insulation:
      a. BASF Corporation
      b. Dow Chemical Company
      c. Gaco Western, Inc.
      d. Henry Company
      e. SWD Urethane Company
      f. Engineer approved equal
   3. Glass Fiber Insulation:
      a. CertainTeed Corporation
      b. Knauf Fiber Glass GmbH
      c. Owens Corning Fiberglas Corporation
      d. Johns Manville Corporation
      e. Engineer approved equal
   4. Vapor Retarders:
      a. DURA SKRIM 6WW; Raven Industries, Inc.
      b. Griffolyn T 65; Reef Industries, Inc., Griffolyn Div.
      c. Engineer approved equal
   5. Adhesively Attached, Spindle Type Anchors:
      a. TACTOO Insul Hangers; AGM Industries, Inc.
      b. Spindle Type Gemco Hangers; Gemco
      c. Engineer approved equal
   6. Anchor Adhesives:
      a. TACTOO Adhesive; AGM Industries, Inc.
      b. Tuff Bond Hanger Adhesive; Gemco
      c. Engineer approved equal

2.2 INSULATING MATERIALS

A. Provide insulating materials that comply with requirements specified herein and with referenced standards.
   1. Preformed Units: Sizes to fit applications indicated; selected from manufacturer's standard thicknesses, widths, and lengths.

B. Extruded Polystyrene Board Insulation: Rigid, cellular polystyrene thermal insulation formed from polystyrene base resin by an extrusion process using hydrochlorofluorocarbons as blowing agent to comply with ASTM C578 for type and with other requirements indicated below:

1. Type IV, 1.60 lb/cu. ft. minimum density, unless otherwise indicated.
2. Surface Burning Characteristics: Maximum flame spread and smoke developed indices of 75 and 450, respectively.
3. Recycled Content: Not less than 50 percent blend of postconsumer and recovered polystyrene resins.

C. Unfaced Mineral Fiber Blanket Insulation: Thermal insulation combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665, Type I (blankets without membrane facing).
1. Mineral Fiber Type: Fibers manufactured from glass.
2. Surface Burning Characteristics: Maximum flame spread and smoke developed indices of 25 and 50, respectively.

D. Faced Mineral Fiber Blanket Insulation: ASTM C665, Type III (blankets with reflective membrane facing), Class A (membrane faced surface with a flame spread of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim kraft, foil scrim, or foil scrim polyethylene vapor retarder membrane on one face; consisting of fibers manufactured from glass.

E. Sound Attenuation Blankets: ASTM C665, Type I; semi rigid mineral fiber blanket without membrane, Class 25 flame spread. Furnish in 2-3/4", 4" and 6" thicknesses. Provide minimum thickness as required to achieve a minimum 50 STC in all walls.

2.3 SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Polyurethane foam Insulation: ASTM C1029, Type II, with maximum flame spread and smoke-developed indices of 75 and 450 respectively, per ASTM E84.
1. Minimum Density: 1.5 pcf
2. Thermal Resistivity: 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.4 SAFING INSULATION AND ACCESSORIES

A. Slag Wool Fiber Board Safing Insulation: Semirigid boards designed for use as fire stop at openings between edge of slab and exterior wall panels, produced by combining slag wool fibers with thermosetting resin binders to comply with ASTM C612, Type IA and IB.
1. Nominal density: 4 pcf
2. Combustion Characteristics: Passing ASTM E136
3. Thermal Resistivity: 4 deg F x h x sq ft/Btu x in at 75 deg F.

B. Calking Compound: Material approved by manufacturer of safing insulation for sealing joint between foil backing of safing insulation and edge of concrete floor slab against penetration of smoke.

C. Safing Clips: Galvanized steel safing clips approved by manufacturer of safing insulation for holding safing insulation in place.

2.5 VAPOR RETARDERS

A. Reinforced Polyethylene Vapor Retarders: Two outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than 25 lb/1000 sq ft, with maximum permeance rating of 0.0507 perm.

B. Vapor Retarder Tape: Pressure sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.6 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

2.7 INSULATION FASTENERS

A. Adhesively Attached, Spindle Type Anchors: Plate welded to projecting spindle; capable of holding insulation, of thickness indicated, securely in position indicated with self locking washer in place; and complying with the following requirements:
   1. Plate: Perforated galvanized carbon steel sheet, 0.030 inch thick by 2 inches square.
   2. Spindle: Copper coated low carbon steel, fully annealed, 0.105 inches in diameter, length to suit depth of insulation indicated.

B. Insulation Retaining Washers: Self locking washers formed from 0.016-inch thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1 1/2 inches square or in diameter.
   1. Where spindles will be exposed to human contact after installation, protect ends with capped self locking washers incorporating a spring steel insert to ensure permanent retention of cap.

C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulations or vapor retarders, including removing projections capable of puncturing vapor retarders or that interfere with insulation attachment.

[COMMENTS]

3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, unsoiled, and has not been exposed at any time to ice and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

3.4 INSTALLATION OF PERIMETER INSULATION

A. On vertical surfaces, set units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.

B. Protect below grade insulation on vertical surfaces from damage during backfilling by applying protection board. Set in adhesive according to written instructions of insulation manufacturer.

3.5 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between closed cell insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Set vapor retarder faced units with vapor retarder to warm side of construction, unless otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.
   1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Install mineral fiber blankets in cavities formed by framing members according to the following requirements:
   1. Use blanket widths and lengths that fill cavities formed by framing members. Where more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
   2. Place blankets in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

E. Stuff glass fiber loose fill insulation into miscellaneous voids and cavity spaces. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

[COMMENTS]

3.6 INSTALLATION OF SAFING INSULATION

A. Install safing insulation to fill gap between edge of concrete floor slab and back of exterior spandrel panels on safing clips spaced as needed to support insulation, but no further apart than 24 inches. Cut safing insulation wider than gap to be filled to ensure compression fit and seal joint between insulation and edge of slab with calking approved by safing insulation manufacturer for this purpose. Leave no voids in completed installation.

3.7 INSTALLATION OF VAPOR RETARDERS

A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping not less than 3 inches. Fasten vapor retarders to framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners at maximum of 16 inches.

C. Seal overlapping joints in vapor retarders with adhesives or vapor retarder tape according to vapor retarder manufacturer's instructions. Seal butt joints and fastener penetrations with vapor retarder tape. Locate all joints over framing members or other solid substrates.

D. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by vapor retarder manufacturer.

E. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor retarder tape to create an airtight seal between penetrating objects and vapor retarder.

F. Repair any tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor retarder tape or another layer of vapor retarder.

3.8 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

[COMMENTS]

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SECTION 07 41 13
METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Factory formed and field assembled, standing seam metal roof panels.
   2. Metal soffit and fascia panels.
   3. Downspouts and gutters.

1.2 RELATED SECTIONS

A. Section 01 81 11 – Wind Design Criteria

B. Section 07 62 00 – Sheet Metal Flashing and Trim

C. Section 07 72 00 – Roof Accessories

D. Section 07 92 00 – Joint Sealants

1.3 REFERENCES

A. American Architectural Manufacturers' Association (AAMA) standards, most recent editions:

AAMA 2605	Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

B. ASTM International (ASTM) standards, most recent editions:

ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A755	Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM C1289	Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D226	Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

ASTM D1970	Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2244	Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D4214	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E283	Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1514	Standard Specification for Structural Standing Seam Steel Roof Panel Systems

C. Factory Mutual Global (FMG) standards, most recent editions:

FMG 4471	Approval Standard for Class 1 Panel Roofs

D. National Association of Architectural Metal Manufacturers (NAAMM) standards, most recent editions:

Metal Finishes Manual for Architectural and Metal Products

E. Sheet Metal & Air Conditioning Contractors' National Association (SMACNA) standards, most recent editions:

Architectural Sheet Metal Manual

F. Society for Protective Coatings (SSPC) standards, most recent editions:

SSPC Paint 12	Cold-Applied Asphalt Mastic (Extra Thick Film)

1.4 DEFINITIONS

A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal roof panel and accessory.

C. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory and field assembled work.
   1. Accessories: Include details of the following items, at a scale of not less than 1 1/2 inches per 12 inches:
      a. Flashing and trim.
      b. Gutters.
      c. Downspouts.
      d. Roof curbs.
      e. Snow guards.

D. Coordination Drawings: Roof plans drawn to scale and coordinating penetrations and roof mounted items. Show the following:
   1. Roof panels and attachments.
   2. Roof mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, snow guards, and items mounted on roof curbs.

E. Samples for Selection: For each type of metal roof panel indicated with factory applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.

F. Qualification data for installer.

G. Maintenance data for metal roof panels to include in operation and maintenance manuals.

H. Warranties: Special warranties specified in this Section.

1.6 DEFINITIONS

A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Installer's responsibilities include fabricating and installing metal roof panel assemblies.

B. Source Limitations: Obtain each type of metal roof panels through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal roof panels and are based on the specific system indicated.
1. Do not modify intended aesthetic effects, as judged solely by Engineer, except with Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to Engineer for review.

D. Surface Burning Characteristics: Provide insulation material with the following surface burning characteristics as determined by testing identical products per ASTM E84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
1. Flame Spread Index: 25 or less, unless otherwise indicated.
2. Smoke Developed Index: 450 or less, unless otherwise indicated.

E. Preliminary Roofing Conference: Before starting roof sheathing construction, conduct conference at Project site. Review methods and procedures related to roof sheathing construction and metal roof panels including, but not limited to, the following:
1. Meet with Owner, Engineer, Owner's insurer if applicable, testing and inspecting agency representative, metal roof panel Installer, metal roof panel manufacturer's representative, sheathing Installer, and installers whose work interfaces with or affects metal roof panels including installers of roof accessories and roof mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal roof panel installation, including manufacturer's written instructions.
4. Examine sheathing conditions for compliance with requirements, including flatness and attachment to structural members.
5. Review structural loading limitations of sheathing during and after roofing.
6. Review flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
7. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
8. Review temporary protection requirements for metal roof panels during and after installation.
9. Review roof observation and repair procedures after metal roof panel installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.

C. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.

D. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

E. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

F. Protect foam-plastic insulation as follows:
   1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver foam plastic insulation materials to Project site before installation time.
   3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.9 FIELD CONDITIONS

A. Ambient Conditions: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify locations of roof framing and roof opening dimensions by field measurements before metal roof panel fabrication and indicate measurements on Shop Drawings.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal roof panels without field measurements, or allow for field trimming of panels. Coordinate roof construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.10 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations, which are specified in Section 07 72 00 – Roof Accessories.

B. Coordinate metal panel roof assemblies with rain drainage work, flashing, trim, and construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

B. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Weathertight Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Thermal insulation for field assembled metal roof panels:
   a. Cool-Vent, Hunter Panels
   b. Engineer approved equal
2. Self-Adhering, Polyethylene Faced Sheet:
   a. Dri Start "A;" Carlisle Coatings & Waterproofing
   b. Grace Ice and Water Shield; W.R. Grace & Company
   c. Roof Defender; Johns Manville International, Inc
   d. WeatherLock; Owens Corning
   e. Rainproof TM; Protecto Wrap Company
   f. Engineer approved equal
3. Air and Vapor Barrier:
   a. CCW-705; Carlisle Coatings & Waterproofing
   b. Engineer approved equal
4. Fiberglass Mat Faced Gypsum Roof Board:
   a. Densdeck; Georgia-Pacific Corporation
   b. Engineer approved equal
5. Standing Seam Metal Roof Panels:
   a. AEP Span
   b. Berridge Manufacturing Company
   c. BHP Steel Building Products USA Inc.
   d. CENTRIA Architectural Systems
   e. MBCI; Div. of NCI Building Systems
   f. Engineer approved equal
6. Flush Profile Metal Soffit Panels:
   a. AEP Span
   b. Berridge Manufacturing Company
   c. BHP Steel Building Products USA Inc.
   d. CENTRIA Architectural Systems
   e. MBCI; Div. of NCI Building Systems
   f. Engineer approved equal
7. Snow Guards:
   a. Alpine SnowGuards, Div. of Vermont Slate & Copper Services, Inc.

b. Berger Brothers Company
c. Polar Blox
d. Rocky Mountain Snow Guards, Inc.
e. Engineer approved equal

2.2 PERFORMANCE REQUIREMENTS

A. General: Provide metal roof panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.

B. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq ft of roof area when tested according to ASTM E283.

C. Water Penetration: No water penetration when tested according to ASTM E331.

D. Wind Uplift Resistance: Provide metal roof panel assemblies that comply with UL580 for wind uplift resistance class indicated.

E. FMG Listing: Provide metal roof panels and component materials that comply with requirements in FMG 4471 as part of a panel roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
1. Fire/Windstorm Classification: Class 1A 90.
2. Hail Resistance: SH.

F. Structural Performance: Provide metal roof panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E330:
1. Wind Loads: Determine loads based on the wind design information included in Section 01 81 11 – Wind Design Criteria and as shown on the Contract Drawings.

G. Thermal Movements: Provide metal roof panel assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.3 PANEL MATERIALS

A. Metallic Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot dip process and prepainted by the coil coating process to comply with ASTM A755.
1. Recycled Content: Provide steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Zinc Coated (Galvanized) Steel Sheet: ASTM A653, G90 coating designation; structural quality.
3. Surface: Smooth, flat finish.

4. Exposed Finishes: Apply the following coil coating, as specified or indicated on Drawings.
    a. High Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
        1) Fluoropolymer Three Coat System: Manufacturer's standard three coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a minimum total dry film thickness of 1.5 mil; complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:
            a) Humidity Resistance: 2000 hours.
            b) Water Resistance: 2000 hours.
5. Concealed Finish: Apply pretreatment and manufacturer's standard white or light colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

B. Panel Sealants:
1. Sealant Tape: Pressure sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.

2.4 THERMAL INSULATION FOR FIELD ASSEMBLED METAL ROOF PANELS

A. Faced, Polyisocyanurate Board Insulation:
1. ASTM C1289, Type V, oriented-strand-board facing, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core.
2. Cross vent 1.5” air space to provide cold-roof system.
3. Mechanically attached to deck.

2.5 UNDERLAYMENT MATERIALS

A. Felts: ASTM D226, Type II (No. 30), asphalt saturated organic felts.

B. Self Adhering, Polyethylene Faced Sheet: ASTM D1970, 40 mils thick minimum, consisting of slip resisting polyethylene film reinforcing and top surface laminated to SBS modified asphalt adhesive, with release paper backing; cold applied.

C. Slip Sheet: Building paper, minimum 5 lb/100 sq ft, resin sized.

D. Air and Vapor Barrier: Carlisle CCW-705 or approved equal.

E. Fiberglass Mat Faced Gypsum Roof Board:

1. Thickness: 1/4 inch.

2.6 MISCELLANEOUS MATERIALS

A. Fasteners: Self tapping screws, bolts, nuts, self locking rivets and bolts, end welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory applied coating.
   1. Fasteners for Roof Panels: Self drilling or self tapping, zinc plated, hex head carbon steel screws, with a stainless steel cap or zinc aluminum alloy head and EPDM or neoprene sealing washer.
   2. Fasteners for Flashing and Trim: Blind fasteners or self drilling screws with hex washer head.
   3. Blind Fasteners: High strength aluminum or stainless steel rivets.

B. Bituminous Coating: Cold applied asphalt mastic, SSPC Paint 12, compounded for 15 mil dry film thickness per coat. Provide inert type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.7 STANDING SEAM METAL ROOF PANELS

A. General: Provide factory formed metal roof panels designed to be field assembled by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
   1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

B. Vertical Rib, Seamed Joint, Standing Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and mechanically seaming panels together.
   1. Basis of Design Product: Berridge Manufacturing Company, ZEE-Lock Panel or a comparable product of one of the approved manufacturer's listed above.
   2. Material: Zinc coated (galvanized) steel sheet, 0.0269-inch thick.
      a. Exterior Finish: Fluoropolymer.
      b. Color: As selected by Engineer from manufacturer's full range.
   3. Batten: Same material, finish, and color as roof panels.
   4. Clips: Floating to accommodate thermal movement.
      a. Material: 0.0528-inch thick, zinc coated (galvanized) steel sheet.
   5. Joint Type: Single folded.
   6. Weatherseal: Provide factory applied extruded vinyl weatherseal.
   7. Panel Coverage: 16 inches.
   8. Panel Height: 2.0 inches.
   9. Uplift Rating: UL 90.

2.8 METAL SOFFIT PANELS

A. General: Provide factory formed metal soffit panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory applied sealant in side laps. Include accessories required for weathertight installation.

B. Flush Profile Metal Soffit Panels: Solid panels formed with vertical panel edges and flat pan between panel edges; with flush joint between panels.
   1. Basis of Design Product: Berridge Manufacturing Company, VEE Panel or a comparable product of one of the approved manufacturer's listed above.
   2. Material: Zinc coated (galvanized) steel sheet, 0.0269 inch thick.
      a. Exterior Finish: Fluoropolymer.
      b. Color: As selected by Architect from manufacturer's full range.
   3. Panel Coverage: 3-7/8 inches.
   4. Panel Height: 0.500 inch
   5. Sealant: Factory applied within interlocking joint.

2.9 ACCESSORIES

A. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including trim, copings, fascia, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.
   1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
   2. Clips: Minimum 0.0625-inch thick, stainless steel panel clips designed to withstand negative load requirements.
   3. Cleats: Mechanically seamed cleats formed from minimum 0.0250-inch thick, stainless steel or nylon coated aluminum sheet.
   4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
   5. Closure Strips: Closed cell, expanded, cellular, rubber or crosslinked, polyolefin foam or closed cell laminated polyethylene; minimum 1 inch thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

B. Flashing and Trim: Formed from 0.0179-inch thick, zinc coated (galvanized) steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fascia, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

C. Gutters: Formed from 0.0179-inch thick, zinc coated (galvanized) steel sheet prepainted with coil coating. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch long sections, sized according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced 36 inches o.c., fabricated from same metal as gutters. Provide bronze, copper, or aluminum wire ball strainers at outlets. Finish gutters to match roof fascia and rake trim.

D. Downspouts: Formed from 0.0179-inch thick, zinc coated (galvanized) steel sheet prepainted with coil coating; in 10-foot long sections, complete with formed elbows and offsets. Finish downspouts to match metal roof panels.

E. Snow Guards: Prefabricated, noncorrosive units designed to be installed without penetrating metal roof panels, and complete with predrilled holes, clamps, or hooks for anchoring.
   1. Seam-Mounted, Fence-Type Snow Guards: Cast-aluminum stops designed for attachment to vertical ribs of standing-seam metal roof panels with stainless-steel set screws.
   2. Color to match roof panel.

F. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

2.10 FABRICATION

A. General: Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Where indicated, fabricate metal roof panel joints with factory installed captive gaskets or separator strips that provide a tight seal and prevent metal to metal contact, in a manner that will minimize noise from movements within panel assembly.

D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat lock seams. Tin edges to be seamed, form seams, and solder.
   3. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
   4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal roof panel manufacturer.
      a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal roof panel manufacturer for application but not less than thickness of metal being secured.

2.11 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of work.
   1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

B. Examine roughing in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.

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

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

B. Install flashings and other sheet metal to comply with requirements specified in Division 7 Section "Sheet Metal Flashing and Trim."

C. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written recommendations.

3.3 THERMAL INSULATION INSTALLATION FOR FIELD ASSEMBLED METAL ROOF PANELS

A. Board Insulation: Extend insulation in thickness indicated to cover entire roof.
   1. Erect insulation horizontally and hold in place with Z shaped furring members spaced 24 inches o.c. Securely attach narrow flanges of furring members to roof deck with screws spaced 24 inches maximum.

3.4 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Install felt underlayment and building paper slip sheet on roof sheathing under metal roof panels, unless otherwise recommended by metal roof panel manufacturer.

Use adhesive for temporary anchorage, where possible, to minimize use of mechanical fasteners under metal roof panels. Apply at locations indicated below, in shingle fashion to shed water, with lapped joints of not less than 2 inches.

1. Apply on roof not covered by self adhering sheet underlayment. Lap edges of self adhering sheet underlayment not less than 3 inches, in shingle fashion to shed water.

B. Self Adhering Sheet Underlayment: Install self adhering sheet underlayment, wrinkle free, on roof sheathing under metal roof panels. Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply at locations indicated below, in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3 1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

1. Roof perimeter for a distance up from eaves of 24 inches beyond interior wall line.
2. Valleys, from lowest point to highest point, for a distance on each side of 18 inches. Overlap ends of sheets not less than 6 inches.
3. Rake edges for a distance of 18 inches.
4. Hips and ridges for a distance on each side of 12 inches.
5. Roof to wall intersections for a distance from wall of 18 inches.
6. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches.

C. Install flashings to cover underlayment to comply with requirements specified in Section 07 62 00 – Sheet Metal Flashing and Trim.

D. Apply slip sheet over underlayment before installing metal roof panels.

3.5 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cutting of metal roof panels by torch is not permitted.
2. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels.
3. Provide metal closures at peaks, rake edges, each side of ridge and hip caps.
4. Flash and seal metal roof panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self tapping screws.
5. Locate and space fastenings in uniform vertical and horizontal alignment.
6. Install ridge and hip caps as metal roof panel work proceeds.
7. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four panel lap splice condition.
8. Lap metal flashing over metal roof panels to allow moisture to run over and off the material.

B. Fasteners:

1. Steel Roof Panels: Use stainless steel fasteners for surfaces exposed to the exterior and galvanized steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
   1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.
   2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 – Joint Sealants.

3.6 FIELD ASSEMBLED METAL ROOF PANEL INSTALLATION

A. Standing Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing seam joint at location, spacing, and with fasteners recommended by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
   3. Seamed Joint: Crimp standing seams with manufacturer approved motorized seamer tool so clip, metal roof panel, and factory applied sealant are completely engaged.

3.7 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather resistant performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1 1/2 inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
   1. Provide elbows at base of downspouts to direct water away from building.

E. Snow Guards: Attach bar supports to vertical ribs of standing seam metal roof panels with clamps or set screws. Do not use fasteners that will penetrate metal roof panels.
   1. Install snow guards above entrances, adjacent to walking surfaces, at other areas where falling snow may be hazardous and at locations as recommended by the manufacturer and where shown on the Contract Drawings. Install in accordance with manufacturer's printed instructions and recommendations.

F. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.8 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8 inch offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

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SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sheet metal flashing and trim:
   1. Manufactured reglets.
   2. Formed roof drainage system.
   3. Formed low-slope roof flashing and trim.
   4. Formed wall flashing and trim.
   5. Formed equipment support flashing.

B. Related Sections include the following:
   1. Division 1 Section "LEED Requirements" for LEED certification targets, related LEED requirements, recycled content minima, other LEED criteria and constraints.
   2. Information attached for reference, including LEED Checklist for Project building(s), indicating which LEED credits are targeted for attainment.
   3. LEED reference documents, not attached but available for use, including the “LEED-New Construction v.2.2 Rating System,” explaining requirements for each prerequisite and credit, and the “LEED-New Construction v2.2 Reference Guide,” detailing requirements and documentation options for application for each prerequisite and credit.
   4. Division 4 Section "Unit Masonry Assemblies" for installing through-wall flashing, reglets, and other sheet metal flashing and trim.
   5. Division 6 Section "Miscellaneous Carpentry" for wood nailers, curbs, and blocking.
   6. Division 7 Section "Metal Roof Panels" for factory-formed metal roof panels and flashing and trim not part of sheet metal flashing and trim.
   7. Division 7 Section "Roof Accessories" for set-on-type curbs, roof hatches, and other manufactured roof accessory units.
   8. Division 7 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

1.3 PERFORMANCE REQUIREMENTS

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:Section Includes

1. Wind Zone 1: For velocity pressures of (21 to 30 lbf/sq. ft.): (60-lbf/sq. ft.) perimeter uplift force, (90-lbf/sq. ft.) corner uplift force, and (30-lbf/sq. ft.) outward force.

C. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
1. Temperature Change (Range): (120 deg F), ambient; (180 deg F), material surfaces.

D. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:
1. Product Data for Credit MR 4.1 and Credit MR 4.2: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
a. Include statement indicating costs for each product having recycled content.

C. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop and field assembled work. Include the following:
1. Identify material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
4. Details of expansion joint covers, including showing direction of expansion and contraction.

D. Samples for Selection: For each type of sheet metal flashing and trim indicated with factory applied color finishes.
1. Include similar Samples of trim and accessories involving color selection.

1.5 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

B. Mockups: Prior to installing sheet metal flashing and trim, construct mockups indicated to verify selections made under Sample submittals and to demonstrate aesthetic effects as well

as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.

1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Notify Architect one week in advance of the dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Construct mockups for the following type of sheet metal flashing and trim:
    a. Exposed trim, gravel stops, and fasciae.
    b. Copings.
5. Obtain Architect's approval of mockups before start of final unit of Work.
6. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
    a. When directed, demolish and remove mockups from Project site.
    b. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof mounted equipment.
2. Review methods and procedures related to sheet metal flashing and trim.
3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.7 COORDINATION

A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
   2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 SHEET METALS

A. Zinc Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, (G90) coating designation; structural quality, mill phosphatized for field painting.

B. Prepainted, Metallic Coated Steel Sheet: Steel sheet metallic coated by the hot dip process and prepainted by the coil coating process to comply with ASTM A 755/A 755M.
   1. Recycled Content: Provide steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
   2. Zinc Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, (G90) coating designation; structural quality.
   3. Exposed Finishes: Apply the following coil coating:
      a. High Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
         1) Fluoropolymer 3 Coat System: Manufacturer's standard 3 coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a minimum total dry film thickness of (1.5 mil); complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:
            a) Humidity Resistance: 2000 hours.
            b) Salt Spray Resistance: 2000 hours.
         2) Color: Custom color as selected by Architect from manufacturer's full range, to match existing, including deep tone colors.

C. Lead Sheet: ASTM B 749, Type L51121, copper bearing lead sheet.

D. Zinc Sheet: Electrolytic, 99 percent pure zinc alloyed with 1 percent titanium and copper.
   1. Finish: Bright rolled.

2.3 UNDERLAYMENT MATERIALS

A. Polyethylene Sheet: (6 mil) thick polyethylene sheet complying with ASTM D 4397.

B. Slip Sheet: Rosin sized paper, minimum (3 lb/100 sq. ft.).

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

B. Fasteners: Wood screws, annular threaded nails, self tapping screws, self locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
   1. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory applied coating.
   2. Fasteners for Flashing and Trim: Blind fasteners or self drilling screws, gasketed, with hex washer head.
   3. Blind Fasteners: High strength aluminum or stainless steel rivets.
   4. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

C. Solder for Lead: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

D. Solder for Zinc: ASTM B 32, 60 percent lead and 40 percent tin with low antimony, as recommended by manufacturer.

E. Burning Rod for Lead: Same composition as lead sheet.

F. Sealing Tape: Pressure sensitive, 100 percent solids, polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

G. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

H. Butyl Sealant: ASTM C 1311, single component, solvent release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked type expansion joints with limited movement.

I. Bituminous Coating: Cold applied asphalt mastic, SSPC Paint 12, compounded for (15 mil) dry film thickness per coat. Provide inert type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 MANUFACTURED SHEET METAL FLASHING AND TRIM

A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory mitered and welded corners and junctions.
   1. Available Manufacturers:
      a. Fry Reglet Corporation.
   2. Material: Galvanized steel, (0.0217 inch) thick.

3. Surface Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
4. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
   a. Available Manufacturers:
      1) Cheney Flashing Company, Inc., Type B Snap Lock.
5. Flexible Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
6. Counterflashing Wind Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

2.6 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.

B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
1. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat lock seams. Tin edges to be seamed, form seams, and solder.

D. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

E. Seams: Comply with SMACNA AArchitectural Sheet Metal Manual@, (Sixth Edition, September 2003) Figure no. 3-2 and 3-3 as applicable to specific installations.
1. Standing Seams: Provide double lock standing seams (detail no. 25, figure no. 3-3), with finish not less than 1-1/4" high.

F. Expansion Provisions: Where lapped or bayonet type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than (1 inch) deep, filled with elastomeric sealant concealed within joints.

G. Conceal fasteners and expansion provisions where possible on exposed to view sheet metal flashing and trim, unless otherwise indicated.

H. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

2.7 ROOF DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum (96 inch) long sections. Furnish flat stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
   1. Gutter Style: D and as detailed.
   2. Expansion Joints: Built in.
   3. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen.
   4. Gutters with Girth up to (15 Inches): Fabricate from the following material:
      a. Prepainted, Metallic Coated Steel: 0.0299 inch thick.

B. Downspouts: Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
   1. Fabricate downspouts from the following material:
      a. Prepainted, Metallic Coated Steel: 0.0299 inch thick.

2.8 LOW SLOPE ROOF SHEET METAL FABRICATIONS

A. Copings: Fabricate in minimum (96 inch) long, but not exceeding (10 foot) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.
   1. Joint Style: Standing seams.
   2. Fabricate copings from the following material:
      a. Prepainted, Metallic Coated Steel: 0.0396 inch thick.

B. Roof and Roof to Wall Transition Expansion Joint Cover: Fabricate from the following material:
   1. Prepainted, Metallic Coated Steel: 0.0336 inch thick.

C. Base Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0276 inch thick.

D. Counterflashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0217 inch thick.

E. Flashing Receivers: Fabricate from the following material:
   1. Galvanized Steel: 0.0217 inch thick.

F. Roof Penetration Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0276 inch thick.

2.9 WALL SHEET METAL FABRICATIONS

A. Through Wall Flashing: Fabricate continuous flashings in minimum (96 inch) long, but not exceeding (12 foot) long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend (6 inches) beyond each side of wall openings. Form with (2 inch) high end dams. Fabricate from the following material:
   1. Zinc: 0.040 inch thick.

B. Openings Flashing in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with (2 inch) high end dams. Fabricate from the following material:
   1. Prepainted, Metallic Coated Steel: 0.0217 inch thick.

C. Wall Expansion Joint Cover: Fabricate from the following material:
   1. Prepainted, Metallic Coated Steel: 0.0276 inch thick.

2.10 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0276 inch thick.

2.11 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
   1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   1. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
   1. Coat side of sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
   3. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.

C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.

D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.

E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
   1. Space cleats not more than (12 inches) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of (10 feet) with no joints allowed within (24 inches) of corner or intersection. Where lapped or bayonet type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than (1 inch) deep, filled with elastomeric sealant concealed within joints.

G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than (1 1/4 inches) for nails and not less than (3/4 inch) for wood screws.
   1. Galvanized or Prepainted, Metallic Coated Steel: Use stainless steel fasteners.

H. Seal joints with elastomeric sealant as required for watertight construction.
   1. Where sealant filled joints are used, embed hooked flanges of joint members not less than (1 inch) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between (40 and 70 deg F), set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant type joints at temperatures below (40 deg F).

2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of (1 1/2 inches) except where pretinned surface would show in finished Work.
   1. Do not solder prepainted, metallic coated steel sheet.
   2. Pretinning is not required for lead.
   3. Where surfaces to be soldered are lead coated, do not tin edges, but wire brush lead coating before soldering.
   4. Do not use open flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

3.3 ROOF DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with elastomeric sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets spaced not more than (36 inches) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
   1. Fasten gutter spacers to front and back of gutter.
   2. Loosely lock straps to front gutter bead and anchor to roof deck.
   3. Anchor and loosely lock back edge of gutter to continuous eave or apron flashing.
   4. Anchor back of gutter that extends onto roof deck with cleats spaced not more than (24 inches) apart.
   5. Anchor gutter with spikes and ferrules spaced not more than 24 inches apart.
   6. Install gutter with expansion joints at locations indicated but not exceeding (50 feet) apart. Install expansion joint caps.
   7. Install continuous gutter screens on gutters with noncorrosive fasteners, hinged to swing open for cleaning gutters.

C. Downspouts: Join sections with (1 1/2 inch) telescoping joints. Provide fasteners designed to hold downspouts securely (1 inch) away from walls; locate fasteners at top and bottom and at approximately (60 inches) o.c. in between.
   1. Provide elbows at base of downspout to direct water away from building or connect downspouts to underground drainage system indicated.

3.4 ROOF FLASHING INSTALLATION

A. General: Install sheet metal roof flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1 49 for specified wind zone and as indicated.
   1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 16 inch centers.

C. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1 49 for specified wind zone and as indicated.
   1. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 16 inch centers.
   2. Anchor interior leg of coping with screw fasteners and washers at 18 inch centers.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close fitting collar with top edge flared for elastomeric sealant, extending a minimum of (4 inches) over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing (4 inches) over base flashing. Lap counterflashing joints a minimum of (4 inches) and bed with elastomeric sealant.
   1. Secure in a waterproof manner by means of snap in installation and sealant.

F. Roof Penetration Flashing: Coordinate installation of roof penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:
   1. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.5 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall opening components such as windows, doors, and louvers.

B. Through Wall Flashing: Installation of formed through wall flashing is specified in Division 4 Section "Unit Masonry Assemblies."

C. Reglets: Installation of reglets is specified in Division 3 Section "Cast in Place Concrete and in 4 Section "Unit Masonry Assemblies."

D. Openings Flashing in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.6 MISCELLANEOUS FLASHING INSTALLATION

A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.7 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 72 00
ROOF ACCESSORIES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all roof accessories and appurtenant work, complete, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Trade Standards

National Roofing Contractors Association (NRCA).

1.3 CONTRACTOR SUBMITTALS

A. All submittals shall be in accordance with Section 01 33 00 - Contractor Submittals.

B. The manufacturer's specifications, literature, and published installation instructions for each accessory, product, or system shall be submitted.

C. Shop drawings shall be submitted for all roof hatches, Bermuda-type ventilators, and openable fire and smoke hatches with skylights, prior to fabrication.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken, packages, containers, or bundles bearing the name of the manufacturer.

B. Storage: All materials shall be carefully stored on wood blocking in an area that is protected from the elements. Storage shall be in a manner that will prevent damage or marring of finish.

PART 2 - PRODUCTS

2.1 ROOF VENTS

A. Roof relief vents with bird screens shall be provided, and shall be of the type recommended by the National Roofing Contractor's Association (NRCA) and approved by the roofing manufacturer.

2.2 CEILING EXHAUST FAN OPENINGS

A. Design: Ceiling exhaust fan openings (used for pump access) shall be constructed of aluminum unless otherwise indicated, and shall be provided with stainless steel hardware, including padlocking hardware inside and outside, and neoprene gaskets and seals. Ceiling

exhaust fan openings are considered corrosive or damp environments and shall be provided with stainless steel hardware. Ceiling exhaust fan openings shall be either:

1. A hinged opening from the Exhaust Fan Manufacturer or:
2. A constructed opening that meets the design provided in the contract documents.

B. Manufacturers, or Equal

1. Babcock Davis.
2. Bilco Company.
3. Inryco-Milcor.
4. Milcor.

2.3 BERMUDA-TYPE ROOF VENTILATOR (ATTIC VENT)

A. Roof attic vents shall be fiber glass, bermuda-type roof ventilators complete with one-piece, molded vent hood with integral mounting frame in each corner braced vertically as well as horizontally. The ventilators shall include a one-piece molded curb with integral internal weather baffle, molded-in cant strip, and a plastic coated galvanized bird screen. Sizes of ventilators indicated are minimum throat sizes.

2.4 PREFABRICATED CURBS

A. Design: Opening dimensions shall be coordinated with skylight penetrations, duct penetrations, and roof-mounted equipment sizes. Heights shall be as required to place top of curb not less than 8 inches above top of insulation. The top edge of the curb shall be a level surface for installation, connection or mounting of exhaust fan equipment and skylights. Sides of curbs shall have heights adjusted per job and field conditions and roof stoops. Base flange shall be not less than 4 inches wide. Curbs shall be fabricated of 14 gauge or thicker galvanized steel with continuously welded corners and shall be provided with pressure preservative treated, kiln dried, fire-treated wood nailer at top.

B. Manufacturers, or Equal

1. Pate Company.
2. S & L Manufacturing Company.
3. Thybar Corporation.

PART 3 - EXECUTION

3.1 GENERAL

A. The installation shall conform to applicable codes and the manufacturers published or written recommendations, specifications, and published installation instructions for the type of work being performed. The construction shall be coordinated with the work of other trades.

B. All roof openings, roof-mounted equipment, duct openings, and skylights shall be provided with a prefabricated curb unless the equipment above the roof opening is supplied with its own curb which extends to 8 inches or higher beyond the top of the roof insulation.

C. Roof hatches with ladders shall be provided with a ladder-up device.

3.2 INSTALLATION

A. Ceiling Exhaust Fans and Roof Ventilators: Units shall be installed over prepared openings with their own curbs or prefabricated curbs, and shall be fastened to roof deck in accordance with the manufacturer's printed directions. Lifting mechanisms and accessories shall be adjusted to insure proper operation. Abraded prime and finish coat surfaces shall be touched-up after completion of installation with the same type finish and the same dry-film thickness.

1. Roof Hatches: Dissimilar metals shall be properly isolated. Thermal movement, up to 100 degrees F change, shall be accommodated without distress in assembly of fasteners.
2. Roof Vents: Roof vents shall be provided on lightweight concrete or lightweight insulating concrete and shall be placed in such a manner so that one vent will be used for venting 1,000 square feet of roof fill. No area shall have fewer than two vents. Vents shall not be installed in walk pads or other traffic areas. Vent pipes shall have a coat of plastic cement applied at the joint between the vent pipe and the roofing before aggregate is applied. Roof insulation shall be removed from below vent per NRCA instructions. Roof vents shall be painted to match roofing color.

B. Protective Coating: All roof accessories shall be coated in accordance with Section 09 90 00 Protective Coatings and Linings, to match the roofing color unless directed otherwise by the Engineer. Primer coats shall be compatible with finish coats.

END OF SECTION

SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes sealant work associated with joints between similar and dissimilar materials in the Work.

B. Work included consists of, but is not necessarily limited to the following:
   1. Sealing all joints which would otherwise permit penetration of moisture, unless sealing work is specifically required under other sections.
      a. Flashing reglets and retainers.
      b. Exterior wall joints.
      c. Flooring joints.
      d. Isolation joints.
      e. Joints between paving and sidewalks and building.
      f. Concrete control and expansion joints, exterior and interior.
      g. Joints at penetrations of walls, floors, and decks by piping and other services and equipment.
      h. Exterior and interior perimeters of exterior and interior door and window frames, louvers, grilles, etc.
      i. Thresholds at exterior doors.
      j. Sealing of plumbing fixtures to floor or wall.
      k. Other joints where calking, sealant, or compressible sealant is indicated.

1.2 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM C1087	Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems
ASTM C1193	Standard Guide for Use of Joint Sealants
ASTM C1247	Standard Test Method for Durability of Sealants Exposed to Continuous Immersion in Liquids

B. Federal Specification (FS), most recent editions:

TT-S-001543A	Sealing Compound: Silicone Rubber Base (for Caulking, Sealing, and Glazing in Buildings and Other Structures)

TT-S-00230C	Sealing Compound: Elastomeric Type, Single Component (For Calking, Sealing, and Glazing in Buildings and Other Structures)
TT-S-00227E	Sealing Compound: Elastomeric Type, Multi-Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures)

C. Underwriters Laboratories Inc. (UL):

Building Materials Directory

D. National Sanitation Foundation (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects

1.3 DEFINITIONS

A. Words "calk," "sealant," and "calking" mean sealant Work.

B. "Interior wet areas" mean toilets, showers, sinks, and similar areas.

C. "Applicator" means the individual actually on site performing the installation.

D. "Vertical" means any surface with a slope greater than 1.5 horizontal to 1.0 vertical.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Contractor Submittals.

B. Product Data
1. Letter of certification that products submitted meet requirements of standards referenced.
2. Manufacturer's installation instructions.
3. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling, and bond breaker.
4. Applicator qualifications.
5. Warranty.
6. Certification from sealant manufacturer stating that product being used is recommended for and is best suited for joint in which it is being applied.

C. Field Samples
1. Cured sample of each color for Engineer's color selection. Color chart not acceptable.

D. Preconstruction field test reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in below in QUALITY ASSURANCE.

E. Product test reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Sealant applicator shall have a minimum of five years of experience on projects with similar scope.

B. Mock-ups:
   1. Before calking work is started, a sample of each type of joint shall be caulked where directed by Engineer. The approved samples shall show the workmanship, bond, and color of calking materials as specified or selected for the Work and shall be the minimum standard of quality on the entire Project.

C. Preconstruction compatibility and adhesion testing:
   1. Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact of affect joint sealants.
      a. Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
      b. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
      c. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
      d. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
      e. Testing will not be required if sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Preconstruction field-adhesion testing: Before installing elastomeric sealants, field test their adhesion to joint substrates found in the Work as follows:
   1. Locate test joints where indicated in the Work or, if not indicated, as directed by the Engineer.
   2. Conduct tests for each application indicated below:
      a. Each type of elastomeric sealant and joint substrate indicated.
   3. Notify Engineer a minimum of 7 days in advance of dates and times when test joints will be evaluated.
   4. Test method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 of ASTM C1193.
   5. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
   6. Evaluation of preconstruction field-adhesion test results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with

requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Deliver material in manufacturer's original unopened containers with labels intact. Labels shall indicate contents and expiration date of material.

C. Store all materials off the ground and protect from rain, freezing, or excessive heat until ready for use.

D. Condition the specified products before use as recommended by the manufacturer.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Schedule Work to be performed when temperature and humidity are as recommended by the sealant manufacturer during and after installation until products are fully cured.

1.8 WARRANTY

A. Material and Labor Warranty:
   1. Sealant work shall be free of defects for a period of 5 years from date of final acceptance.
   2. Failure of watertightness constitutes defect.
   3. Remove any defective work and/or materials and replace with new materials.
   4. Warranty must be sighed jointly by applicator and sealant manufacturer.

B. Special installer’s warranty:
   1. Installer’s standard form in which installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified herein within specified warranty period.
      a. Warranty period: Five years from date of final acceptance.
   2. Special warranties herein specified exclude deterioration or failure of elastomeric joint sealants from the following:
      a. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer’s written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design.
      b. Disintegration of joint substrates from natural causes exceeding design specifications.
      c. Mechanical damage by individuals, tools, or other outside agents.
      d. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Polyurethane sealants.
      a. MAMECO International.
      b. Pecora.
      c. PSI Polymeric Systems, Inc.
      d. Sika Chemical Corporation.
      e. Sonneborn – Rexnord.
      f. Tremco
      g. Engineer approved equal.
   2. Silicone sealants:
      a. Dow Corning Corporation.
      b. General Electric.
      c. Tremco
      d. Engineer approved equal.
   3. Fire Resistant Sealant:
      a. 3M Corporation.
      b. Dow Corning.
      c. Engineer approved equal.

2.2 MATERIALS

A. Sealants – General:
   1. Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
   2. Where compound is exposed to view in finished Work, provide colors matching materials being sealed.
   3. Where compound is not exposed to view in finished Work, provide manufacturer's color with best performance.
   4. For joints in potable water reservoirs, provide only 2-component polyurethane sealant with NSF 61 certification.
   5. Provide non sagging sealant for vertical and overhead joints.
   6. Sealants for horizontal joints:
      a. Self-leveling pedestrian/traffic grade.
   7. Suitability for immersion in liquids: Where elastomeric sealants are indicated for submerged use, provide products that have undergone testing according to ASTM C1247 and qualify for the length of exposure indicated by reference to ASTM C920 for Classes 1 or 2. Liquid used for testing sealants is chlorinated potable water, unless otherwise noted.

B. Polyurethane Sealant:
   1. One or two components.
   2. Meet ASTM C920; F.S. TT-S-00230C, Type I or Type II, Class A, or TT-S-00227E, Type I or Type II, Class A.

a. Pecora Dynatrol I, Dynatrol II, Urexpan NR-200 or NR-201.
b. PSI PSI-270.
c. Sika Sikaflex-1A, Sikaflex-2C.
d. Sonneborn Sonolastic NP-1, NP-II, SL-1.
e. Tremco Vulkem 116, 227, 45, 245.

C. Silicone Sealant:
1. One component.
2. Meet F.S. TT-S-001543A, Class A:
a. Dow Corning 790, 795, 786.
b. General Electric Silpruf, Silglaze, Sanitary SCS 1700 sealant.
c. Tremco Spectrem.

D. Bond breaker tape: Polyethylene tape of other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint surfaces of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
1. Unless specifically shown on the Drawings, bond breaker shall not be used in joints within the reservoir.

E. Joint Cleaner, Primer, Bond Breaker:
1. As recommended by sealant manufacturer.

F. Sealant Backer Rod: Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer to:
1. Control joint depth
2. Break bond of sealant oat bottom of joint
3. Provide proper shape of sealant bead.

G. Fire-Resistant Sealant:
1. One or two component.
2. Furnish sealant which has been tested for use as a fire and smoke penetration seal.
a. 3M Corporation Fire Dam 150.
b. Dow Corning Firestop.
3. UL approved for intended use.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before using any sealant, investigate its compatibility with adjacent joint surfaces, fillers, and other materials in the joint system.

B. Use only compatible materials.

C. Clean and prime joint surfaces in accordance with manufacturer's instructions.
1. Limit application to surfaces to receive sealant.
2. Mask off adjacent surfaces.

D. Commencing sealant installation constitutes acceptance of joints and surfaces.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Where finish coating or covering is to be applied to surface, wait until such coating or covering has been applied before installing sealant; e.g., paint, wall covering, glazed coatings.

C. Make all joints water and air tight.

D. Make depth of sealing compounds not more than one-half width of joint, but in no case less than 1/4 inch nor more than 5/8 inch.

E. Provide correctly sized backer rod in all joints to proper depth

F. Apply bond breaker where required.

G. Tool sealants using sufficient pressure to fill all voids.

H. Upon completion, leave sealant with smooth even neat finish.

3.3 CLEANING

A. Clean adjacent soiled surfaces free of sealant.

3.4 PROTECTION

A. Protect finished installation.

B. Protect sealants until fully cured.

3.5 SCHEDULES

A. Furnish sealant as indicated for the following areas:
    1. Exterior areas:
        a. Joints in concrete and masonry:
            1) Use 2-component polyurethane only.
        b. All other joints:
            1) Single or 2-component Polyurethane or.
            2) Silicone.
    2. Interior wet areas:
        a. Joints in concrete and masonry:
            1) Use 2-component polyurethane only.
        b. All other joints:
            1) Single or 2-component Polyurethane or.
            2) Silicone.
    3. Interior non-wet, corrosive areas:
        a. Joints in concrete and masonry:
            1) Use 2-component polyurethane only.

b. All other joints:
    1) Single or 2-component Polyurethane or.
    2) Silicone.

4. Interior non-wet, drywall and plaster noncorrosive areas:
    a. All Joints:
        1) Single or 2-component Polyurethane or.
        2) Silicone.

5. Fire-rated construction: Fire-resistant sealant.

END OF SECTION

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DIVISION 8
OPENINGS

[COMMENTS]

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install hollow metal doors and frames for construction in accordance with Contract Documents.

B. Section Includes:
1. Steel doors.
2. Fire and smoke doors.
3. Steel door frames.

1.2 RELATED SECTIONS

A. Section 08 71 00 - Door Hardware

B. Section 08 81 00 - Glass and Glazing

C. Section 09 90 00 – Painting and Coatings

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A879	Standard Specification for Steel Sheet, zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
ASTM A924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM C578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C591	Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C612	Mineral Fiber Block and Board Thermal Insulation
ASTM D2863	Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

ASTM E283	Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E1300	Determining Load Resistance of Glass in Buildings
ASTM F2248	Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass

B. American Welding Society (AWS) standards, most recent editions:

D1.1	Structural Welding Code – Steel

C. Builder's Hardware Manufacturers Association (BHMA) standards, most recent editions:

ANSI/BHMA A156.115	Hardware Preparation in Steel Doors and Steel Frames

D. Consumer Product Safety Commission (CPSC) publications, most recent editions:

16 CFR 1201	Safety Standard for Architectural Glazing Materials

E. National Association Of Architectural Metal Manufacturers (NAAMM) standards, most recent editions:

NAAMM HMM	Hollow Metal Manual

F. National Fire Protection Association (NFPA), standards most recent editions:

NFPA 80	Standard for Fire Doors and Other Opening Protectives
NFPA 105	Standard for Installation of Smoke Door Assemblies and Other Opening Protectives
NFPA 252	Standard Methods of Fire Tests of Door Assemblies
NFPA 257	Standard on Fire Test for Window and Glass Block Assemblies

G. Steel Door Institute (SDI) standards, most recent editions:

SDI 111	Recommended Selection and Usage Guide for Standard Steel Doors, Frames and Accessories
SDI 113	Standard Practice for Determining the Steady State Thermal Transmittance of Steel Door and Frame Assemblies
SDI A250.3	Test Procedure and Acceptance Criteria for Factory Applied Finish Painted Steel Surfaces for Steel Doors and Frames

SDI A250.4	Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcing
SDI A250.6	Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
SDI A250.8	Recommended Specifications for Standard Steel Doors and Frames
SDI A250.11	Recommended Erection Instructions for Steel Frames

H. Underwriters Laboratories (UL) standards, most recent editions:

UL 10C	Standard for Positive Pressure Fire Tests of Door Assemblies

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire resistance ratings, and finishes. Use same reference designations indicated on Contract Drawings in preparing schedule for doors and frames.

C. Shop Drawings: Show the following for each door:
1. Elevations of each door design.
2. Details of doors including vertical and horizontal edge details.
3. Frame details for each frame type including dimensioned profiles.
4. Details and locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, accessories, joints, and connections.
7. Coordination of glazing frames and stops with glass and glazing requirements.

D. Samples
1. Factory Applied Enamel Finish: Where colors are not indicated, submit manufacturer's standard colors and patterns for selection.

E. Certificates
1. Oversize Construction Certificates: For door assemblies required to be fire protection rated and exceeding size limitations of labeled assemblies.
2. Metallic Construction Certificates: For door assemblies (doors and frames) required to be of metallic coated steel for compliance with this specification section.

1.5 QUALITY ASSURANCE

A. Steel Door and Frame Standard: Comply with SDI A250.8, unless more stringent requirements are indicated.

B. Fire Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire protection ratings indicated, based on testing according to NFPA 252.

C. Test Pressure: Test at atmospheric pressure.

D. Oversize Fire Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire rated door assemblies except for size.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Delivery and Acceptance Requirements
   1. Deliver doors and frames cardboard wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory finished doors and frames.
   2. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damage may be repaired provided refinished items match new Work and are acceptable to the Engineer. Remove and replace damaged items that cannot be repaired as directed.

C. Storage and Handling Requirements
   1. Store doors and frames at building site under cover. Place units on minimum 4 inch high wood blocking. Avoid using non vented plastic or canvas shelters that could create a humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4 inch spaces between stacked doors to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Steel Doors and Frames:
      a. Amweld Building Products, Inc.
      b. Ceco Door Products; a United Dominion Company
      c. Curries Company
      d. Kewanee Corporation
      e. Pioneer Industries Inc.
      f. Republic Builders Products
      g. Steelcraft; a division of Ingersoll Rand
      h. Engineer approved equal.

[COMMENTS]

2.2 MATERIALS

A. Steels used to manufacture doors, frames, anchors, and accessories shall meet at least one or more of the following requirements:
   1. Hot Rolled Steel Sheets: ASTM A1011, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
   2. Cold Rolled Steel Sheets: ASTM A1008, Commercial Steel (CS) or Drawing Steel (DS), Type B; stretcher leveled standard of flatness.
   3. Metallic Coated Steel Sheets: ASTM A653, Commercial Steel (CS), Type B, with an A40 zinc iron alloy coating (Galvannealed); stretcher leveled standard of flatness.

2.3 STANDARD STEEL DOORS

A. Conform to SDI A250.8, except as specified otherwise. Prepare doors to receive door hardware as specified in Section 08 71 00. Undercut where indicated.

B. Exterior doors shall have top edge closed flush and sealed to prevent water intrusion. Doors shall be 1-3/4 inch thick, unless otherwise indicated. When indicated, provide exterior glazing in accordance with ASTM F2248 and ASTM E1300.

C. Classification Level, Performance, Model
   1. Standard Duty Doors
      a. Level 1
      b. Physical Performance Level: C
      c. Model: 1
      d. Size: Per Contract Drawings
      e. Provide for door numbers: 3 & 4
   2. Heavy Duty Doors
      a. Level 2
      b. Physical Performance Level: B
      c. Model: 1
      d. Size: Per Contract Drawings
      e. Provide for door numbers: 1 & 2

2.4 CUSTOM HOLLOW METAL DOORS

A. Provide custom hollow metal doors where nonstandard steel doors are indicated. At the Contractor's option, custom hollow metal doors may be provided in lieu of standard steel doors. Door size, design, materials, construction, gages, and finish shall be as specified for standard steel doors and shall comply with the requirement of NAAMM HMM.

B. Fill all spaces in doors with insulation. Close top and bottom edges with steel channels not lighter than 16 gauge. Close tops of exterior doors flush with an additional channel and seal to prevent water intrusion.

C. Prepare doors to receive hardware specified in Section 08 71 00 – Door Hardware. Undercut doors where indicated.

D. Doors shall be 1-3/4 inch thick, unless otherwise indicated.

[COMMENTS]

2.5 INSULATED STEEL DOOR SYSTEMS

A. At the option of the Contractor, insulated steel doors and frames may be provided in lieu of Level 1 standard steel doors and frames. Door size, design, and material shall be as specified for standard steel doors.

B. Conform to SDI A250.4. Prepare doors to receive door hardware as specified in Section 08 71 00. Undercut where indicated.

C. Exterior doors shall have top edge closed flush and sealed to prevent water intrusion. Doors shall be 1-3/4 inch thick, unless otherwise indicated.

D. Performance Level: C.

E. Core: Foam core with an R-factor of 10.0 or more (based on a k-value of 0.16).

F. Steel Thickness (galvanized)
1. Face Sheets: 20 gauge minimum.
2. Edges: 16 gauge minimum.
3. Frames: 16 gauge minimum.

G. Accessories
1. Gasketing
2. Non-removable-pin hinges
3. Thermal break aluminum threshold
4. Vinyl door bottom.

H. Finish: Doors and frames shall receive phosphate treatment, rust-inhibitive primer, and baked acrylic enamel finish.

I. Provide for door numbers: 1 & 2

2.6 SOUND RATED STEEL DOORS

A. Doors shall have a sound transmission class (STC) as indicated on Drawings .

2.7 ACCESSORIES

A. Shelves for Dutch Doors: Conform to SDI 111. Fabricate shelves of steel not lighter than 16 gage, 12 inches wide by full door width. Brackets shall be stock type fabricated of the same metal used to fabricate shelves.

B. Louvers
1. Interior Louvers
a. Conform to SDI/DOOR 111, Louvers shall be stationary and sight proof.
b. Detachable moldings on room or non security side of door.
c. Moldings to be integral part of louver on security side of door.
d. Form louver frames from minimum 20 gauge steel.
e. Form louver blades from minimum 24 gauge.
f. Sight proof louvers to be inverted percent net-free opening.

2. Exterior Louvers
   a. Type: Inverted .
   b. Material: Hot-dip galvanized steel of same gage as door facings.
   c. Free Opening Area: Minimum of percent net-free opening. Net-free louver area to be before screening.
   d. Weld or tenon louver blades to continuous channel frame and weld assembly to door to form watertight assembly.
   e. Provide aluminum wire cloth, 18 by 18 or 18 by 16 inch mesh, steel-framed screens secured to room side and readily removable.

C. Astragals
1. For pairs of exterior steel doors which will not have aluminum astragals or removable mullions, as specified in Section 08 71 00 – Door Hardware provide overlapping steel astragals with the doors.
2. For interior pairs of fire rated or smoke control doors, provide stainless steel astragals complying with NFPA 80 for fire rated assemblies and NFPA 105 for smoke control assemblies.

D. Moldings
1. Provide moldings around glass of interior and exterior doors and louvers of interior doors. Provide non removable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings. Muntins shall interlock at intersections and shall be fitted and welded to stationary moldings.

2.8 INSULATION CORES

A. Insulated cores shall be of type specified, and provide an apparent U-factor of 0.16 (R-factor of 10.0 or more) in accordance with SDI 113 and shall conform to one of the following:
1. Rigid Cellular Polyisocyanurate Foam: ASTM C591, Type I or II, foamed-in-place or in board form, with oxygen index of not less than 22 percent when tested in accordance with ASTM D2863.
2. Rigid Polystyrene Foam Board: ASTM C578, Type I or II.
3. Mineral board: ASTM C612, Type I.

2.9 STANDARD STEEL FRAMES

A. General
1. Conform to SDI A250.8, Level 1, except as otherwise specified.
2. Form frames to sizes and shapes indicated, with welded corners.
3. Provide steel frames for doors, transoms, sidelights, mullions, cased openings, and interior glazed panels unless otherwise indicated.

B. Welded Frames
1. Continuously weld frame faces at corner joints.
2. Mechanically interlock or continuously weld stops and rabbets.
3. Grind welds smooth.
4. Weld frames in accordance with AWS D1.1, Sections 1 through 6, and in accordance with the practice specified by the producer of the metal being welded.

C. Knock-Down Frames
   1. Design corners for simple field assembly by concealed tenons, splice plates, or interlocking joints that produce square, rigid corners and a tight fit and maintain the alignment of adjoining members.
   2. Provide locknuts for bolted connections.

D. Mullions and Transom Bars
   1. Mullions and transom bars shall be closed or tubular construction and be a member with heads and jambs butt-welded thereto or knock-down for field assembly.
   2. Bottom of door mullions shall have adjustable floor anchors and spreader connections.

E. Stops and Beads
   1. Form stops and beads from 20 gage steel.
   2. Provide for glazed and other openings in standard steel frames.
   3. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 12 to 16 inch on center.
   4. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

F. Cased Openings: Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

G. Anchors: Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated or painted with rust-inhibitive paint, not lighter than 18 gage.
   1. Wall Anchors
      a. Provide at least three anchors for each jamb. For frames which are more than 7.5 feet in height, provide one additional anchor for each jamb for each additional 2.5 feet or fraction thereof.
         1) Masonry: Provide anchors of corrugated or perforated steel straps or 3/16 inch diameter steel wire, adjustable or T-shaped.
         2) Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to wood studs with nails, or to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding.
         3) Solid plaster partitions: Secure anchors solidly to back of frames and tie into the lath. Provide adjustable top strut anchors on each side of frame for fastening to structural members or ceiling construction above. Size and type of strut anchors shall be as recommended by the frame manufacturer.
         4) Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI 111.
   2. Floor Anchors
      a. Provide floor anchors drilled for 3/8 inch anchors at bottom of each jamb member.
      b. Where floor fill occurs, terminate bottom of frames at the indicated finished floor levels and support by adjustable extension clips resting on and anchored to the structural slabs.

[COMMENTS]

2.10 FIRE AND SMOKE DOORS AND FRAMES

A. Provide per requirements of and this specification. The requirements of the applicable NFPA publication take precedence over details indicated or specified.

B. Labels: Fire doors and frames shall bear the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing shall be in accordance with NFPA 252 or UL 10C. Labels shall be metal with raised letters, and shall bear the name or file number of the door and frame manufacturer. Labels shall be permanently affixed at the factory to frames and to the hinge edge of the door. Door labels shall not be painted.

C. Oversized Doors:
   1. For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

D. Astragal on Doors
   1. On pairs of labeled fire doors, conform to NFPA 80 and UL requirements.
   2. On smoke control doors, conform to NFPA 105.

2.11 WEATHERSTRIPPING

A. Refer to Section 08 71 00 – Door Hardware.

B. Integral Gasket: Black synthetic rubber gasket with tabs for factory fitting into factory slotted frames, or extruded neoprene foam gasket made to fit into a continuous groove formed in the frame, may be provided in lieu of head and jamb seals. Insert gasket in groove after frame is finish painted. Air leakage of weatherstripped doors shall not exceed 1.25 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283.

2.12 HARDWARE PREPARATION

A. Provide minimum hardware reinforcing gages as specified in SDI 250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI A250.8 and SDI A250.6. For additional requirements refer to ANSI/BHMA A156.115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of SDI A250.8, as applicable.

B. Except for frames that will have weatherstripping or soundproofing gaskets, punch door frames to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.13 FINISHES

A. Factory-Primed Finish

1. All surfaces of doors and frames shall be thoroughly cleaned, chemically treated and factory primed with a rust inhibiting coating as specified in SDI A250.8. Where coating is removed by welding, apply touchup of factory primer.

B. Hot-Dip Zinc-Coated and Factory-Primed Finish
1. Fabricate scheduled doors and frames from hot dipped zinc coated steel, alloyed type, complying with ASTM A924 and ASTM A653.
2. The coating weight shall meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., A40ZF120.
3. Repair damaged zinc-coated surfaces by the application of zinc dust paint.
4. Thoroughly clean and chemically treat to insure maximum paint adhesion.
5. Factory prime as specified in SDI A250.8.
6. Provide for door openings No. .

C. Electrolytic Zinc-Coated Anchors and Accessories
1. Provide electrolytically deposited zinc-coated steel in accordance with ASTM A879, Commercial Quality, Coating Class A.
2. Phosphate treat and factory prime zinc-coated surfaces as specified in SDI A250.8.

D. Factory-Applied Enamel Finish
1. Coatings shall meet test procedures and acceptance criteria in accordance with SDI A250.3. After factory priming, apply of enamel to exposed surfaces. Separately bake or oven dry each coat. Drying time and temperature requirements shall be in accordance with the coating manufacturer's recommendations.
2. Color(s) of finish coat shall be as selected from manufacturer’s standard color chart or sample(s).

E. Topcoat Finish: Refer to Section 09 90 00 – Painting and Coatings.

2.14 FABRICATION AND WORKMANSHIP

A. Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable.
1. Frames for use in solid plaster partitions shall be welded construction.
2. On wraparound frames for masonry partitions, provide a throat opening 1/8 inch larger than the actual masonry thickness.
3. Design frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive caulking compound.

B. For frames to be installed in masonry walls and to be filled with mortar or grout, fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of stop-applied head and jamb seals.

[COMMENTS]

2.15 PROVISIONS FOR GLAZING

A. Refer to Section 08 81 00 - Glazing.

A. Safety Glazing
1. Comply with testing requirements of 16 CFR 1201.
2. Maximum glass area: As shown on Contract Drawings, 9 sq ft maximum.
3. Thickness: 1/4 inch minimum.
4. Use units permanently marked with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.

B. Glazing for fire-Rated Door and Window Assemblies
1. Glazing for assemblies that conform to NFPA 80 and that are listed and labeled by a testing and inspection agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 (Doors) and NFPA 257 (Windows).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Frames
1. Set frames in accordance with SDI A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction.
2. Where frames require ceiling struts or overhead bracing, anchor frames to the struts or bracing.
3. Backfill frames with mortar. Coat inside of frames with corrosion-inhibiting bituminous material. For frames in exterior walls, ensure that stops are filled with rigid insulation before grout is placed.

B. Doors
1. Hang doors in accordance with clearances specified in SDI A250.8.
2. Install door hardware per Section 08 71 00 – Door Hardware.
3. After erection and glazing, clean and adjust hardware.

C. Fire and Smoke Doors and Frames
1. Install fire doors and frames, including hardware, in accordance with NFPA 80.
2. Install smoke doors and frames in accordance with NFPA 105.

3.2 PROTECTION

A. Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the Project or replace with new, as directed by the Engineer. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

[COMMENTS]

3.3 CLEANING

A. Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

END OF SECTION

SECTION 08 33 23
OVERHEAD COILING DOORS

GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Insulated service doors

B. Related Sections:
   1. Division 05 for miscellaneous steel supports.
   2. Division 09 for finish painting of factory-primed doors.
   3. Division 26 Sections for electrical service and connections for powered operators and accessories.

1.3 PERFORMANCE REQUIREMENTS

A. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

B. Wind Loading: Overhead coiling door shall be designed and reinforced to withstand a 40-psf wind-loading pressure.

1.4 SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:
   1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
   2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
   3. For fire-rated doors, description of fire-release system including testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Show locations of replaceable fusible links.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
   1. Include similar Samples of accessories involving color selection.

D. Qualification Data: For qualified Installer.

E. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.
   1. Obtain operators and controls from overhead coiling door manufacturer.

PART 2 - PRODUCTS

2.1 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
   1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch and as required to meet requirements.
   2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within slat faces.
   3. Gasket Seal: Provide insulated slats with manufacturer's standard interior-to-exterior thermal break or with continuous gaskets between slats.

B. Bottom Bar for Service Doors: Consisting of two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.

2.2 HOOD

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Galvanized Steel: Nominal 0.028-inch- thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.

2.3 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

B. Chain Lock Keeper: Suitable for padlock.

2.4 CURTAIN ACCESSORIES

A. Weatherseals: Equip each exterior door with weather-stripping gaskets fitted to entire perimeter of door for a weathertight installation, unless otherwise indicated.
1. At door head, use 1/8-inch- thick, replaceable, continuous sheet secured to inside of hood.
2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- thick seals of flexible vinyl, rubber, or neoprene.

B. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
1. Provide pull-down straps or pole hooks for doors more than 84 inches high.

2.5 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.

C. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.6 MANUAL DOOR OPERATORS

A. Equip door with manufacturer's recommended manual door operator unless another type of door operator is indicated.

B. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 30 lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

2.7 DOOR ASSEMBLY

A. Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ACME Rolling Doors.
      b. Alpine Overhead Doors, Inc.
      c. AlumaTek, Inc.
      d. C.H.I. Overhead Doors.
      e. City-Gates.
      f. Cookson Company.
      g. Cornell Iron Works, Inc.
      h. Dynamic Closures Corp.
      i. Lawrence Roll-Up Doors, Inc.
      j. Mahon Door Corporation.
      k. McKeon Rolling Steel Door Company, Inc.
      l. Metro Door.
      m. Overhead Door Corporation.
      n. QMI Security Solutions.
      o. Raynor.
      p. Southwestern Steel Rolling Door Co.
      q. Wayne-Dalton Corp.
      r. Windsor Door.
      s. <Insert manufacturer's name>.

B. Operation Cycles: Not less than 50,000.
   1. Include tamperproof cycle counter.

C. Door Curtain Material: Galvanized steel.

D. Door Curtain Slats: Flat profile slats of 2-5/8-inch center-to-center height.
   1. Insulated-Slat Interior Facing: Metal.

E. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.

F. Locking Devices: Equip door with slide bolt for padlock and chain lock keeper.
   1. Locking Device Assembly: Cremone type, both jamb sides locking bars, operable from inside with thumb turn.

G. Manual Door Operator: Chain-hoist operator.
   1. Provide operator with manufacturer's standard removable operating arm.

H. Door Finish:
   1. Baked-Enamel or Powder-Coated Finish: Color as selected by Engineer from manufacturer's full range.
   2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 STEEL AND GALVANIZED-STEEL FINISHES

A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.

C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.3 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide weathertight fit around entire perimeter.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION

[COMMENTS]

SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Commercial door hardware for the following:
      a. Swinging doors.
      b. Other doors to the extent indicated.
   2. Cylinders for doors specified in other Sections.

B. Products Furnished or Supplied, But Not Installed, Under This Section
   1. Cylinders for locks on aluminum and glass entrance doors.
      a. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

1.2 RELATED SECTIONS

A. Section 07 92 00 – Joint Sealants

B. Section 08 11 13 – Hollow Metal Doors and Frames

1.3 REFERENCES

A. American Architectural Manufacturers' Association (AAMA) standards, most recent editions:

AAMA 701/702	Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals

B. ASTM International (ASTM) standards, most recent editions:

ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications

C. Builder's Hardware Manufacturers Association (BHMA) standards, most recent edition:

Certified Products Directory

BHMA 156.1	Butts and Hinges
BHMA 156.2	Bored & Preassembled Locks and Latches

BHMA 156.3	Exit Devices
BHMA 156.4	Door Controls-Closers
BHMA 156.5	Cylinders and Input Devices for Locks
BHMA 156.13	Mortise Locks
BHMA 156.16	Auxiliary Hardware
BHMA 156.18	Materials and Finishes
BHMA 156.21	Thresholds
BHMA 156.22	Door Gasketing and Edge Seal Systems
BHMA 156.25	Electrified Locking Devices
BHMA 156.28	Recommended Practices for Mechanical Keying Systems
BHMA A156.115	Hardware Preparation in Steel Doors or Steel Frames
BHMA A156.115W	Hardware Preparation in Wood Doors with Wood or Steel Frames

D. Door and Hardware Institute (DHI) standards, latest editions:

Sequence and Format for the Hardware Schedule

DHI WDHS.2	Recommended Fasteners for Wood Doors
DHI WDHS.3	Recommended Hardware Locations for Wood Flush Doors

E. International Code Council (ICC) standards, latest edition:

IBC	International Building Code
A117.1	Accessible and Usable Buildings and Facilities

F. National Fire Protection Association (NFPA) standards, most recent editions:

NFPA 70	National Electrical Code
NFPA 80	Fire Doors and Other Opening Protectives
NFPA 105	Standard for Smoke Door Assemblies and Other Opening Protectives
NFPA 252	Standard Methods of Fire Tests of Door Assemblies

G. Steel Door Institute (SDI) standards, most recent editions:

SDI 107	Hardware on Steel Doors (Reinforcement - Application)

H. UL, LLC (UL) standards, latest editions:

UL 10B	Standard for Fire Tests of Door Assemblies
UL 305	Standard for Panic Hardware
UL 1784	Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.

C. Shop Drawings: Details of electrified door hardware, indicating the following:
   1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer installed and field installed wiring. Include the following:
      a. System schematic.
      b. Point to point wiring diagram.
      c. Riser diagram.
      d. Elevation of each door.
   2. Detail interface between electrified door hardware and building control system.

D. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of door hardware indicated.

E. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
   1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
   2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
      a. Organize door hardware sets in same order as in the Door Hardware Schedule given at the end of Part 3 of this Section.
   3. Content: Include the following information:
      a. Type, style, function, size, label, hand, and finish of each door hardware item.
      b. Manufacturer of each item.
      c. Fastenings and other pertinent information.

d. Location of each door hardware set, cross referenced to Drawings, both on floor plans and in door and frame schedule.
e. Explanation of abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for door hardware.
g. Door and frame sizes and materials.
h. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
1) Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.

4. Submittal Sequence: Submit initial draft of final schedule along with essential Product Data to facilitate the fabrication of other work that is critical in the Project construction schedule. Submit the final Door Hardware Schedule after Samples, Product Data, coordination with Shop Drawings of other work, delivery schedules, and similar information has been completed and accepted.

F. Keying Schedule: Prepared by or under the supervision of supplier, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

G. Maintenance Data: For each type of door hardware to include in operation and maintenance manuals.

H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in service performance.

B. Supplier Qualifications: Door hardware supplier with warehousing facilities in Project's vicinity and who is, or employs a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Engineer, and Owner about door hardware and keying.
1. Scheduling Responsibility: Preparation of door hardware and keying schedules.

C. Architectural Hardware Consultant Qualifications: A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

D. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

E. Regulatory Requirements: Comply with provisions of the following:

1. Where indicated to comply with accessibility requirements, comply with ICC/ANSI A117.1, as follows:
   a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
   b. Door Closers: Comply with the following maximum opening force requirements indicated:
      1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
      2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
   c. Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.

F. Fire Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
   1. Test Pressure: Test at atmospheric pressure.

G. Keying Conference: Conduct conference at Project site. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
   1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
   2. Preliminary key system schematic diagram.
   3. Requirements for key control system.
   4. Address for delivery of keys.

H. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to electrified door hardware including, but not limited to, the following:
   1. Inspect and discuss electrical roughing in and other preparatory work performed by other trades.
   2. Review sequence of operation for each type of electrified door hardware.
   3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Review required testing, inspecting, and certifying procedures.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Inventory door hardware on receipt and provide secure lock up for door hardware delivered to Project site.

C. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

D. Deliver keys to Owner by registered mail or overnight package service.

1.7 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Electrical System Roughing in: Coordinate layout and installation of electrified door hardware with connections to power supplies and building control system.

1.8 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
   1. Structural failures including excessive deflection, cracking, or breakage.
   2. Faulty operation of operators and door hardware.
   3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

C. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

D. Warranty Period for Manual Closers: 10 years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Hinges and Pivots:
      a. Bommer Industries, Inc. (BI)
      b. Hager Companies (HAG)
      c. Ives: H. B. Ives (IVS)
      d. McKinney Products Company; Div. of ESSEX Industries, Inc. (MCK)
      e. Stanley Commercial Hardware; Div. of The Stanley Works (STH)

f. Engineer approved equal

2. Mechanical Locks and Latches:
   a. Schlage Lock Company; an Ingersoll Rand Company (SCH)
   b. Engineer approved equal
3. Electromechanical Locks and Latches:
   a. Best Lock Corporation (BLC)
   b. Locknetics Security Engineering; a Harrow Company (LSE)
   c. Schlage Lock Company; an Ingersoll Rand Company (SCH)
   d. Engineer approved equal
4. Flush Bolts:
   a. Glynn Johnson; an Ingersoll Rand Company (GJ)
   b. Ives: H. B. Ives (IVS)
   c. NT Quality Hardware; an Ingersoll Rand Company (NTQ)
   d. Rockwood Manufacturing Company (RM)
   e. Engineer approved equal
5. Exit Devices:
   a. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT)
   b. Precision Hardware, Inc. (PH)
   c. Von Duprin; an Ingersoll Rand Company (VD)
   d. Engineer approved equal
6. Key Control Systems:
   a. Key Control Systems, Inc. (KCS)
   b. Major Metalfab Co. (MM)
   c. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT)
   d. Sunroc Corporation (SUN)
   e. Engineer approved equal
7. Operating Trim:
   a. Hager Companies (HAG)
   b. Ives: H. B. Ives (IVS)
   c. NT Quality Hardware; an Ingersoll Rand Company (NTQ)
   d. Rockwood Manufacturing Company (RM)
   e. Stanley Commercial Hardware; Div. of The Stanley Works (STH)
   f. Engineer approved equal
8. Coordinators:
   a. Glynn Johnson; an Ingersoll Rand Company (GJ)
   b. Hager Companies (HAG)
   c. Ives: H. B. Ives (IVS)
   d. Rockwood Manufacturing Company (RM)
   e. Engineer approved equal
9. Removable Mullions:
   a. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT)
   b. Von Duprin; an Ingersoll Rand Company (VD)
   c. Engineer approved equal
10. Surface Mounted Closers:
   a. LCN Closers; an Ingersoll Rand Company (LCN).
   b. Engineer approved equal
11. Metal Protective Trim Units:
   a. Hager Companies (HAG)

b. Ives: H. B. Ives (IVS)
c. NT Quality Hardware; an Ingersoll Rand Company (NTQ)
d. Rockwood Manufacturing Company (RM)
e. Engineer approved equal

12. Stops and Holders:
    a. Hager Companies (HAG)
    b. Ives: H. B. Ives (IVS)
    c. NT Quality Hardware; an Ingersoll Rand Company (NTQ)
    d. Rockwood Manufacturing Company (RM)
    e. Engineer approved equal
13. Door Gasketing:
    a. Hager Companies (HAG)
    b. National Guard Products, Inc. (NGP)
    c. Pemko Manufacturing Co., Inc. (PEM)
    d. Zero International, Inc. (ZRO)
    e. Engineer approved equal
14. Thresholds:
    a. Hager Companies (HAG)
    b. National Guard Products, Inc. (NGP)
    c. Pemko Manufacturing Co., Inc. (PEM)
    d. Reese Enterprises, Inc. (RE)
    e. Engineer approved equal

2.2 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section, and the Door Hardware Schedule at the end of Part 3.
   1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.
   2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
   3. Certified Products: Provide door hardware listed in BHMA's "Certified Products Directory."
   4. Finish: Finish numbers and descriptions as indicated in the Door Hardware Schedule comply with ANSI/BHMA A156.18.
      a. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
      b. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Schedule at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names may be abbreviated in the Door Hardware Schedule.

2.3 HINGES AND PIVOTS

A. Applicable Standard: ANSI/BHMA A156.1, Grade 1.

B. Quantity: Provide the following, unless otherwise indicated:
1. Two Hinges: For doors with heights up to 60 inches.
2. Three Hinges: For doors with heights 61 to 90 inches.
3. Four Hinges: For doors with heights 91 to 120 inches.
4. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

C. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template produced units.

D. Hinge Base Metal: Unless otherwise indicated, provide stainless steel hinges with stainless steel pins.

E. Hinge Options: Comply with the following where indicated in the Door Hardware Schedule or on Contract Drawings:
1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:
a. Outswinging exterior doors.
b. Outswinging corridor doors with locks.
2. Corners: Square.

F. Fasteners: Comply with the following:
1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
2. Wood Screws: For wood doors and frames.
3. Threaded to the Head Wood Screws: For fire rated wood doors.
4. Screws: Phillips flat head screws; machine screws (drilled and tapped holes) for metal doors, wood screws for wood doors and frames. Finish screw heads to match surface of hinges.

2.4 LOCKS AND LATCHES

A. Cylindrical Locks
1. Applicable Standard: ANSI/BHMA A156.2, Grade 1, Series 4000.
2. Backset: 2-3/4 inches standard unless noted otherwise.
3. Door Thickness: 1-3/4 inches.
4. Handles: Lever
5. Latchbolts: 1/2 inch throw.
6. Lock Chassis: Heavy gauge steel, zinc plated for corrosion resistance.

7. Faceplate: 1-1/8 inch by 2-1/4 inch.
8. Trim:
   a. Lever: Cast.
   b. Escutcheon (Rose): Wrought.
   c. Dummy Trim: Match lever lock trim and escutcheons.
9. Lock Function: ANSI F109.
10. Finish: ANSI 630 (US32D)
11. Lockset Designs: Provide design indicated in schedules.

B. Mortise Locks
1. Applicable Standard: ANSI/BHMA A156.13, Grade 1, Series 1000.
2. Backset: 2-3/4 inches standard unless noted otherwise.
3. Door Thickness: 1-3/4 inches.
4. Armor Front: 1-1/4 inch by 8 inch.
5. Handles: Lever
6. Latchbolts:
   a. Deadbolt: 1 inch throw.
   b. Latch: 3/4 inch throw with anti-friction toungue.
7. Lock Case: 4-7/16 inch by 6 inch by 1 inch.
8. Exposed Trim:
   a. Lever: Cast.
   b. Escutcheon (Rose): Forged.
   c. Dummy Trim: Match lever lock trim and escutcheons.
9. Lock Function: ANSI F20.
10. Finish: ANSI 630 (US32D)
11. Lockset Designs: Provide design indicated in schedules.

2.5 DOOR BOLTS

A. Flush Bolts: ANSI/BHMA 156.16, Grade 1, designed for mortising into door edge.

B. Bolt Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:
1. Half Round Surface Bolts: Minimum 7/8 inch throw.
2. Interlocking Surface Bolts: Minimum 15/16 inch throw.
3. Fire Rated Surface Bolts: Minimum 1 inch throw; listed and labeled for fire rated doors.
4. Mortise Flush Bolts: Minimum 3/4 inch throw.

2.6 EXIT DEVICES

A. Applicable Standard: ANSI/BHMA 156.3, Grade 1, Type 3 (Mortise)

B. Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

C. Fire Exit Devices: Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

D. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
1. Operation: Rigid.

E. Outside Trim: Lever or Lever with cylinder; material and finish to match locksets, unless otherwise indicated.
1. Match design for locksets and latchsets, unless otherwise indicated.

F. Through Bolts: For exit devices and trim on metal doors, non fire rated wood doors, and fire rated wood doors.

2.7 CYLINDERS AND KEYING

A. Applicable Standard: ANSI/BHMA 156.5, Grade 1

B. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
1. Number of Pins: Six minimum.
2. Mortise Type: Threaded cylinders with rings and straight or clover type cam.
3. Rim Type: Cylinders with back plate, flat type vertical or horizontal tailpiece, and raised trim ring.

C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
1. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

D. Construction Keying: Comply with the following:
1. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.
a. Replace construction cores with permanent cores, as directed by Owner.

E. Keying System: Unless otherwise indicated, provide a factory registered keying system complying with the following requirements:
1. Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.

F. Keys: Provide nickel silver keys complying with the following:
1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
a. Notation: "DO NOT DUPLICATE."
2. Quantity: In addition to one extra blank key for each lock, provide the following:
a. Cylinder Change Keys: Three.
b. Master Keys: Five.
c. Grand Master Keys: Five.

G. Key Control System: ANSI/BHMA 156.28 system, including key holding hooks, labels, two sets of key tags with self locking key holders, key gathering envelopes, and temporary and permanent markers. Contain system in metal cabinet with baked enamel finish.
   1. Wall Mounted Cabinet: Cabinet with hinged panel door equipped with key holding panels and pin tumbler cylinder door lock.
   2. Capacity: Able to hold keys for 150 percent of the number of locks.
   3. Cross Index System: Set up by key control manufacturer, complying with the following:
      a. Card Index: Furnish four sets of index cards for recording key information. Include three receipt forms for each key holding hook.

2.8 STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
   1. Flat Lip Strikes: For locks with three piece antifriction latchbolts, as recommended by manufacturer.
   2. Extra Long Lip Strikes: For locks used on frames with applied wood casing trim.

B. Dustproof Strikes: ANSI/BHMA 156.16, Grade 1.

2.9 OPERATING TRIM

A. Materials: Fabricate from stainless steel, unless otherwise indicated.

B. Push Pull Design: As illustrated on Drawings.

2.10 ACCESSORIES FOR PAIRS OF DOORS

A. Fire Exit Removable Mullions: Provide removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested.

2.11 CLOSERS

A. Applicable Standard: ANSI/BHMA 156.4, grade 1.

B. Hold Open Closers/Detectors: Coordinate and interface integral smoke detector and closer device with fire alarm system.

C. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory sized closers, adjustable to meet field conditions and requirements for opening force.

[COMMENTS]

2.12 PROTECTIVE TRIM UNITS

A. Materials: Fabricate protection plates from the following:
   1. Stainless Steel: 0.050 inch thick; beveled top and 2 sides.

B. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine or self-tapping screws.

C. Furnish protection plates sized 2 inches less than door width on push side and 1/2 inch less than door width on pull side, by height specified in Door Hardware Schedule.

2.13 STOPS AND HOLDERS

A. Electromagnetic Door Holders for Labeled Fire Door Assemblies: Coordinate with fire detectors and interface with fire alarm system.

B. Floor Stops: For doors, unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic.
   1. Where floor or wall stops are not appropriate, provide overhead holders.

C. Silencers for Wood Door Frames: ANSI/BHMA Grade 1; neoprene or rubber, minimum 5/8 by 3/4 inch; fabricated for drilled in application to frame.

D. Silencers for Metal Door Frames: ANSI/BHMA Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled in application to frame.

2.14 WEATHER STRIPPING

A. Applicable Standard ANSI/BHMA 156.22.

B. Provide continuous weather strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.
   1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
   2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
   3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

C. Air Leakage: Not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E283.

D. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
   1. Provide smoke labeled gasketing on 20 minute rated doors and on smoke labeled doors.

E. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL 10B or NFPA 252.

F. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

G. Gasketing Materials: Comply with ASTM D2000 and AAMA 701/702.

2.15 THRESHOLDS

A. Applicable Standard: ANSI/BHMA 156.21.

B. Heavy Duty Saddle Threshold:
1. Type: J32100.
2. Material: Extruded tempered aluminum 6063-T6.
3. Finish Mill finish aluminum.
4. Width: Match door width.

2.16 FABRICATION

A. Manufacturer's Nameplate: Do not provide manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire rated labels and as otherwise approved by Engineer.
1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and ANSI/BHMA 156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat head screws with finished heads to match surface of door hardware, unless otherwise indicated.
1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Steel Machine or Wood Screws: For the following fire rated applications:
   a. Mortise hinges to doors.
   b. Strike plates to frames.
   c. Closers to doors and frames.

3. Steel Through Bolts: For the following fire rated applications, unless door blocking is provided:
   a. Surface hinges to doors.
   b. Closers to doors and frames.
   c. Surface mounted exit devices.
4. Spacers or Sex Bolts: For through bolting of hollow metal doors.
5. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

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

3.2 PREPARATION

A. Steel Doors and Frames: Comply with ANSI/BHMA A156.115.
   1. Surface Applied Door Hardware: Drill and tap doors and frames according to SDI 107.

B. Wood Doors: Comply with DHI A115 W series.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
   1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface mounted items until finishes have been completed on substrates involved.
   1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
   2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Key Control System: Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Section 07 92 00 – Joint Sealants.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
   1. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
   2. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

B. Six Month Adjustment: Approximately six months after date of Substantial Completion, Installer shall perform the following:
   1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
   2. Consult with and instruct Owner's personnel on recommended maintenance procedures.
   3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.7 DOOR HARDWARE SCHEDULE

A. Refer to Contract Drawings.

END OF SECTION

[COMMENTS]

DIVISION 9
FINISHES

SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide gypsum wallboard, complete, and in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications

QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated)

B. Commercial Standards

ASTM C 11	Terminology Relating to Gypsum and Related Building Materials and Systems
ASTM C 36	Specification for Gypsum Wallboard
ASTM C 208	Specification for Cellulosic Fiber Insulating Board
ASTM C 475	Specifications for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 514	Specification for Nails for the Application of Gypsum Board
ASTM C 630	Specification for Water-Resistant Gypsum Backing Board
ASTM C 754	Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Board
ASTM C 1002	Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases
ASTM D 2626	Specification For Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing
ASTM E 90	Method for Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions
ASTM E 119	Method for Fire Tests of Building Construction and Materials
ASTM E 413	Classification for Rating Sound Insulation

C. Trade Standards

GA-201	(Gypsum Association) Using Gypsum Board for Walls and Ceilings
GA-214	(Gypsum Association) Recommended Specifications: Levels of Gypsum Board Finish
GA-216	(Gypsum Association) Recommended Specifications for the Application and Finishing of Gypsum Board
GA-290	(Gypsum Association) Area Separation Walls.
GA-505	(Gypsum Association) Glossary of Terminology
GA-530	(Gypsum Association) Design Data - Gypsum Products
GA-600	(Gypsum Association) Fire Resistance Manual
GA-801	(Gypsum Association) Handling Gypsum Board

1.3 CONTRACTOR SUBMITTALS

A. General: Provide the following submittals in accordance with the requirements in Section 01 33 00 - Contractor Submittals.

B. Product Data: Submit Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations, as may be required to show compliance with these Specifications.

1.4 QUALITY ASSURANCE

A. Manufacturers' Standards: The gypsum board products and their installation shall be in accordance with the Manufacturers published recommendations and specifications and recommendations and specifications of the Gypsum Association. In the event of conflicts, the more stringent requirement shall apply.

B. Gypsum Board Construction Terminology: Refer to ASTM C 11, Gypsum Association publication GA-505 for definitions of terms related to gypsum board assemblies not defined in this Section or in other referenced standards.

C. Fire-Test-Response Characteristics: Where fire-rated gypsum board assemblies are indicated, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction. Fire resistance ratings shall be as indicated by reference to file numbers in Gypsum Association, (GA), publication GA-600, or to design designations in UL "Fire Resistance Directory" or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.

D. Sound Transmission Characteristics: For gypsum board assemblies indicated to have STC ratings, provide materials and construction identical to those of assemblies whose STC

ratings were determined per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing agency.

E. Single-Source Responsibility for Steel Framing: Steel-framing members for gypsum board assemblies shall be obtained from a single manufacturer.

F. Single-Source Responsibility for Panel Products: Each type of gypsum board and other panel products shall be obtained from a single manufacturer.

G. Single-Source Responsibility for Finishing Materials: Finishing materials shall be obtained from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to the gypsum board manufacturer.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD

A. General: All gypsum wall board shall be fire-rated, conforming to ASTM C 36, unless otherwise indicated.

B. Gypsum Wall Board: All gypsum wall board shall be 5/8 inch thick and provided with tapered edges unless otherwise indicated.
1. Water-resistant gypsum board shall conform to ASTM C 630 with tapered edges, type "x".
2. Ceramic tile backing board shall be a Portland cement slurry, reinforced with fiber glass mesh and coated vinyl board. The board shall be not less than 1/2 inch thick and shall be designed for use behind ceramic tile. Tile backing board shall be United States Gypsum's "Durock Board"; Laticrete International's "Latipanel"; or equal.
3. Sound deadening board shall conform to ASTM C 208 (wood fiber) Class A.
4. Foil backed gypsum board shall conform to ASTM C 36, Type "x", with foil laminated to back surface.

C. Manufacturers, or Equal:
1. Georgia-Pacific Corporation.
2. Gold Bond Building Products.
3. United States Gypsum Co.

2.2 JOINT TREATMENT MATERIALS

A. General: Joint reinforcing tape and joint compound shall conform to ASTM C 475 and shall be of the type recommended by the manufacturer for the application indicated.

B. Joint Tape: Tape shall be paper reinforcing tape of the type recommended by the Manufacturer for the application indicated.

C. Joint Compound: On interior work, compound shall be a chemical-hardening type for bedding and filling, and a ready-mixed vinyl type for topping.

D. Exterior Joint Compound: On exterior work, compound shall be a special chemical-hardening type formulated for exterior application.

E. Water-Resistant Joint Compound: Compound for water-resistant application shall be a special water-resistant type for treatment of joints, fastener heads and cut edges of water resistant backing board. Water-resistant joint compound shall be Sheetrock Brand W/R Compound, as manufactured by United States Gypsum Co., or approved equal.

2.3 FASTENERS

A. Nails shall conform to ASTM C 514 and shall be of the length recommended by the Gypsum Association referenced standards and the Building Code for various gypsum board thicknesses.

B. Screws shall conform to ASTM C 1002, and shall be self-drilling, self-tapping, bugle head, for use with power tools, length as recommended by Gypsum Association referenced standards and the Building Code.
1. Type "S" for wallboard to sheet metal application.
2. Type "W" for wallboard to wood application.
3. Type "G" for wallboard to wallboard application.
4. Type "S" or "S-12", 1-1/4-inch for tile backing board to metal studs application.

C. Resilient channels shall be metal channels design for use with sound wall construction. They shall be as recommended and approved by the gypsum board Manufacturer and code.

2.4 ADHESIVES

A. Adhesives for fastening gypsum board to gypsum board shall be in accordance with the printed recommendations of the gypsum board Manufacturer.

2.5 ACCESSORIES

A. Metal trim, corner beads, edge, casing beads, and accessories shall be manufactured from galvanized sheet steel unless otherwise indicated and shall be Manufacturer's standard products. Special shapes shall be provided where indicated.

2.6 ACCESS PANELS

A. Access panels shall be provided where shown and/or where required for access to valves and equipment. Access panels shall be MILCOR "Type DW"; BOICE "Type C"; or equal, for flush installation. Cylinder locks shall be provided where indicated.

B. In fire-rated construction, both wall and ceiling access panels shall have a fire rating equivalent to that of the assemblies within which they are installed.

2.7 WATERPROOF MEMBRANE

A. Waterproof membrane shall be asphaltic saturated 43-pound (vapor-retarder) membrane conforming to ASTM D 2626 Type 1, 25 pounds per 100 square foot minimum or 10-mil polyethylene film membrane.

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Manufactured materials shall be delivered in original unbroken packages, containers, or bundles bearing the Manufacturer's label with manufacturer's name and product description and rating.

B. Storage: All materials shall be carefully stored in an area which is protected from the elements, and in a manner recommended by the referenced standards. Storage shall be in a manner that will prevent damage to the material and its finish.

C. Handling: Gypsum board shall be handled in conformance with Gypsum Association Publication 801 so as to prevent damage to edges, ends, and surfaces. Metal corner beads and trim shall not be bent or otherwise damaged.

3.2 PROJECT CONDITIONS

A. Environmental Requirements, General: The Contractor shall comply with requirements of the referenced gypsum board application standards, and recommendations for the gypsum board manufacturer, for environmental conditions before, during and after application of gypsum board.

B. Ventilation: The Contractor shall ventilate building spaces as required to remove moisture in excess of that required for drying of joint treatment materials, immediately after their application. Drafts shall be avoided during dry, hot weather to prevent too rapid drying.

3.3 PREPARATION FOR METAL SUPPORT SYSTEMS

A. [Ceiling Anchorages: The Contractor shall coordinate Work of this Section with structural ceiling work to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling hangers. Inserts, hanger clips and similar devices shall be furnished to other trades for installation at times appropriate for proper coordination with other work.]

3.4 INSTALLATION OF METAL SUPPORT SYSTEMS

A. General
   1. Installation of metal supports and framing shall conform to standards established in ASTM C 754.
   2. Support system framing shall not bridge building expansion joints. Both sides of joints shall be framed with furring and other support as indicated.
   3. Nail or screw furring members to subframing as indicated.

B. Ceiling Support Suspension
   1. Hangers shall be secured to structural support by connecting directly to structure where possible. Otherwise, hangers shall be connected to inserts, clips or other anchorage devices or fasteners as indicated.
   2. Main runners shall be spaced 4 feet on center and hangers shall be spaced no more than 4 feet on center along runners, unless otherwise indicated. Main runners shall

be leveled to a tolerance of 1/4 inch in 12 feet, measured both lengthwise on each runner and transversely between parallel runners.

3. Furring members shall be spaced 16 inches on center and wire tied or clipped to main runners and to other structural supports as indicated.
4. Where direct-hung support is indicated, perimeter wall track or angle shall be attached wherever the support system meets vertical surfaces. Support members shall be mechanically joined to each other and butt-cut to fit into wall track.
5. Auxiliary framing shall be installed at terminations of gypsum board ceilings and at openings for light fixtures and similar work, and as may be required for support of both the ceiling construction and other work which is indicated to be supported by the ceiling.
6. For exterior soffits, cross-bracing and additional framing shall be provided as indicated or as may be required to resist wind uplift.
7. Seismic Restraint Systems: The ceiling support system shall be provided with horizontal and vertical (uplift) seismic restraint systems conforming to applicable code requirements and approved by local authorities having jurisdiction. Locations and spacing shall conform to applicable code requirements.
8. Horizontal Restraint: Horizontal restraints shall be provided in the form of four, no. 12-gauge diagonal bracing wires, secured to the main ceiling support members, within 2 inches of intersections with secondary supports. Bracing wires shall be splayed at 90 degrees from each other at an angle not exceeding 45 degrees from the plane of the ceiling. These horizontal restraint points shall be placed not more than 12 feet on center in both directions with the first point no more than 4 feet from each bounding wall. Restraint wire attachment to the supporting structure shall be adequate for the loads imposed. Side wall ties shall be provided where necessary.
9. Vertical Restraint: Vertical restraints shall be provided to resist seismic uplift movements. Restraints shall be telescoping, compressive posts or vertical metal struts attached to the main ceiling support members and secured to the underside of the structure above, in conformance with code requirements. Vertical restraints shall be located at each horizontal restraint and at additional locations as may be required by code.

C. Partition Support Framing

1. Supplementary framing, blocking and bracing shall be installed at terminations in the Work and where necessary for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, and similar work, in compliance with details indicated or if not otherwise indicated, in compliance with applicable published recommendations of the gypsum board manufacturer.
2. Stud support system shall be isolated from transfer of structural loading to the system, both horizontally and vertically. Slip or cushion type joints shall be provided to attain lateral support while avoiding axial loading.
3. Runner tracks shall be installed at floors, ceilings and structural walls and columns where gypsum drywall stud system abuts other work, unless otherwise indicated.
4. Partition stud system shall be [extended through the acoustical ceilings to the structural support and substrate above the ceiling] [terminated at ceilings, except where indicated otherwise].
5. Metal studs shall be spaced at [16] [24] inches on center unless otherwise indicated.
6. Door openings shall be framed in compliance with details indicated or if not otherwise indicated, in compliance with applicable published recommendations of

the gypsum board manufacturer. Vertical studs shall be attached to jambs with screws either directly to the frames or to jamb anchor clips on the door frames. Runner track for jack studs shall be installed at the head and secured to the jamb studs on each side.

7. Openings other that door openings shall be framed in compliance with details indicated or if not otherwise indicated, in compliance with applicable published recommendations of the gypsum board manufacturer. Framing above and below openings shall be installed with runner track and jack studs, similar framing required above door heads.
8. Wall furring members shall be spaced [16] [24] inches on center, unless otherwise indicated.]

3.5 GENERAL GYPSUM BOARD INSTALLATION REQUIREMENTS

A. Application and finishing of gypsum wallboard shall conform to ASTM C 840, Gypsum Association publication 216, and manufacturer's printed recommendations.

B. Exposed end-butt joints of adjacent gypsum board panels shall be located as far from the center of walls and ceilings as possible, and staggered not less than one foot in alternate courses of board.

C. Ceiling boards shall be installed before wall boards. Ceiling boards shall be installed in a direction and manner which will minimize the number of end-butt joints, and which will avoid end joints in the central area of the ceiling. End-butt joints shall be staggered at least one foot between adjacent panel rows.

D. Gypsum board wall panels shall be installed vertically to avoid end-butt joints wherever possible. At stairwells and similar high walls, boards may be installed horizontally with end joints staggered over studs.

E. Exposed gypsum board shall be installed with face side out. Imperfect, damaged or damp boards shall not be installed. Boards shall be butted together for a light contact at edges and ends, with not more than 1/16-inch open space between boards. Boards shall not be forced into place.

F. Either edge or end joints shall be located over supports, except in horizontal applications or where intermediate support or gypsum board back-blocking is provided behind end joints. Boards shall be positioned so that like edges abut; tapered edges against tapered edges and mill-cut or field-cut ends against mill-cut or field-cut ends. Tapered edges shall not be placed against cut edges or ends. Vertical joints shall be staggered over different studs on opposite sides of partitions.

G. Gypsum board shall be attached to all supplementary framing and blocking provided for additional support at openings and cutouts.

H. Control joints and expansion joints shall be formed with adequate space between edges of boards to receive trim accessories.

I. Both faces of stud partition framing shall be covered with gypsum board in concealed spaces above ceilings, except in chase walls which are braced internally.

J. The perimeter of non-load-bearing drywall partitions shall be isolated where they abut structural elements. A 1/4-inch space shall be provided at the interface, and a continuous J-type metal trim edge installed. The resultant joint shall be sealed with acoustical sealant.

K. Where sound-rated gypsum board construction is indicated on the Drawings, including multi-layer construction and work on resilient furring, all perimeters and all interstitial spaces of such construction shall be sealed on both sides with acoustical sealant, including such occurrences above acoustical ceilings. Sealant beads shall be positioned and applied in compliance with ASTM C 919 and the sealant manufacturer's recommendations. The intent of this requirement is the closure of all sound-flanking paths around or through the Work.]

3.6 CEILING SYSTEM FIRE RATING

A. Where a fire rating is indicated, the complete ceiling system shall meet the requirements for the rating specified or shown. The system shall conform to governing codes and shall meet UL requirements for the approved system. Light fixtures, speakers, and other recessed items in rated ceilings shall be provided with gypsum board enclosures as required for rated ceiling system.

3.7 INSTALLATION OF METAL ACCESSORIES

A. Metal edge trim shall be applied at all discontinued edges, where abutting with another material, and where indicated. Corner beads shall be applied at all exterior corners.

B. All metal accessories shall be set plumb, level, and true and shall be shimmed where necessary. The accessories shall be mitered at corners; exposed joints shall be accurately and tightly fitted. Sections shall be installed in lengths as long as practicable and splices shall be held to a minimum.

C. All accessories, trim, and beads shall be securely fastened to framing members.

3.8 EDGE SEALING

A. All cut, broken, or exposed edges of moisture-resistant gypsum board shall be sealed with a sealer recommended in the printed standards of the gypsum board manufacturer.

3.9 SURFACE FINISH

A. All gypsum board joints shall be taped, and all joints, end trim, corner beads, fastener, and other depressions shall be treated with joint and finishing compounds applied per Manufacturer's printed recommendations for three-coat work.

B. The gypsum board shall be sanded smooth, dusted, and provided with a textured roller finish coat.

C. Gypsum board behind vinyl wall covering shall be left with a sanded, flush, and smooth finish surface ready for painting.

D. Gypsum board at nonvisible locations, such as within attics, shall be finished as required for fire protection.

3.10 ATTIC SEPARATIONS

A. Gypsum board attic separations, with framing if necessary, shall be provided where indicated and shall be installed and taped in accordance with applicable building code requirements. Access doors shall be selfclosing, and return air openings shall be equipped with fusible fire links and selfclosures.

3.11 TILE BACKING

A. General: Tile backing board shall be installed behind all tile walls which are not indicated to have mortar set tiles. Backing board shall be installed per Manufacturer's published instructions.

B. Backing Surface Treatment: Gypsum drywall backing surfaces shall have all nails and screws recessed. Joints shall be taped and all joints, nail, and screw depressions shall be floated.

C. Finish: The finish surface shall be a sanded, dusted, and smooth finish ready for application of finish material. Joints or any other irregularities of backing surfaces shall not be visible.

D. Shower: Tile backing board at showers shall be installed over a waterproof membrane.

END OF SECTION

SECTION 09 90 00
PROTECTIVE COATINGS AND LININGS

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section covers surface preparation, furnishing, and application of protective coatings, complete.

B. It is the intent of this specification that all new or existing expose metal surfaces, shall be coated with a protective coating, unless specifically excluded.

C. Shop or existing surface preparation methods, cleanliness, and existing paint, rust, and mill scale removal is not known nor documented. Contractor shall be solely responsible for determining work effort, abrasive blast requirements, and any other factors that may affect work productivity as required to provide the specified surface preparation cleanliness; regardless of prior system preparation or coating application.

D. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.02 GENERAL:

A. See section GENERAL CONDITIONS, which contain information and requirements that apply to the work specified and are mandatory for this project.

1.03 ABBREVIATIONS

ANSI	American National Standards Institute
AWWA	American Water Works Association
MDFT	Minimum Dry Film Thickness
MDFTPC	Minimum Dry Film Thickness Per Coat
mil	Thousandths of an Inch
OSHA	Occupational Safety and Health Act
PSDS	Paint System Data Sheet
SFPG	Square Feet Per Gallon
SFPGPC	Square Feet Per Gallon Per Coat
SP	Surface Preparation
SSPC	Steel Structures Painting Council

1.04 REFERENCE STANDARDS

A. This specification recognizes AWWA, NACE, and SSPC standards as minimum industry standards and they are referenced for purpose of conformance, except where modified in this section. The requirements of this specification section have been written to a

higher design standard with the intent of achieving a long-term coating performance of 100 years.

NACE SP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
NACE RP-0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
SSPC-SP-1	Solvent Cleaning Surface Preparation
SSPC-SP-2	Hand Tool Cleaning Surface Preparation
SSPC-SP-3	Power Tool Cleaning Surface Preparation
SSPC-SP-5	White metal Abrasive Blast Surface Preparation
SSPC-SP-6	Commercial Abrasive Blast Surface Preparation
SSPC-SP-10	Near White Metal Abrasive Blast Surface Preparation
SSPC-SP-11	Power Tool Cleaning to Bare Metal
SSPC-SP-13	Surface Preparation of Concrete

1.05 SUBMITTAL REQUIREMENTS

A. Contractor submittals shall be made in accordance with this Section of these Specifications.

B. Shop Drawings: Catalog cuts and other information for all products proposed. Provide copy of approved coating system submittals to the coating applicator.

C. Quality Control Submittals: Furnish the following:
   1. Applicator's Experience with list of references substantiating compliance.
   2. Coating manufacturer's certification stating the individual coating applicators have met the qualification certification requirements as specified this section.
   3. Coating manufacturer shall provide a copy of the manufacturer’s coating application quality assurance manual.
   4. If the manufacturer of field-applied coating differs from that of the shop applied primer, provide written confirmation from both manufacturers’ that the two coating materials are compatible.

D. Product Data: Furnish the following Data Sheets:
   1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers. A sample PSDS form is appended at the end of this section.
   2. The required information shall be submitted on a system-by-system basis.
   3. The Contractor shall also provide copies of the paint system submittals to the coating applicator.
   4. Indiscriminate submittal of manufacturer's literature only is not acceptable.

E. Where ANSI/NSF Standard 60 and 61 approvals is required, submit ANSI/NSF certification letter for each coating in the system indicating product application limits on size of tank or piping, dry film thickness, number of coats, specific product tested, colors certified, and approved additives.

F. Provide TCLP test data for lead and other regulated heavy metals in non-recyclable, slag type abrasive blast media to be used on the project. Acceptable abrasive test data

shall indicate the abrasive manufacturer, location of manufacture, and media gradation and type. Surface preparation will not be permitted to begin until acceptable test data has been submitted.

1.06 QUALITY ASSURANCE

A. Coating Applicator's Experience and Certification:
   1. Coating Application Company and coating application supervisor (Certified Applicator) shall have a minimum of 5 years' experience applying the specified coating system.
   2. Coating application personnel, whom have direct coating application responsibility, shall have a minimum of 2 years practical experience in application of the indicated coating system.
   3. Coating applicator shall be certified by the coating manufacturer as an approved applicator.

B. Continuity of Contractor: Contractor's site supervisor shall be coordinated with the Engineer. Any replacement of the supervisor on site will require notification of Engineer 72 hours in advance and will be subject to approval by the Owner.

C. Coating and/or lining manufacturer shall provide a technical representative to visit the jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these Specifications, and as may be necessary to resolve field problems attributable to, or associated with, the manufacturer's products furnished under this Contract. Sale representatives are not acceptable as a technical representative unless written authorization from the coating manufacture is provided which states the sales representative has full authority to act on the behalf of the coating manufacturer.

1.07 WARRANTY

A. The Contractor and coating manufacturer shall jointly and severally warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of 2 year(s) commencing on the date of final acceptance of the work.

1.08 ENGINEER OBSERVATIONS

A. The Contractor shall give the Owner Representative notice a minimum of 14 days prior to start of work for scheduling shop or field observation.

B. Provide Owner Representative a minimum 3 days' notice for actual start of surface preparation and coating application work.

C. Provisions shall be made to allow Owner's representative full access to facilities and appropriate documentation regarding coating application.

D. Observation by the Owner's representative or the waiver of observation of any portion of the work shall not be construed to relieve the Contractor of his responsibility to perform the work in accordance with these Specifications.

E. Materials shall be subject to testing for conformance with this specification as the Owner's representative may elect, prior to or during incorporation into the work.

F. Perform work in the presence of ENGINEER or Owner Representative, unless prior approval to perform such work is granted. Approval to perform work is limited to the current day unless specifically noted to extend beyond the completion of the workday.

PART 2 PRODUCTS

2.01 GENERAL

A. Coatings and linings will be stored and handled per manufacturer's written directions.

B. All metallic surfaces shall be prepared and coated in accordance with referenced standards, written instructions of the coating or lining manufacturer, and these specifications, whichever is more stringent, unless specified otherwise.

C. Coatings shall be the product of a single manufacturer. Product substitutions during the project will not be permitted, without ENGINEER approval.

2.02 PAINT DELIVERY, STORAGE, AND HANDLING

A. Delivered paint to the project site in unopened containers that plainly show, at the time of use, the designated name, date of manufacture, color, and name of manufacturer.

B. Stored paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the paint manufacturer.

C. Shipping:
1. Where shop finish coated or primed items are to be shipped to the jobsite, protect coating from damage. Batten coated items to prevent abrasion.
2. Use nonmetallic or padded slings and straps in handling.
3. Items will be rejected for excessive damage.

2.03 PAINT AND COATINGS MANUFACTURERS

A. A manufacturer letter code as follows will be found following the generic descriptions of materials outlined in the Specifications. Address is that of the general offices. Contact these offices for information regarding the location of representative nearest the project site.

B. MANUFACTURER CODE A - COATINGS MANUFACTURERS (Able to supply most heavy-duty industrial coatings and architectural paints):

1. Carboline Coatings Company, St. Louis, MO.
2. ICI Devoe Coatings Company, Louisville, KY.
3. International Coatings,
4. Pittsburgh Paints (PPG), Pittsburgh, PA.

5. Sherwin Williams, Cleveland, OH
6. Tnemec Coatings, Kansas City, MO

2.04 PAINT MATERIALS

A. Products shall meet federal, state, and local requirements limiting the emission of volatile organic compounds. Specific information may be secured through the local office of the Air Pollution Control Officer.

B. Materials Including Primer and Finish Coats: Produced by same paint manufacturer.

C. Thinners, Cleaners, Driers, and Other Additives: As recommended by paint manufacturer of the coating system. Where coatings are required to meet ANSI/NSF Standard 60 and 61, addition of thinners, driers, and other paint additives not approved under the ANSI/NSF certification letter will not be permitted without written approval from the Engineer.

D. Paint products are listed according to their approximate order of appearance in the paint systems. The letter designating the manufacturer code refers to Article PAINT AND COATING MANUFACTURERS.

Products	**Description**
Epoxy, NSF	Amine or polyamine epoxy coating, two parts, suitable for immersion service, 75% volume solids minimum, capable of 4 to 8 MDFT per coat, approved for potable water contact in conformance to ANSI/NSF Standard 60 and 61, and suitable for the application temperatures and conditions. MANUFACTURER CODE: A
Epoxy	Polyamine or polyamide epoxy, two parts, suitable for immersion service, 75% volume solids minimum, capable of 4 to 8 MDFT per coat, and suitable for the application temperatures and conditions. MANUFACTURER CODE: A
Polysiloxane	Acrylic polysiloxane hybrid coating, single component, suitable for shop or field application at 32 degrees F, minimum, recoat window of not less than 12 months with preference for products with unlimited overcoat capability, solids content of 85% minimum, high gloss, and tintable colors. Tinted colors shall be capable of storage for 30 days or longer prior to application. Coating shall be capable of spray, roller, or brush application on all metal substrates and specified prime and intermediate coats. MANUFACTURER CODE: A
Inorganic Zinc Primer	Solvent or water based, 14 lbs. metallic zinc content per gallon minimum; unlimited recoat window, conform to manufacturer's recommended top coats as specified herein. MANUFACTURER CODE: A
Wash Primer	Vinyl butyral acid or equivalent coating for enhancing finish coat adhesion to galvanized steel surfaces. MANUFACTURER CODE: A

Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish, suitable for continuous dry service at 200 degrees F without discoloration or peeling. MANUFACTURER CODE: A

2.05 COLORS

A. Provide as selected by the Owner.

B. Formulated with colorants free of lead, lead compounds, or other materials which might be affected by the presence of hydrogen sulfide or other gas likely to be present at the project.

C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply matches.

D. Equipment Colors:
   1. Equipment shall be meant to include the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
   2. Paint non-submerged portions of equipment in the same color as the process piping it serves, except as itemized below:
      a. Dangerous parts of equipment and machinery: OSHA Orange
      b. Fire protection equipment and Apparatus: OSHA Red
      c. Radiation hazards: OSHA Purple
      d. Physical hazards in normal operating area: OSHA Yellow
   3. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as specified.

E. Pipe Identification Painting:
   1. Color code non-submerged metal piping except electrical conduit. Paint fittings and valves the same color as the pipe.
   2. Piping color coding: In accordance with the Piping Schedule as shown.
   3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at all connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along the piping not greater than 9 feet on center, with identification labels applied to each exposed run of pipe as specified herein.
   4. Pipe supports: Mild steel, painted No. 70 light gray as specified in ANSI Z35.1.
   5. Fiberglass reinforced plastic (FRP) pipe and polyvinyl chloride (PVC) pipe located outside of buildings and enclosed structures will not require painting, except as noted.

F. Labels for Piping:
   1. Identification labels shall bear the full piping system name as specified in the Piping Schedule shown.
   2. Install separate flow directional arrows with each label.
   3. Include black lettering on OSHA safety yellow self-adhesive vinyl or vinyl cloth.
   4. Lettering height: Meet ANSI A13.1.
   5. Label and Adhesive: Long lasting, resistant to moisture, oils, solvents, and weathering, meeting OSHA requirements.
   6. Locate labels at all connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along the piping not greater than 18 feet on center, with at least one label applied to each exposed run of pipe.

7. Manufacturers:
    a. W. H. Brady Co., Milwaukee, WI
    b. Seton Nameplate Corp., New Haven, CT
    c. or Equal.

2.06 QA/QC TESTING AND INSPECTION

A. General
1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
2. Quality control testing as specified in AWWA standards are minimum industry standards and it is the intent of this specification to provide a higher level of quality control for the objective of achieving maximum coating performance.
3. If any conflict between this specification and referenced standards occurs, the more stringent requirement shall apply and any interpretation of this requirement or results shall be with the objective of achieving maximum coating performance.
4. The frequency of the testing shall be determined by the applicator but shall not be less than the requirements of this specification.

B. Surface Profile Testing
1. Surface profile of abrasive blasted surfaces to be tested with “Press-O-Film” tester tape or equivalent in accordance with NACE RP287.
2. Tester tape shall be suitable for the intended profile height.
3. Profile shall be measured to a minimum tolerance of 0.1 mils, maximum.
4. Electronic surface profilometer shall be used, where deemed necessary, to verify tester tape measurements.

C. Adhesion testing: As specified in Section 09 90 10, where directed by the Engineer for assessing coating application problems.

D. Holiday Testing
1. Holiday tests on polyurethane coatings or linings will be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE SP-0188 and these specifications.
2. Coating thickness used for high voltage holiday testing setting shall be the average dry coating thickness.

E. Dry Film Thickness Testing
1. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off, eddy current, or ultrasonic equipment.
2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

PART 3 EXECUTION

3.01 GENERAL

A. The intention of this specification is for all existing and new, interior and exterior surfaces are painted, whether specifically mentioned or not, except as modified herein.

Concealed structural steel surfaces shall receive prime coat only unless modified herein. Exterior concrete surfaces will not be painted unless specifically indicated hereinafter.

B. Surface preparation and coating application shall be in conformance with these specifications and the coating manufacturer's written product data sheets and written recommendations of the manufacturer's technical representative. Where conflicts occur between the manufacturer's recommendations and these specifications, the more stringent of the two shall apply unless otherwise approved by the Engineer.

C. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating for any purpose until completion of curing cycle.

3.02 REGULATORY REQUIREMENTS

A. Meet federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposures.

B. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application and dust prevention including, but not limited to the following Acts, Regulations, Standards, and Guidelines:
   1. Clean Air Act
   2. National Ambient Air Quality Standard
   3. Resource Conservation and Recovery Act (RCRA)

C. Comply with applicable federal, state, and local regulations for confined space entry.

D. Provide and operate equipment that meets explosion proof requirements.

3.03 ENVIRONMENTAL CONDITIONS

A. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees F above the dew point of the ambient air.

B. Surface preparation power tools and blast equipment shall contain dust collection equipment that will prevent discharge of dust particles into the atmosphere.

C. Do not apply paint when:
   1. Surface temperatures exceeds the maximum or minimum temperature recommended by the paint manufacturer,
   2. In dust, smoke-laden atmosphere, damp or humid weather, or under conditions which could cause icing on the metal surface.
   3. When it is expected that surface temperatures will drop below 5 degrees above dew point within 8 hours after application of coating.

3.04 DEHUMIDIFICATION

A. Where environmental conditions cannot be met or controlled, Contractor shall provide and operate desiccant dehumidification equipment to maintain environmental conditions for 24 hours a day during abrasive blasting and coating application and cure. Liquid, granular, or loose lithium chloride drying systems will not be acceptable.

B. Contractor shall provide dehumidification equipment sized to maintain dew point temperature 17 degrees or more below surface temperature of metal surfaces to be cleaned and coated. System shall provide ventilation within the environmentally controlled areas as required for the following requirements:
   1. One air exchange per hour, minimum,
   2. Maintenance of personnel exposures limits (PEL) at 50 percent of OSHA PEL limits for all chemicals used in the performance of the work, and
   3. Maintenance of lower explosive limits (LEL) to less than 50 percent of the most volatile solvent used in the performance of the work.

C. Dehumidification equipment type, size, air flow, and power requirements shall be designed by a qualified company knowledgeable in dehumidification equipment, and its operation based on project requirements and anticipated seasonal weather conditions for the project schedule. Design to include evaluation of existing conditions, humidity, and temperature, proper air exchange requirements, ventilation requirements, ducting requirements for adequate air flow, and any other issues necessary to achieve the specified performance and environmental conditions throughout the duration of the project.

D. Contractor to submit written recommendations from dehumidification subcontractor for bulkhead locations, bulkhead venting, duct work for each bulkhead section, any secondary ventilation requirements for coating cure, dust collection equipment CFM requirements, and drying requirements for blast hose compressed air necessary to maintain environmental control as specified herein.

E. Dehumidification subcontractor shall either operate the equipment or provide training to Contractor on the proper operation and setup of dehumidification equipment. Dehumidification subcontractor shall provide a technical representative on site for a minimum of two 8-hour days to ensure proper operation of the equipment, achievement of desired environmental control, and to insure Contractor can properly setup, operate, monitor, and maintain the equipment.

F. Dehumidification shall be operated in a manner that prevents all condensation or icing throughout surface preparation and coating application and cure.

G. Reblasting of flash rusted metal surfaces or removal of damaged coatings, as a result of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor. Cleaned metal surfaces subject to flash rusting shall be cleaned to the same cleanliness as prior to the flash rust formation and shall be approved by the Engineer.

H. Contractor shall monitor ambient temperature, humidity, dew point temperature, and pipe surface temperature both outdoors and within the work area at the start, midpoint, and end of each work shift, minimum, but not greater than 5 hours between measurements.

I. Daily environmental condition monitoring and maintenance of the equipment shall be documented in writing and posted near the equipment for review by the Engineer.

3.05 VENTILATION AND ILLUMINATION

A. Adequate illumination shall be provided while work is in progress. Whenever required by the inspector, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the inspector.

B. Ventilation shall be used to control potential dust and hazardous conditions within the tank. Ventilation flow rates shall be in accordance with OSHA regulations and as required to reduce air contamination to nonhazardous conditions.

3.06 SURFACES NOT REQUIRING PAINTING

A. Unless otherwise stated herein or shown, the following areas or items will not require painting:
   1. Concrete and masonry surfaces
   2. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:
      a. Required for electrical insulation between dissimilar metals.
      b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
      c. Color coding of equipment and piping is required.
   3. Nonmetallic materials such as glass, PVC, wood, porcelain, and plastic (FRP) except as required for architectural painting or color coding.
   4. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panel boards, transformers, disconnect switches, acoustical tile, cabinets, elevators, building louvers, wall panels, etc.; color coding of equipment is required.
   5. Non-submerged electrical conduits attached to unpainted concrete surfaces.
   6. Cathodic protection anodes.
   7. Items specified to be galvanized after fabrication unless specifically required elsewhere or subject to immersion.
   8. Insulated piping and/or insulated piping with jacket will not require exterior coating, except as required for architectural painting or color coding.

3.07 PREPARATION OF SURFACES

A. Surface Preparation Inspection:
   1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied.
   2. Provide Engineer minimum 3 days' notice prior to start of surface preparation work or coating application work.
   3. Perform such work only in the presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence.

B. Metal Surface Preparation:

1. General:
    a. Do not perform a surface preparation blast prior to submission of samples. Workmanship for metal surface preparation as specified shall meet current Steel Structures Painting Council (SSPC) Specifications as follows:
        (1) Solvent Cleaning: SP 1
        (2) Hand Tool Cleaning: SP 2
        (3) Power Tool Cleaning: SP 3
        (4) White Metal Blast Cleaning: SP 5
        (5) Commercial Blast Cleaning: SP 6
        (6) Brush-Off Blast Cleaning: SP 7
        (7) Pickling: SP 8
        (8) Near-White Blast Cleaning: SP 10
        (9) Bare Metal Power Tool Cleaning: SP 11
    b. All surface preparation shall be assumed to be on a SSPC Grade A steel surface condition, unless specifically noted otherwise.
    c. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in these Specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications listed above.
    d. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply. Wet blasting methods shall be approved by the Engineer.
    e. Hand tool clean areas that cannot be cleaned by power tool cleaning.
2. Welds and adjacent areas:
    a. Prepared such that there is:
        (1) No undercutting or reverse ridges on the weld bead.
        (2) No weld spatter on or adjacent to the weld or any other area to be painted.
        (3) No sharp peaks or ridges along the weld bead.
    b. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.
3. Preblast Cleaning Requirements:
    a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
    b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
    c. Clean small isolated areas as above or solvent cleaned with suitable solvents and clean cloths.
    d. Round or chamfered all sharp edges and grind smooth burrs, jagged edges, and surface defects.
4. Blast Cleaning Requirements:
    a. General:
        (1) Type of Equipment and Speed of Travel: Designed to obtain specified degree of cleanliness.
        (2) Select type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendations for the particular coating to be applied or not less than 20 percent of the specified coating thickness, whichever is more stringent.
        (3) Meet applicable federal, state, and local air pollution control regulations for blast cleaning and disposition of spent aggregate and debris.

(4) Do not reuse abrasive, unless abrasive is recyclable steel grit or shot abrasive.

b. Shop Blasting
   (1) Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the work during surface preparation and shop application of paints. Work shall be subject to the Engineer's approval before shipment to the jobsite.
   (2) Items such as structural steel, metal doors and frames, metal louvers, and similar items as reviewed by the Engineer may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate to shop blast cleaning. Blast clean and prime in accordance with these Specifications.

c. Field Blasting
   (1) Perform sandblasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, procedures, shall meet requirements of Steel Structures Painting Council.
   (2) Field blasting in areas with electrical or mechanical equipment, within buildings, or on coated surfaces with lead paint greater than 2,000 mg/L total lead shall be performed with dustless abrasive systems such as "Sponge-Jet", dry ice abrasive blasting.

5. Post-Blast Cleaning and Other Cleaning Requirements:
   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wiped with a tack cloth.
   b. Paint surfaces the same day they are sandblasted. Reblast surfaces that have started to rust before they are painted.

C. Concrete Surface Preparation:
   1. Do not begin until 30 days after the concrete has been placed.
   2. Remove grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent, or other suitable cleaning methods.
   3. Clean concrete using mechanical or chemical methods for the degree of cleaning specified for the coating system in accordance with SSPC SP-13, Surface preparation of Concrete.
   4. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to coating.
   5. Bug holes, air pockets, and other voids in the concrete will be filled or patched in chemical exposure areas, secondary containment, and where specifically required.
   6. Concrete Surface Preparation Inspection:
      a. Adhesion Testing:
         (1) Tensile testing of the surface preparation shall be performed by the Engineer as necessary using Type 4 or Type 5 pneumatic adhesion testing equipment in accordance with ASTM D4541 using 2-inch diameter dollies for concrete surface adhesion testing.
         (2) Applied coating greater than 20 mils in thickness or with a tensile strength greater than 2,500 psi shall be scored for concrete adhesion testing.

(3) Adhesive failure greater than 50 percent of the dolly surface area shall indicate inadequate surface preparation.
(4) Cohesive failures which results in loss of sound concrete will be acceptable provided the loss is greater than 50 percent of the dolly surface area.
(5) Low adhesion cohesive failures with a thin layer of concrete due to weak concrete or laitance over 50 percent of the dolly surface will be rejected.

b. Concrete Soundness:
(1) Concrete soundness shall be determined using the scratching or hammer impact methods as defined in SSPC SP-13.

c. Moisture Content:
(1) Moisture shall be tested as Specified in SSPC SP-13 and shall not exceed the moisture content recommended by the coating manufacturer.

D. Brush-off Blast Cleaning:
1. Equipment, procedure, and degree of cleaning shall meet SSPC-SP 7, Brush-off Blast Cleaning and shall achieve a profile on the coating equivalent to 80 grit sandpaper with no exposed metal. Profile shall be uniform over the surface with no glossy areas visible.
2. Where metal substrate is exposed, Contractor shall apply full coating system as specified for new metal surfaces.
3. Repair or replace surfaces damaged by blast cleaning, where damage is defined as visible metal substrate. If less than 5 percent of prepared surface has the metal substrate visible, the coating shall be repaired by application of a brush applied intermediate coat. If greater than 5 percent the coating shall be fully removed to meet the specified surface cleanliness and recoated with the specified coating system.
4. Abrasive: Either conventional abrasive blasting with sand, grit, or nut shells or specialized abrasive blasting. Abrasives shall be 60 mesh grit, maximum.
5. Select various surface preparation parameters such as size and hardness of the abrasive, nozzle size, air pressure, and nozzle distance from the surface such that the surface is cleaned without pitting, chipping, or other damage.
6. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
7. The Engineer shall approve trial blast cleaned area and shall use area as a representative sample of surface preparation.

E. Solvent Cleaning:
1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action.
2. Method meets SSPC-SP 1.

3.08 PROTECTION OF MATERIALS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering the motors.

3.09 PAINT MIXING

A. Multiple-component coatings:
   1. Prepare using all the contents of the container for each component as packaged by the paint manufacturer.
   2. No partial batches will be permitted.
   3. Do not use multiple-component coatings that have been mixed shall not be used beyond their pot life.
   4. Provide small quantity kits for touchup painting and for painting other small areas.
   5. Mix only components specified and furnished by the paint manufacturer.
   6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
   7. Fast set or plural component products shall be applied using an appropriate multipart pump that properly mixes both components at the recommended ratio using equipment recommended by the coating manufacturer. Hot mixing of fast set or plural component products will not be permitted.

B. Keep paint materials sealed when not in use and provide nitrogen blanket on fast set, plural, or moisture cured coatings on opened product containers when stored or not in use more than 8 hours.

C. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

3.10 APPLICATION OF PAINT

A. General:
   1. Inspection: Schedule with Engineer in advance for cleaned surfaces and all coats prior to the succeeding coat.
   2. Apply coatings in accordance with the paint manufacturer's recommendations. Allow sufficient time between coats to assure thorough drying of previously applied paint.
   3. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
   4. Paint units to be bolted together and to structures prior to assembly or installation.
   5. Shop Primed or Factory Finished Surfaces:
      a. Inspection: Schedule with Engineer in advance for shop primed or factory-finished items delivered to jobsite for compliance with these Specifications.

b. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
c. For two-package or converted coatings, consult the coatings manufacturer for specific procedures as relates to top coating of these products.
d. Prior to application of finish coats, clean shop primed surfaces of dirt, oil, and grease, and apply a mist coat of specified primer, 1.0 mil dry film thickness.
e. After welding, prepare and prime holdback areas as required for the specified paint system. Apply primer in accordance with manufacturer's instructions.

6. Manufacturer Applied Paint Systems:
   a. Repair abraded areas on factory-finished items in accordance with the equipment manufacturer's directions.
   b. Carefully blend repaired areas into the original finish.

B. Application Safety
1. Performed painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. NACE contained in the publication, Manual for Painter Safety.
   c. Federal, state, and local agencies having jurisdiction.
2. Contractor will be solely and completely responsible for condition of the project site, including safety of all persons (including employees) and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. Safety provisions will conform to U.S. Department of Labor, Occupational Safety and Health Act, any equivalent state law, and all other applicable federal, state, county, and local laws, ordinances, and codes.
3. Contractor will comply with all safety-training requirements promulgated or required for this project.

C. Film Thickness:
1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG). Per coat determinations are listed as MDFTPC or SFPGPC.
2. Applied coating system film thickness per coat shall be applied at the specified coating thickness or the manufacturer’s recommended minimum thickness, whichever is greater. Where the manufacturer has not specified a minimum coating thickness on the product data sheets, the minimum recommended coating application thickness shall apply.
3. Maximum film build per coat shall not exceed the coating manufacturer's recommendations.

D. Stripe Coats:
1. Surfaces that are subject to immersion, condensing environments, or where specifically specified shall be stripe coated on all angles, edges, corners, threads, welds, and similar type surfaces.
2. Stripe coat shall be an extra coat of the intermediate coating material and shall be applied between the prime and intermediate coats.
3. The stripe coat shall be a separate coat from coats specified under the coating system.
4. Stripe coats shall be alternated in color like a full coat.

E. Number of coats:
   1. Apply specified number of coats, minimum, irrespective of the coating thickness.
   2. Additional coats may be required to obtain the minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.

F. Porous Surfaces, Such as Concrete, Masonry:
   1. Prime Coat:
      a. May be thinned to provide maximum penetration and adhesion.
      b. Type and Amount of Thinning: Determined by the paint manufacturer and is dependent on surface density and type of coating.
      c. Surfaces Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of the coating.

G. Existing Coated Surfaces:
   1. General:
      a. Equipment or components with shop primer or shop finish coated surfaces shall be reviewed with the Engineer to determine coating damage, repair methods, surface preparation requirements, and conformance with color uniformity, where required.
      b. All shop primed or finished coated surfaces shall be verified to be chemically compatible with field applied finish coats.
      c. If a cured epoxy, polyurethane, or plural-component material is to be top coated, contact the coating manufacturer for additional surface preparation requirements. Existing coated surfaces shall be prepared as follows"
         (1) Existing coated surfaces shall be brush-off blasted as specified herein to remove all gloss and provide a uniform profile on existing coating for adhesion of subsequent coats.
         (2) Power or hand sanding will not be allowed as a surface preparation procedure for existing coatings, unless reviewed and approved by the Engineer.
         (3) Where coating manufacturer surface preparation recommendations conflict with this section, the more stringent requirements shall apply.
         (4) Profile shall be as specified for by the manufacturer or equivalent of 80 grit sandpaper; whichever is more stringent. Profile shall be visible and uniform over existing coated surfaces.
      d. All existing coated surfaces, where demolition of equipment was specified or required, shall be surface prepared, touch-up coating repairs completed, and a cosmetic overcoat applied using the specified coating system on all existing coated surfaces associated with the demolition work, unless otherwise specified.
      e. Existing coatings on immersed equipment shall be removed to bare metal and recoated with the specified coating system where demolition work was specified.
      f. Apply sealer/primer where recommended by coating manufacturer for coating compatibility.
   2. To be Recoated or Final Coated:
      a. Detergent wash and freshwater rinse.
      b. Perform touch-up repairs of existing coating.
      c. Asphaltic varnish coated ductile iron pipe will require an application of a seal coat prior to the application of a cosmetic finish coat.

3. Touch-up Repairs:
    a. Clean loose, abraded, or damaged coatings to substrate by Power Tool (SP 3).
    b. Feather surrounding intact coating.
    c. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.
    d. Apply one full finish coat of the specified primer or finish coat(s) overall.
4. Application of a Cosmetic Coat:
    a. The exact nature of shop-applied coatings is not known in all cases.
    b. Check compatibility by application to a small area prior to starting the coating.
    c. If lifting or other problems occur, request disposition from the Engineer.
    d. Cured epoxy, polyurethane, plural component materials or any other coating system that has exceeded its maximum recoat window shall be prepared as specified this section.

H. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repaired in accordance with the recommendations of the paint manufacturer.
2. Repair fusion bonded coatings to be as recommended by the original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by the coating manufacturer.
3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

I. Unsatisfactory Application:
1. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.
3. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.
4. Repair defects in coating system per written recommendations of coating manufacturer.
5. Leave all staging up until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by Engineer.

3.11 COATING INSPECTION

A. General
1. Film thickness measurements and electrical inspection of the coated surfaces:
2. Perform with properly calibrated instruments.
3. Recoat and repair as necessary for compliance with the Specifications.
4. All coats will be subject to inspection by the Engineer and the coating manufacturer's representative.
5. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.

6. Give particular attention to edges, angles, flanges, and other areas where insufficient film thicknesses are likely to be present and ensure proper milage in these areas.

B. Coating Thickness Testing:
   1. Engineer shall conduct coating thickness testing as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.
   2. Measure coating thickness specified in mils with a magnetic type dry film thickness gauge as specified.
   3. Check each coat for the correct milage. Do not make measurement before a minimum of 8 hours after application of the coating.
   4. Tests for concrete coating thickness shall be with a Tooke Gauge, a destructive test. Contractor shall repair coating after thickness testing.

C. Coating Continuity Testing
   1. Holiday detect coatings with high voltage units in accordance with NACE SP-0188. High voltage detector shall have adjustable voltages in 100 volt increments and shall be operated in accordance with the manufacturer's instructions and the specified standard.
   2. Use of an electrical holiday detector, low voltage, wet sponge type holiday detector will be permitted for coating systems less than 20 mils total dry film thickness and are not for immersion or condensing environments.
   3. Holiday detect coatings on pipe for buried application with high voltage spark tester in accordance with NACE RP0274.

3.12 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroyed at the end of each day.

B. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroyed in a legal manner.

C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

D. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

3.13 MANUFACTURER' SERVICES

A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

3.14 PROTECTIVE COATING SYSTEMS AND APPLICATION SCHEDULE:

A. Unless otherwise shown or specified in these Specifications painted or coated the work in accordance with the following application schedule.

B. In the event of discrepancies or omissions in the following, request clarification from the Engineer before starting the work in question.

System No.	Title
1	SUBMERGED METAL - IMMERSION
4	EXPOSED METAL – HIGHLY CORROSIVE
5	EXPOSED METAL – ATMOSPHERIC
8	BURIED METAL - MISCELLANEOUS
10	GALVANIZED METAL
21	EPOXY FLOOR, CONCRETE
27	ALUMINUM AND DISSIMILAR METAL INSULATION
29	FUSION BONDED COATING

C. System No. 1 - Submerge Metal, Immersion

1. Surface Preparation and Coating System

Surface Prep.	Coating Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 5) Cement Mortar Prep: see Interior Linings, this section	Epoxy, NSF	3 coats, 16 MDFT

2. Application:
   a. All metal surfaces subject to immersion or contact with potable water.
   b. Use on the following areas:
      (1) Coat the exposed portion of pipe ends at flexible pipe couplings with high solids epoxy lining, this section.
      (2) Access manhole interior surfaces.
      (3) All steel pipe without a cement mortar lining.
3. Material Requirements:
   a. Polyamide Epoxy: Amine or polyamine epoxy coating, two parts, suitable for immersion, application temperatures, and environmental exposures and conditions, 75% volume solids minimum, capable of 4 to 8 MDFT per coat.
   b. Epoxy coating shall be NSF certified for potable water contact in conformance to ANSI/NSF Standard 60 and 61.
4. Special Requirements:
   a. Epoxy coating applied to immersed surfaces that contact potable water shall be NSF certified for potable water contact.
   b. NSF certified fusion bonded epoxy linings will be permitted as alterative lining for small diameter pipes, valves, and couplings. FBE coating to be

applied as specified for FBE coatings this section and in accordance with the manufacturer's recommendations.

c. All welds, angles, edges, and bolted connections shall be stripe coated as specified this section.

D. System No. 4 - Exposed Metal, Highly Corrosive

1. Surface Preparation and Coating System

Surface Prep.	Coating Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Inorganic Zinc Rich Primer	1 coat, 3.0 to 4.0 DFT
	Epoxy	1 coat, 4 MDFT
	Polyurethane Enamel	2 coats, 6 to 8 DFT
	Or	
	Polysiloxane	2 coats, 4 to 6 DFT

2. Application:
   a. All exposed metal surfaces, new and existing, located inside of vaults or structures.
   b. Use on the following areas:
      1) 16" discharge pipe in flow meter vault
      2) Manways and miscellaneous exposed piping.
   c. Contractor choice of top coat material shall not be changed. Only one top coat materials will be permitted on the project.
3. Special Requirements:
   a. Surface preparation and primer shall be shop applied to all surfaces prior to installation.
   b. DFT thicknesses greater than manufacturer's recommendations shall be subject to rejection and removal.
   c. Intermediate and top coats shall be field applied after installation.
   d. All shop primed or finish coated surfaces shall be prepared as an existing coated surface as specified herein and shall be top coated with intermediate and/or finish coats as required to provide color uniformity throughout the vault or structure.
   e. Color uniformity requirements shall apply to all components installed within the vault and visibly part of completed installation regardless of shop applied coating system.

B. System No. 5 - Exposed Metal, Atmospheric:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Inorganic Zinc Rich Primer	1 coat, 2.5 MDFT
	Polysiloxane	2 coats, 6 MDFT

2. Application:

a. Exposed metal surfaces, new and existing, located outside of structures and exposed to weather and the following specific surfaces unless otherwise specified.
b. Use on the following items or surfaces:
(1) Exposed surfaces of air vent piping, unless hot dipped galvanized.
(2) Hollow metal doors per architectural drawings.

3. Special Requirements:
a. All shop primed or finish coated surfaces shall be prepared as an existing coated surface as specified herein and shall be top coated with intermediate and/or finish coats as required to provide color uniformity.
b. Color uniformity requirements shall apply to all components visibly part of the completed installation regardless of shop applied coating system.
c. Galvanized steel surfaces shall be coated per the coating manufacturer's requirements.
d. Polysiloxane coating to overlap buried pipe coating a minimum of 4 inches below top of concrete.
e. Aliphatic polyurethane will not be allowed as a substitute for polysiloxane due to restrictive overcoat requirements.
f. Dry film coating thickness of polysiloxane, including touch up repairs, shall not exceed the manufacturer's recommended maximum film thickness.

C. System No. 8 - Buried Metal, General:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast or Centrifugal Wheel Blast (SP 10)	Wax Tape Coating	Wax tape as specified in Section 09 90 10, Pipeline Coatings and Linings

2. Application:
a. All buried miscellaneous pipe, joints, fittings, and other pipe appurtenances shall be coated as specified under Section 09 90 10, Pipeline Coatings and Linings.
b. All buried, below grade portions of steel items, except buried stainless steel or ductile iron, unless otherwise specified.

3. Special Requirements:
a. Metallic air vent pipe, buried, may be coated with System No. 1 at Contractor's option.

D. System No. 10 - Galvanized Metal Conditioning:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2) or Power Tool (SP 3)	Wash Primer Finish Coats to Match Existing Paint	1 Coat, 0.4 MDFT As Required to Match Surrounding Area

2. Application:
   a. All galvanized surfaces requiring painting and the following specific surfaces unless otherwise specified.
3. Special Requirements:
   a. Sweep blast as specified this section, may be used in lieu of hand or power tool cleaning of galvanized surfaces provided Contractor can demonstrate that damage to the zinc coating will not result. Engineer approval of sweep blasting locations, methods, and surface cleanliness and profile results is required.
   b. See applicable coating systems for finish coating system and coating requirements based on area and/or surface to be coated.

E. System No. 21 Epoxy Floor, Concrete:

1. Surface Preparation and Coating System

Surface Prep.	Paint Materials	Min. Coats, Cover
Concrete	Epoxy	1st coat (thinned) 2 coats (unthinned) Total system 80 SFPG

2. Application:
   a. Use on the following areas:
      (1) The floors of all cast-in-place concrete vaults.
      (2) All other areas as shown on the Drawings or specified to receive, epoxy floor coating, concrete.
3. Special Requirements:
   a. Epoxy coating to be applied a minimum of 6-inches onto walls, pipe supports, and any other metallic component attached to the floor or wall within the 6-inch limit.
   b. All areas above the 6-inch limit shall be masked, provide a straight-line demarking coated versus uncoated areas.
   c. Abrasively blast miscellaneous metal surfaces to an SSPC SP-10, near white blast, as specified this section.
   d. Prime coat of epoxy shall be a thinned coat of the epoxy coating to fill and seal the concrete before the final coats applied, per the coating manufacturer's requirements.
   e. Apply non-skid aggregate between coats where specified or shown.

A. System No. 27 Aluminum and Dissimilar Metal Insulation:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Wash Primer Epoxy	1 coat, 0.4 MDFT 1 coat, 8 MDFT

2. Application:
   a. Use on all non-submerged concrete embedded aluminum surfaces, and the following specific surfaces unless otherwise specified.
   b. Use on the following surfaces:
      (1) All concrete embedded components of vault hatches
      (2) All concrete embedded surfaces where electrical isolation from concrete reinforcement is required.

B. System No. 29 Fusion Bonded Coating:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10) or Acid Pickling (SP 8)	Fusion Bonded 100% solids Epoxy or Polyurethane	1 or 2 coats, 10 MDFT

2. Application:
   a. Use where specified.
   b. Use on the following items or surfaces:
      (1) Concrete embedded anchor bolts, except threads.
      (2) Removable handrail sleeves.

(See PSDS form following this section)

PAINT SYSTEM DATA SHEET

Attached products' Technical Data Sheet (if applicable) to this sheet for each paint system submittal.

Paint System Number (from spec.):		
Paint System Title (from spec.):		
Coatings Manufacturer:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number Proprietary)**	**Min. Coats, Coverage**

Additional Information Required (check applicable items):

☐ ANSI/NSF Certification letter for each paint material listed above requiring ANSI/NSF Standard 60 and 61 approvals.

☐ Manufacturer's minimum and maximum recommended coating thickness per coat and for total coating system.

☐ Immersion coating cure requirements from minimum coating application temperature to 100 degrees in 15-degree temperature increments.

SECTION 09 90 10
PIPELINE COATINGS AND LININGS

PART 1 GENERAL

1.1 WORK RESULTS

A. This section covers the work necessary to apply external coating and internal lining on steel pipe, field coating of joints, and shop and field repair of coating damage, complete.

B. Exposed steel pipe will be shop coated as specified in Section 09 90 00, Protective Coatings.

1.2 RELATED SECTIONS:

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

C. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
   1. Section 01 33 00 - Submittal Procedures.
   2. Section 09 90 00 – Protective Coatings

1.3 GENERAL:

A. See section GENERAL CONDITIONS, which contain information and requirements that apply to the work specified and are mandatory for this project.

1.4 SUBMITTAL REQUIREMENTS

A. Contractor submittals shall be made in accordance with Section 01 33 00 of these Specifications.

B. Shop Drawings: Catalog cuts and other information for all products proposed. Provide copy of approved coating system submittals to the coating applicator.

C. Quality Control Submittals: Furnish the following:

   1. Applicator's Experience with list of references substantiating compliance.
   2. Coating manufacturer's certification stating the individual coating applicators have met the qualification certification requirements as specified this section.

3. Coating manufacturer shall provide a copy of the manufacturer's coating application quality assurance manual.
4. If the manufacturer of field-applied coating differs from that of the shop applied primer, provide written confirmation from both manufacturers' that the two coating materials are compatible.

1.5 QUALITY ASSURANCE

A. Coating Applicator's Experience and Certification:

1. Coating Application Company and coating application supervisor (Certified Applicator) shall have a minimum of 5 years' experience applying the specified coating system.
2. Coating application personnel, whom have direct coating application responsibility, shall have a minimum of 2 years practical experience in application of the indicated coating system.
3. Coating applicator shall be certified by the coating manufacturer as an approved applicator.

B. Coating and/or lining manufacturer technical representative shall be present for a minimum of three days technical assistance and instruction at the start of coating and/or lining operations within the shop. During this visit, the technical representative shall observe surface preparation and coating application and conduct tests of the coating to insure conformance with application instructions, recommended methods, and conditions.

C. Coating and/or lining manufacturers technical representative shall be onsite for three working days, minimum, at the start of each construction season to inspect coating application and procedures in the field. During this visit, the technical representative shall observe surface preparation and coating application and conduct tests of the coating to insure conformance with application instructions, recommended methods, and conditions.

D. Coating and/or lining manufacturer shall include 8 hours per month of field or shop coating technical support when requested by the Engineer.

E. Technical representative shall provide a written report to the Engineer for each visit. Report shall include copies of test data collected, description of observations, and all recommended corrective actions. Report shall be submitted within 5 working days after the visit. When deemed necessary by the Engineer, work will not be permitted to proceed until the recommended corrective actions have been implemented. After all corrective recommendations have been completed; the manufacturer representative shall return and certify that the application complies with the manufacturer's coating application recommendations.

F. Additional visits by the manufacturer's representative shall be made at sufficient intervals during surface preparation and coating or lining as may be required for product application quality assurance, and to determine compliance with

manufacturer's instructions, and as may be necessary to resolve problems attributable to, or associated with, manufacturer's products furnished for this project.

1.6 ABBREVIATIONS

MDFT	Minimum Dry Film Thickness
mil	Thousandths of an Inch

1.7 DEFINITIONS

A. MANUFACTURER'S REPRESENTATIVE: Employee of coating manufacturer who is factory trained and knowledgeable in all technical aspects of their products and systems. Sales representatives are not acceptable as a technical representative unless written authorization from the coating manufacture is provided which states the sales representative has full authority to act on the behalf of the coating manufacturer.

B. SPECIALS FITTINGS AND CONNECTIONS: Defined as any joint of pipe with turnout, blowoff, fabricated tee, cross, wye, manhole, mitered angles or elbows, crotch plates, butt straps, or fabricated pipe that cannot be coated using through put or straight pipe coating application equipment and the following specific items:
   1. All pipe joint sections entering a structure.
   2. Pipe joints with weld lead pass through holes.

C. SHOP: A shop is defined as a permanent, fully enclosed building with a concrete floor that can be power washed with a potable water supply and floor drains.

1.8 REFERENCE STANDARDS

A. This specification recognizes AWWA, NACE, and SSPC standards as minimum industry standards and they are referenced for purpose of conformance, except where modified in this section. The requirements of this specification section have been written to a higher design standard with the intent of achieving a long-term coating performance of 100 years.

AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4-inch and Larger- Shop Applied.
AWWA C210	Liquid-Epoxy Coating Systems for Steel Water Pipelines.
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipe.
AWWA C215	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines.
AWWA C216	Heat-shrinkable Cross-linked Polyolefin Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
AWWA C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
NACE SP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
NACE RP-0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.

NACE RP0303	Field-Applied Heat-Shrinkable Sleeves for Pipelines: Application, Performance, and Quality Control
NACE SP0394	Application, Performance and Quality Control for Plant Applied Single Layer Fusion-Bonded Epoxy External Pipe Coating.
SSPC-SP-1	Solvent Cleaning Surface Preparation
SSPC-SP-2	Hand Tool Cleaning Surface Preparation
SSPC-SP-3	Power Tool Cleaning Surface Preparation
SSPC-SP-5	White metal Abrasive Blast Surface Preparation
SSPC-SP-6	Commercial Abrasive Blast Surface Preparation
SSPC-SP-10	Near White Metal Abrasive Blast Surface Preparation
SSPC-SP-11	Power Tool Cleaning to Bare Metal

1.9 SPECIAL WARRANTY REQUIREMENTS

A. The Contractor and coating applicator shall warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of two (2) years commencing on the date of final acceptance of the work.

1.10 OBSERVATION OF WORK

A. The Contractor shall give the Owner Representative notice a minimum of 14 days prior to start of work for scheduling shop or field observation.

B. Provide Owner Representative a minimum 3 days' notice for actual start of surface preparation and coating application work.

C. Provisions shall be made to allow Owner’s representative full access to facilities and appropriate documentation regarding coating application.

D. Observation by the Owner’s representative or the waiver of observation of any portion of the work shall not be construed to relieve the Contractor of his responsibility to perform the work in accordance with these Specifications.

E. Materials shall be subject to testing for conformance with this specification as the Owner’s representative may elect, prior to or during incorporation into the work.

PART 2 MATERIALS

2.1 GENERAL

A. Coatings and linings will be stored and handled per manufacturer’s written directions.

B. Exterior and interior pipe and fitting surfaces shall be prepared and coated in accordance with referenced standards, written instructions of the coating or lining manufacturer, and these specifications, whichever is more stringent.

C. Pipeline coating or lining shall be the product of a single manufacturer. Product substitutions during the project will not be permitted, without Engineer approval.

2.2 SHOP-APPLIED, BURIED PIPE COATINGS

A. General

1. Buried steel pipe, consisting of straight lengths of pipe, shall be coated with one of the following coating systems at the Contractors option, except where noted otherwise.
   a. Polyethylene Tape Wrap and cement overcoat (AWWA C214 and C205)
   b. Plural Component Epoxy (AWWA **C210**)
   c. Cement Mortar (AWWA C205), only where indicated on Drawings

2. Buried Steel pipe specials, fittings, and other complex shapes, shall be coated with one of the following coating systems.
   a. Plural Component Epoxy (AWWA **C210**)
   b. Cement Mortar (AWWA C205), only where indicated on Drawings.

3. Vault or manhole piping and miscellaneous pipeline components, such as coupling plain ends, access manholes, blowoff piping, or piping less than 12-inches in diameter, shall be coated as specified under Shop Applied, Atmospheric and Immersion Coatings, this section.

4. Mortar over coat shall be provided over tape wrap coating system and where specified. Cement mortar overcoat shall be shop-applied and 1-inch thick, ±1/4-inch, as specified herein.

5. Buried dielectrically coated pipe and fittings passing through a concrete structure wall or floor shall be dielectrically coated for a minimum of four (4) inches beyond the interior wall or floor surface.

6. Exterior surfaces of all butt straps shall be prepared to SP-5, white metal, and coated with inorganic zinc suitable for temperatures over 750 degrees as specified for holdback corrosion protection.

B. Polyethylene Tape Wrap:

1. General Coating Requirements:
   a. Tape wrap coating system shall be machine applied. Hand applied tape coatings will not be permitted.
   b. Tape width shall be 12-inches maximum. Wider tape will be conditionally allowed if the coating applicator can demonstrate that proper maintenance of tension and prevention of mechanical wrinkling throughout the coating application. If at any time during the pipe fabrication tape quality becomes inconsistent with wider tape, the Engineer can require the remainder of the pipe to be coated using the maximum specified tape width.
   c. Tape layers shall have adhesive for the full width of the tape. Adhesive shall have the ability to stick to itself and to the proceeding tape layer or pipe.
   d. Each layer shall be a different color or shade with the outer layer white.

e. Outer wrap shall be white and have sufficient ultraviolet (UV) inhibitors to resist above grade exposure for a minimum of 12 months or the proposed storage and construction time, whichever is greater.

2. Steel Pipe:
   a. Surface Preparation:
      (1) Comply with salt contamination and surface cleanliness (dust) requirements as specified for Quality Control testing.
      (2) Steel Pipe: SSPC-SP5, White Metal blast, 2.5 mils blast profile, minimum.
   b. Coating System
      (1) Pipe shall be coated with an 80 mil (nominal), tape-coating systems applied in accordance with AWWA C214, except as modified herein.
      (2) Steel pipe with cement mortar overcoat shall be coated with 50 mil (nominal), tape-coating systems applied in accordance with AWWA C214, except as modified herein.
      (3) Primer: Polyken 1019, 1027, 1029, or as recommended by the coating manufacturer.
      (4) Weld Stripe Tape: Polyken 931 (no backing), 25 mils nominal, 4-inches wide minimum.
      (5) Inner Wrap: Polyken 989 YGIII, 20 mils nominal, corrosion protection layer.
      (6) Outer Wrap: Polyken 956 YGIII, 30 mils nominal, mechanical protection layer.
      (7) Mechanical Protection: Cement mortar overcoat in accordance with AWWA C205, except as modified herein.

C. Plural Component Epoxy:

1. General:
   a. Plural component, epoxy coating system shall be applied in accordance with AWWA C210, and as modified herein.
   b. All steel pipe specials, fittings, complex shapes, and other surfaces that are not suitable for machine applied tape wrap coating application and are below finished grade or concrete encased shall be coated with this coating system.
   c. Plural component epoxy coating system is not suitable for interior of pipe or where contact with potable water may occur, see Section 09 90 00, PROTECTIVE COATINGS, for applicable protective coating systems.
2. Shop Surface Preparation:
   a. Steel pipe:
      (1) Comply with salt contamination and surface cleanliness requirements as specified for Quality Control Testing.
      (2) SSPC-SP5, White Metal blast, 3.00 mil profile, minimum, or as required by the manufacturer, whichever is greater.
3. Shop Applied Coating Requirements:
   a. Thickness: One coat, 35 mils total dry film thickness, minimum, or as required to meet limits specified for holiday and coating defects, this section.
   b. Cement Mortar Overcoat:
      (1) Apply cement mortar overcoat on epoxy coated specials when used in conjunction with tape wrapped steel pipe as specified this section.
      (2) Ductile iron pipe does not require a cement mortar overcoat.

4. Product Acceptance:
    a. Self-priming, plural component, 100 percent solids, non-extended epoxy, suitable for burial or immersion, and meeting the requirements of AWWA C210 and the following, whichever is more stringent:
        1) Resistance to Water Immersion (ASTM D870) or Wet Adhesion
            a) Acceptance criteria:
                (1) Not greater than 10 percent loss of substrate adhesion when compared to substrate adhesion in an unexposed area of the same sample with adhesion tests completed within 12 to 24 hours after test termination. Average of three pulls per exposure area.
                (2) No blistering or underfilm corrosion when viewed at 10x magnification.
            b) Adhesion Testing:
                (1) Method: ASTM D4541, Method E
                (2) Equipment:Type V, Delfesko Automatic AT Positest
                (3) Dollies: 20 mm and 14 mm, scored to metal substrate
                (4) Test Speed:100 psi per second (both 14 and 20 mm)
            c) Test Duration:30 and 60 days
        2) Cathodic Disbondment (ASTM G95)
            a) Acceptance criteria: 8 mm, maximum
            b) Potential: -3.00 volts
            c) Test Duration: 28 days
            d) Evaluation: Measured from original holiday radius to edge of staining on metal surface.
        3) Water Absorption (ASTM D570)
            a) Acceptance Criteria: 1.80 percent, maximum
            b) Test Duration:30 day and 60 day
    b. Shall be one of the following products:
        (1) Tnemec Series 431, Kansas City, MO
        (2) Or Engineer approved equal

D. Cement Mortar Coating or Cement Mortar Overcoat

1. Apply cement mortar coating system on steel pipe, where specifically shown on the Drawings, in accordance with AWWA C205, except as modified herein.
2. Cement mortar overcoat shall be applied over dielectric coating system on all steel pipe and fittings in accordance with AWWA C205, except as modified herein.
3. Holdback:
    a. Mortar overcoat shall be held back of dielectric coating a minimum of 3 inches for overlap of field applied joint coating onto dielectric coating system.
4. Shop Applied Coating System:
    a. Cement: Conform to ASTM C150, Type II.
    b. Aggregate shall be silica sand or other aggregate that is not subject to leaching. Conform to ASTM C33.
    c. Cement mortar mixture shall consist of 1-part cement to not more than 3 parts aggregate.

d. Water for cement mortar: Clean and free from organic matter, strong alkalis, vegetable matter, and other impurities. Use no more than 4-1/2 gallons of water per sack of cement.
e. Cement mortar coating: Nominal 1-inch thick coating with permitted tolerance of ±1/4-inch.

5. Joint Coating:
   a. Joints shall be cement mortar overcoated after application of heat shrink sleeve joint coating system.
   b. Joints of cement mortar overcoat dielectrically coated pipe do not require field application of cement mortar overcoat when properly coated with heat shrink sleeve joint coating system.

2.3 SHOP-APPLIED INTERIOR LININGS

A. General
1. Clean and cement mortar line steel pipe and fittings 6-inches or greater in diameter in accordance with AWWA C205.
2. Cement mortar line ductile iron pipe and fittings in accordance with C104, provide double thickness lining. Do not seal coat the cement lining.
3. Apply liquid epoxy coating over cement mortar lining at insulating joints as specified this section.
4. Epoxy line pipe 12-inches diameter or smaller per System No. 1 or fusion bonded epoxy lining at contractor's option. Fusion bonded epoxy lining shall be NSF certified.

B. Cement Mortar Lining:
1. Cement: Conform to ASTM C150, Type II.
2. Shop applied cement mortar lining shall be uniform in thickness over the full length of the pipe joint.
3. Aggregate shall be silica sand or other aggregate that is not subject to leaching. Conform to ASTM C33.
4. Water for cement mortar: Clean and free from organic matter, strong alkalis, vegetable matter, and other impurities.

C. Liquid Applied Epoxy Coating:

1. Epoxy Overcoat of Cement Mortar Lining:
   a. Provide liquid epoxy primer and lining in all cement mortar lined metallic pipe at insulating joints for a minimum of one pipe diameters on each side of the insulated joint. If other side of joint is an existing pipe, apply epoxy lining for two pipe diameters in fabricated pipe only.
   b. Epoxy lining shall be polyamine or polyamide cured, NSF approved for potable water contact in accordance with ANSI/NSF Standards 60 and 61, and capable of achieving full cure before placement in service or exposure to water.
   c. Application:
      (1) Apply in two coats at equivalent spread rate for 6 mils dry film thickness per coat.

(2) Epoxy shall be applied over the cement mortar lining where specified for the pipeline lining material.
(3) Cement mortar shall be allowed to cure for a minimum of 15 days prior to surface preparation and coating application or 7 days with steam curing. Mortar lining shall be dry when epoxy lining is applied.
(4) Prepare the cement mortar lining by abrasive blasting to remove all laitance and provide a surface profile equivalent to 80 grit sandpaper.

d. Acceptable manufacturers:
(1) Carboline
(2) ICI Devoe
(3) Tnemec
(4) Sherwin Williams
(5) Or approved equal

2.4 SHOP APPLIED, ATMOSPHERIC OR IMMERSION COATINGS

A. General
1. All atmospherically exposed or vault piping shall be shop primed and field coated with the applicable Exposed Metal coating system as specified in Section 09 90 00, Protective Coatings.
2. Interior of pipe or surfaces in contact with potable water shall be coated with System No. 1.
3. Shop applied inorganic zinc primer shall not be applied at thickness greater than recommended by manufacturer. Excess primer to be removed using method recommended by coating manufacturer.
4. Intermediate and finish coats shall be applied in the field after installation, except where metal surfaces will be concealed after installation.
5. All concealed surfaces of bolted or mechanically secured surfaces shall be finished coated in the shop.
6. Manufacturer of shop-applied primer shall be coordinated with field application to provide a completed system by a single manufacturer. Engineer approval of a coating system with two or more coating manufacturers' will require written approval from all coating manufacturers as to compatibility and acceptance under warranty.

2.5 FIELD APPLIED COATING SYSTEMS

A. General
1. Miscellaneous Metals
a. All buried miscellaneous metal components installed on the pipeline and that is supplied bare or with a shop coating system that is not equal to the specified pipeline coating shall be coated in the field with one of the following coating systems.
(1) Petrolatum or Wax Tape Coating
(2) Heat Shrink Sleeve
b. Miscellaneous metal components shall include, but not be limited too, all exposed metals surfaces, including bolts, couplings, flanges, valves, adapters, pipe spools, and other miscellaneous metal components.

c. Coating system applied shall conform to the manufacturer's requirements and shall be applied in accordance with the application requirements of the coating system.
d. Filler material shall be applied for all field applied coating systems to provide sufficient transition at welds and other dimensional changes to prevent all tenting or voids under the applied coating, regardless of manufacturer's recommendations.

2. Pipe Joints General:
a. Pipe joints shall be field coated after pipe assembly with one of the following coating systems as specified.
(1) Petrolatum or wax tape coating system
(2) Heat Shrink Sleeves.
b. Steel pipe joints shall be coated with a heat shrink coating, unless specified otherwise.
c. Ductile iron push-on bell and spigot joints may be heat shrink sleeve coated, provided filler mastic is used to prevent tenting or voids under the sleeve.
d. Joints of cement mortar overcoated tape wrap steel pipe shall be cement mortar overcoated after application of the specified field applied joint coating, unless specified otherwise.
e. Flanges, couplings, ductile iron pipe joints, and all bolted or threaded joints are classified as complex shapes and shall be wax tape coated with filler material to ensure completed encapsulation and filling of all bolts, crevices, gaps, and dimensional transitions as required to prevent tenting of the finished coating.

B. Petroleum or Wax Tape Coating:
1. Application:
a. Coating shall be applied in accordance with AWWA C217, except as modified herein.
b. Wax tape coatings shall be field applied on all buried couplings, thrust restraint rods and brackets, valves, and on joints, fittings, or irregular shapes or complex configurations that could cause tenting of heat shrink coating system.
c. Provide wax filler material for all complex shapes, bolts, flanges, gaps, and dimensional transitions to completely fill and encapsulate the metal surfaces and prevent tenting of the applied tape coating.
d. Buried wax tape coated surfaces shall be overcoated with plastic shrink film as recommended by the manufacturer.
e. Do not use wax tape coating systems on vault piping, atmospherically exposed piping and appurtenances, or where subject to UV exposures.
f. Use sand backfill to protect wax coating from damage.

2. Surface Preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.

3. Coating System:
a. Primer: petroleum or petrolatum wax, suitable for wet surfaces.
b. Filler Material:

(1) Filler materials shall be petroleum or petrolatum wax sealer/filler with closed cell plastic filler
(2) Provide filler material to fill and smooth all irregular surfaces, such that no tenting or voids remain under the applied wax tape.

c. Inner Tape: Petroleum or petrolatum wax impregnated fabric, 6-inch width maximum, 40 mils thick
d. Outer Wrap: PVC or tape suitable for application to inner tape.

4. Manufacturers: Wax tape coating system shall be as manufactured by:
a. Denso North American
b. Trenton
c. Or approved equal.

C. Heat Shrink Sleeves:
1. Application:
a. Heat shrink sleeves are restricted to pipeline joints and couplings under buried or concrete encased applications only.
b. Application inside vaults or where exposed to the weather will not be allowed.
c. Provide filler material for all welded joints, rolled or Carnegie joints, and at all dimensional changes that could result in tenting or voids under the applied heat shrink sleeve.
d. Pipe joints that have been shop prepared as specified for heat shrink sleeves and shop coated with holdback primer as specified this section, shall be field prepared in accordance with SSPC-SP1, solvent cleaning, and SP3, Power tool cleaning, to remove all dirt, mud, oil, and grease prior to application of heat shrink sleeve.
e. Filler material shall be applied in a manner and of sufficient thickness that no tenting or voids remain under the heat shrink sleeve.
f. Contractor to consider sleeve shrinkage and joint profile in determining sleeve width required. Overlapping of two or more heat shrink sleeves to achieve the necessary width on pipe joints will not be permitted without Engineer approval.

2. Surface preparation: As specified for pipe joint surface preparation.
3. Coating System:
a. Filler Material:
(1) Filler material shall adhere to the pipe and heat shrink sleeve. Size and type shall be as recommended by the sleeve manufacturer for type of pipe and joint.
(2) Filler materials shall be applied as necessary to prevent all tenting or voids under the applied heat shrink sleeve, regardless of manufacturer's written recommendations.
(3) Filler mastic for joints subject to weld after backfill shall have a melt temperature exceeding 500 degrees F.

b. Heat Shrink Sleeve:
(1) Heat shrink, cross-linked polyolefin sleeve with a mastic sealant, 85-mil nominal thickness or greater, suitable for pipeline operating temperature, as recommended by the manufacturer.

(2) Provide standard recovery sleeve for welded or bell and spigot steel pipe joints. High recovery sleeves shall be provided for mechanical or bell and spigot ductile iron pipe, flange joints, and coupling style joints.
(3) Width of heat shrink sleeves shall be sufficient to overlap existing coating 2-inches minimum, except extruded polyolefin coated pipe shall have a minimum overlap of 3-inches. Overlap on tape coated steel pipe shall be based on a sequential 2-inch wide step from outer wrap to middle wrap to inner wrap.
(4) Sleeve shall meet requirements for "Well After Backfill" when procedure is allowed and approved by Engineer.

4. Coating Manufacturer's:
   a. Canusa,
   b. Raychem-Covalence,
   c. Or equal.

D. Epoxy Coating:
1. Application:
   a. Epoxy coatings shall be NSF approved and suitable for water contact in accordance with ANSI/NSF Standards 60 and 61, unless otherwise approved by the Engineer.
   b. Contractor shall ensure that epoxy coating selected is suitable for the application temperatures anticipated and that project schedule will allow adequate cure time before backfilling or immersion based on surface temperatures at the time of application.
   c. Epoxy coating shall be used to coat concrete embedded pipe penetrations for 6 inches outside of interior and exterior surfaces of concrete walls or floors. Epoxy coating at concrete penetrations shall be a minimum of 16 mils dry film thickness.
   d. Buried transitions from epoxy to tape wrap coating systems shall be coated with Heat Shrink Sleeve as specified below. Heat shrink sleeves shall be buried within 72-hours of application to prevent thermal creep of sleeve. Sleeves subject wrinkling due to thermal exposure shall be removed and replaced by the Contractor.
2. Surface Preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.
3. Coating System:
   a. Primer: As required by the coating manufacturer.
   b. High Build Epoxy Coating:
      (1) Two component, high build polyamide or polyamine cured epoxy coating, suitable for direct burial or immersion, dries to touch in 2 or more hours, suitable for immersion or burial after full cure of coating.
      (2) Acceptable manufacturers:
         (a) ICI Devoe
         (b) Sherwin Williams
         (c) Carboline
         (d) Or approved equal
   c. Fast Cure Epoxy Coating:

(1) Two components, 100% solids by volume, fast cure epoxy coating suitable for direct burial or immersion, dry to touch in less than 1 hour at 72 degrees, capable of curing while immersed or buried.

4. Manufacturers:
   a. TC 7010, Tapecoat Inc
   b. Protal 7125 or Protal 7200, North American Denso
   c. Or approved equal.

E. Cement Mortar Coating or Overcoat:
1. Joints of cement mortar coated or cement mortar overcoated steel pipe shall be mortar coated as specified herein after application of the specified joint coating materials, where applicable.
2. Polyethylene foam-lined fabric with steel strapping of sufficient strength to hold the fresh mortar, resist rodding of the mortar and allow excess water to escape.
   a. 100 percent closed-cell
   b. Chemically inert, insoluble in water, resistant to acids, alkalis, and solvents.
   c. Manufacturer and Product: Dow Chemical Company; Ethafoam 222.
3. Fabric Backing:
   a. Cut and sewn into strips wide enough to overlap shop-coated areas by 4 inches on either side.
   b. Strips shall have slots for steel strapping on outer edges.
4. Joint Coating:
   a. Joints of cement mortar overcoat dielectrically coated pipe do not require field application of cement mortar overcoat when properly coated with heat shrink sleeve or wax tape joint coating system.

2.6 FIELD APPLIED INTERIOR JOINT LINING

A. Epoxy Lining:
1. Surface preparation and field lining of pipe joints shall be with the same coating system as the shop-applied lining.
2. Field application shall be performed by a qualified contractor with equipment that meets the application requirements of the coating system and personnel trained and certified by the coating system manufacturer on the proper application of the coating system. Qualified field applicator shall have completed at least three other projects of similar size and magnitude within the last three years using the same or similar coating system.
3. Coating applicator that does not meet the qualifications requirements can be rejected by the Engineer.
4. Field coating application requirements shall be the same as the shop-applied coating requirements. Provide heating and/or dehumidification equipment as required to meet the environmental conditions necessary for proper coating application.

B. Mortar Lining:
1. After the backfill has been completed to final grade, the interior joint recess shall be filled with grout. The grout shall be tightly packed into the joint recess and trowelled flush with the interior surface. Excess shall be removed.

2. At no point shall there be an indentation or projection of the mortar exceeding 1/16-inch.
3. With pipe smaller than 24-inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out.

2.7 REPAIR OF COATINGS AND LININGS

A. General
1. Coating or lining repair materials shall be compatible with the shop-applied coating or lining system and shall be approved by the coating or lining manufacturer.
2. Coating repair materials shall be as required for the coating system and repair classification as defined this section.

B. Coating Repair Materials
1. Heat Shrink Sleeves (major repair):
   a. Filler Mastic: Provide mastic filler to fill tape void as required.
   b. Shrink Sleeve: See Field Applied Coatings, Heat Shrink Sleeves, this section.

2. Heat-Applied Patches (minor repair)
   a. Heat applied adhesive, polyolefin backed, mastic coated tape, 12-inches maximum size.
   b. Patch shall provide a minimum of 2 inches overlap onto intact pipe coating; except for extruded polyolefin coated pipe shall have a minimum overlap of 3-inches in the circumferential direction.
   c. CRP patch as manufactured by Canusa, PERP patch as manufactured by Raychem (Polyken), or equal.

3. Plural Component Epoxy Coating or Lining
   a. Major Repairs:
      (1) Shop repairs shall be completed using the same material as the pipe coating. Coating shall be reapplied using plural component spray equipment in accordance with manufacturer's written requirements.
      (2) Field repairs shall be completed using heat shrink sleeves as specified for field applied coatings, this section.
      (3) Shop or field major repairs to NSF linings shall be with single use kits matching the existing lining.
   b. Minor Repairs:
      (1) Shop minor repairs shall be single use kits matching the existing coating. Pinholes, holidays, or adhesion test repairs are classified as minor repairs.
      (2) Field minor repairs shall be with fast cure epoxy, such as Protal 7125 as manufactured by North American Denso, Inc.
      (3) Shop or field minor repairs to NSF linings shall be with single use kits matching the existing lining.

2.8 HOLDBACK CORROSION PROTECTION

A. Primer for corrosion protection of cutbacks or holdbacks shall be compatible with the specified joint coating system and high heat resistant or weld after backfill requirements, where applicable.

B. Approved holdback primers are:
   1. Tnemec Omnithane – Suitable for all joints, except joints subject to high heat resistant or weld after backfill
   2. Tnemec 90E-92 Ethyl Silicate Inorganic Zinc Primer – suitable for all joints, including high heat resistant or weld after backfill joints.
   3. ICI Devoe Cathacoat 304V Ethyl Silicate Inorganic Zinc Primer – suitable for all joints including high heat resistant or weld after backfill joints.
   4. Polyken Tape Primers – Not allowed

C. Primer shall not result in running or melting of the coating or cause toxic fumes when heated during welding of "weld after backfill" joints.

D. Application and thickness of holding primer shall be in accordance with the coating manufacturer's recommendations, but shall not impair the clearances required for proper joint installation.

E. Holdback requirements shall be as specified this section.

PART 3 EXECUTION

3.1 ENVIRONMENTAL LIMITATIONS

A. General
   1. Products shall comply with federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposure.
   2. Comply with applicable federal, state, and local, air pollution and environmental control regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
   3. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees above the dew point of the ambient air.
   4. Do not apply coatings when:
      a. Surface and ambient temperatures exceed the maximum or minimum temperatures recommended by the coating manufacturer or these specifications,
      b. In dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather, or under conditions that could cause icing on the metal surface.
      c. When it expected that surface temperatures would drop below 5 degrees above dew point within 4 hours after application of coating.
      d. Whenever relative humidity exceeds 85 percent.
   5. Where weather conditions or project requirements dictate, Contractor shall provide and operate heaters and/or dehumidification equipment to allow pipe surfaces to be abrasive blasted and coated as specified and in accordance with the manufacturers coating application recommendations.

6. Work activities can be restricted by the Engineer until adequate temperature and humidity controls are in place and functioning within the environmental limits specified.
7. Coating applicator shall provide a monitoring system approved by the coating manufacturer that constantly records pipe and coating conditions during coating application. Recorded monitoring parameters shall include pipe temperature, line speed, holiday test and other parameters applicable to the type of coating.

B. Temperature Control
1. In cold weather or if moisture collects on the pipe, preheat pipe to a temperature between 45 and 90 degrees or 5 degrees above dew point, whichever is greater.
2. When temperatures are above or below the coating manufacturers recommended application temperatures, the Contractor will provide temperature controls as necessary to permit work to precede within the manufacturer's temperature limitations.
3. Provide tenting, insulating blankets, baffles, or bulkheads as required to zone and control heating or cooling effectiveness.
4. Heating shall be with indirect fired heaters that do not increase humidity levels within the work area. Heaters shall be sized for the area to be heated.

C. Dehumidification
1. Contractor shall provide and operate desiccant dehumidification equipment to maintain environmental conditions during abrasive blasting and coating application and cure. Liquid, granular, or loose lithium chloride drying systems will not be acceptable.
2. Contractor shall provide dehumidification equipment sized to maintain dew point temperature 17 degrees or more below surface temperature of metal surfaces to be cleaned and coated. System shall provide ventilation within the environmentally controlled areas to meet the following requirements:
   a. Two air exchanges per hour, minimum,
   b. Maintenance of personnel exposure limits (PEL) at 50 percent of OSHA PEL limits for all chemicals used in the performance of the work, and
   c. Maintenance of lower explosive limits (LEL) to less than 50 percent of the most volatile solvent used in the performance of the work.
3. Dehumidification equipment type, size, air flow, and power requirements shall be designed by a qualified company knowledgeable in dehumidification equipment, and its operation based on project requirements and anticipated seasonal weather conditions for the project schedule. Design to include evaluation of existing conditions, humidity, and temperature, proper air exchange requirements, ventilation requirements, ducting requirements for adequate air flow, and any other issues necessary to achieve the specified performance and environmental conditions throughout the duration of the project.
4. Contractor to submit written recommendations from dehumidification subcontractor for enclosure work area size, bulkhead venting, duct work for each bulkhead section, any secondary ventilation requirements for coating cure, dust collection equipment CFM requirements, and drying requirements for blast hose compressed air necessary to maintain environmental control as specified herein.
5. Dehumidification subcontractor shall either operate the equipment or provide training to Contractor on the proper operation and setup of dehumidification

equipment. Dehumidification subcontractor shall provide a technical representative on site for a minimum of two 8 hour days to insure proper operation of the equipment, achievement of desired environmental control, and to insure Contractor can properly setup, operate, monitor, and maintain the equipment.

6. Dehumidification shall be operated in a manner that prevents all condensation or icing throughout surface preparation, coating application, and coating cure.
7. Reblasting of flash rusted metal surfaces or removal of damaged coatings, because of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor. Cleaned metal surfaces subject to flash rusting shall be cleaned to the same cleanliness as prior to the flash rust formation and shall be approved by the Engineer.
8. Contractor shall monitor ambient temperature, humidity, dew point temperature, and pipe surface temperature (work area only) both outdoors and within the work area at the start, midpoint, and end of each work shift, minimum, but not greater than 5 hours between measurements.
9. Daily environmental condition monitoring and maintenance of the equipment shall be documented in writing and posted near the equipment for review by the Engineer.

3.2 SURFACE PREPARATION

A. General
1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of coating manufacturer whose product is to be applied.
2. Visible oil, grease, dirt, and contamination shall be removed in accordance with SSPC-SP1, solvent cleaning.
3. Surface imperfections such as metal slivers, burrs, weld splatter, gouges, or delaminations in the metal shall be removed by filing or grinding prior to abrasive surface preparation.
4. Protect prepared pipe from humidity, moisture, and rain. All flash rust, imperfections, or contamination on cleaned pipe surface shall be removed by blasting.
5. Priming and coating of pipe shall be completed the same day as surface preparation.

B. Weld Surface Preparation
1. Requirements:
   a. Spray applied coating systems do not require weld grinding.
   b. Grind welds flush on extruded polyolefin coated pipe as specified herein.
   c. Welds on tape wrap coated pipe shall be either ground flush or a weld stripe tape applied over the weld, at the pipe fabricator's option, unless otherwise specified.
2. Weld Grinding:
   a. Under the weld grinding option, welds higher than 1/32 inch above pipe surface shall be ground to a tolerance of +1/32 inch to 0-inch above the pipe surface as measured on the lowest side of the weld.
3. Weld Stripe Tape:

a. Weld stripe tape will be applied to primed metal.
b. Tape will either have no polyethylene backing or will be double sided adhesive tape to permit adhesion of the inner corrosion protection layer to the weld stripe tape.
c. Apply tape with a pressure roller to fully conform the tape to the weld surface.
d. Adhesion of the weld stripe tape shall be as specified for the coating system.

C. Salt Contamination Removal
1. All bare or shop coated or primed surfaces that will be coated in the field shall be pressure washed with potable water not greater than 8 hours before coating application, including pipeline joints.
2. Residual soluble salt contamination (SSC) shall be tested as specified under Quality Control testing.
3. Surfaces to be Abrasive Blasted:
   a. Surfaces that fail the soluble salt contamination test prior to abrasive blasting shall be cleaned by pressure washing and/or abrasive blasting and retested.
   b. Surfaces that fail the SSC test after surface preparation shall be recleaned and/or abrasive blasting and retested.
   c. Surfaces which still exceed the specified SSC level after recleaning shall be subject to determination by the Engineer if addition work will be required.
   d. Contractor shall remove all surface rust caused by SSC testing in accordance with SP-11, Power Tool to Bare Metal or abrasive blasting to the specified cleanliness.
4. Existing or Shop Primed Surfaces:
   a. All previously coated surfaces shall be tested for SCC prior to application of additional coats.
   b. Surfaces exceeding the specified SSC level after pressure washing shall be subject to additional cleaning as determined by the Engineer.
   c. Any coating applied before SCC testing is completed and accepted by the Engineer will be rejected and removed.

D. Steel Surface Preparation
1. Surface preparation of steel pipe shall be in accordance with SSPC surface preparation standards utilizing the degree of cleanliness specified for the coating system to be applied or as specified herein, whichever is more stringent.
2. Grit and/or shot abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion specified.
3. Pipe cleaned by abrasive blasting with recyclable steel grit and/or shot or other abrasive shall be cleaned of debris and spent abrasive in an air wash separator.
4. Epoxy coated steel shall have a sharp angular surface profile of the minimum depth specified.
5. After abrasive blasting surfaces and before coating application, the metal surface shall be cleaned of residual dust to a minimum of Grade 2 per ISO Standard 8502-3, Test for the Assessment of Surface Cleanliness.
6. Work shall be performed in a manner that does not permit the cleaned metal surface to rust back or flash rust.
7. Rust back or flash rust shall be fully removed with the steel surface cleanliness equal to the metal surface cleanliness prior to rust back or flash rusting.

Determination of the equivalent surface cleanliness shall be at the Engineer's sole discretion.

E. Concrete Surface Preparation:
   1. Cement Mortar or Concrete Cure:
      a. Cement mortar linings shall be allowed to cure for a minimum of 15 days prior to surface preparation and coating application or 7 days with steam curing.
      b. Concrete surfaces shall be cured 30 days.
   2. Preparation Requirements:
      a. Remove grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent, or other suitable cleaning methods.
      b. Clean concrete using mechanical or chemical methods for the degree of cleaning specified for the coating system in accordance with SSPC SP-13, Surface preparation of Concrete.
      c. Abrasive blast to remove all laitance and provide a surface profile equivalent to 80 grit sandpaper.
      d. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to coating.
   3. Inspection:
      (1) Concrete Soundness: Determined using scratching or hammer impact methods as defined in SSPC SP-13.
      (2) Moisture Content: Moisture shall be tested as Specified in SSPC SP-13 and shall not exceed the moisture content recommended by the coating manufacturer.

3.3 SHOP -APPLIED COATING APPLICATION

A. Tape Wrap Coating
   1. Applicator shall provide a monitoring system approved by the tape manufacturer that constantly records pipe and tape conditions during coating application. Recorded monitoring parameters shall include, but not be limited too, pipe temperature; line speed, primer and tape roll body temperature, and tape tension.
   2. Pipe surface temperature shall be between 45 and 120 degrees and 5 degrees above dew point, whichever is greater.
   3. Tape roll temperature shall be in accordance with the manufacturer's recommendations, but shall not be less than 55 degrees for the inner wrap and 65 degrees for the outer wraps.
   4. Apply a uniform coat of primer as recommended by the manufacturer without skips, runs, or sags. Allow to properly dry prior to applying the tape as required by the tape manufacturer and as necessary to achieve maximum tape adhesion. Rug type application will not be allowed.
   5. If welds are not ground flush, apply a weld stripe tape to longitudinal or spiral pipe welds prior to application of the inner wrap.
   6. Tape layers shall be applied continuously with the use of hydro-tension tape stands. Tension shall be maintained between the manufacturer's minimum and maximum tension recommendations or as required to achieve approximately 2.0 percent reduction in tape width.

7. Inner tape wrap shall adhere tightly to the pipe surface. Coating shall be 100 percent adhering to the metal surface and shall not have any visible damage, wrinkles, voids, disbondment, contamination, or holidays.
8. Tape coating adhesion testing shall be performed on the pipe as specified this section.
9. Holidays testing shall be conducted on the inner layer tape prior to proceeding with subsequent tape layers. All holidays detected shall be primed and patch using coating repair procedures specified herein.
10. Perform coating and lining repairs as specified in this section.

B. Plural Component Epoxy Coating
   1. Applicator Qualifications:
      a. Equipment will be certified by the coating manufacturer to meet the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings.
      b. Equipment not meeting the written requirements of the coating manufacturer shall be rejected for coating application until repairs or replacement of the equipment is made to the satisfaction of the Engineer.
      c. Personnel responsible for the application of the coating system shall have certification of attendance at the coating manufacturer's training class within the last three years. The certified applicator shall be present during all coating application work and shall have responsibility for controlling all aspects of the coating application.
   2. Pipe surface temperature shall be between 50 and 100 degrees or 5 degrees above dew point, whichever is greater.
   3. Coating application shall be performed in an environmentally controlled shop area that meets or exceeds the written environmental application requirements of the coating manufacturer. Application in outdoor conditions will not be acceptable without adequate environmental shelter, environmental controls, and/or dehumidification.
   4. Coating adhesion and holidays testing shall be tested as specified this section except adhesion testing is not required on overcoated CCP.
   5. Coating manufacturer shall provide to the Engineer a copy of the manufacturer's coating application quality assurance manual prior to beginning coating application. Strict conformance to the requirements of the manual will be required. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.
   6. Unacceptable Coating Application
      a. Coating applied under improper environmental conditions will be rejected.
      b. Pipes that exceed the allowable quantity of coating defects, regardless of size or cause, shall be rejected.
      c. Coating which fails the adhesion or holiday testing as specified this section shall be rejected.
      d. Pipe coating that is subject to off ratio application, blistering, or is not applied in conformance with the coating manufacturer's written instructions or recommendations shall be rejected.
   7. Rejected coating shall be removed from the full length of the pipe to bare metal and reapplied using proper application methods in accordance with the coating manufacturer's written instruction and the requirements of these specifications.

8. Perform coating and lining repairs as specified in this section.

C. Cement Mortar Coatings
   1. Steel pipe shall have a cement mortar coating applied in accordance with AWWA C205, except as modified herein.
   2. Tape wrap coated steel pipe shall have a cement mortar overcoat applied over the tape wrap or epoxy coating in accordance with AWWA C205, except as modified herein.
   3. Cement Mortar Coating:
      a. Reinforcement:
         (1) For pipe and specials smaller than 48 inches in diameter, reinforce coating with spirally-wound No. 12 gage steel wire spaced at 1-inch centers or with No. 14 gage steel wire at 1/2-inch centers positioned approximately in center of mortar coating.
         (2) For pipe and specials 48 inches in diameter and larger, reinforce coating with 2 layers of spirally-wound No. 12 gage wire spaced at 1-inch centers or with No. 14 gage steel wire spaced at 1/2-inch centers positioned at the third points of mortar coating.
         (3) Lap ends of reinforcement strips 4 inches and tie or loop free ends to assure continuity of reinforcement.
         (4) All steel wire reinforcement placed in the mortar coating shall be electrically isolated from the pipe. Electrical isolation will be tested using high voltage spark test by the manufacturer prior to shipment to the project site. Provide certification that electrical isolation of reinforcement wire from steel pipe.
      b. Special Fittings:
         (1) Coating for steel plate specials may be reinforced with 2-inch by 4-inch No. 13 gage welded wire mesh in lieu of reinforcing specified above.
         (2) One layer of mesh shall be positioned approximately in center of coating for specials smaller than 48 inches in diameter; 2 layers of mesh shall be positioned at the third points of coating for specials 48 inches in diameter and larger.
      c. Coating Defects:
         (1) Coating defects shall be repaired as specified in AWWA C205, except as specified this section.
   4. Cement Mortar Overcoat:
      a. Cement mortar overcoat tape wrapped coated steel pipe as specified in AWWA C205, except mortar coating shall be applied over exterior pipe coating.
      b. Mortar coating shall be held back 3 inches, minimum, behind dielectric coating system cut back at joints.
      c. Cement mortar overcoat holdback shall be increased with extruded polyethylene coating as required to for coating shrinkage and as required to maintain the minimum overlap specified for joint coating application.
      d. Coating Defects:
         (1) Cracking in the mortar “armor” coat less than 1/8-inch in width will be acceptable.

(2) Disbondment of the cement coating over a dielectric coating system should be anticipated and will not be grounds for repair or rejection of the pipe.
(3) Losses of cement mortar coating due to impact, movement, or shipping damage shall be repaired in accordance with C205.

e. Joint Coating:
(1) Joints of cement mortar overcoat dielectrically coated pipe do not require field application of cement mortar overcoat when properly coated with heat shrink sleeve joint coating system.

3.4 SHOP-APPLIED LINING APPLICATION

A. Shop-applied Cement Mortar Lining:
1. Place mortar lining used in steel piping and steel plate specials in pipe to thickness below.

Pipe Diameter, Inches	Lining Thickness, Inches	Tolerances, Inches
4 through 10	3/8	-1/16, +1/8
11 through 24	5/16	-1/16, +1/8
24 through 36	3/8	-1/16, +1/8
Greater than 36	1/2	-1/16, +3/16

2. Centrifugally line straight sections of pipe. Lining of special pieces or fittings shall be by mechanical, pneumatic, or hand placement. Provide cement mortar lining of uniform thickness. Finish to a smooth dense surface.
a. Steel plate specials larger than 16 inches in diameter shall have lining reinforced with 2-inch by 4-inch No. 13-gage welded steel wire mesh.
b. Brace and support pipe during lining application to minimize pipe distortion or vibration. Bracing and supports shall not damage the pipe, coating, or lining.
c. Tightly close ends of pipe and fittings with plastic sheet caps. Plastic end caps shall be of sufficient thickness and strength to resist shipping, handling, and storage stresses.
d. Damage to the cement mortar lining, including disbondment, cracking, or blistering, caused by improper curing, shipping, handling, or installation shall be repaired in accordance with AWWA specifications and to the satisfaction of the Engineer.
3. Other requirements of mortar lining materials and processes: As specified in AWWA C205.

B. Liquid Epoxy Lining:
1. Pipe Lining, Direct to Metal

a. Where epoxy lining on steel pipe is specified or shown on drawings or where the pipe is not cement mortar lined, an epoxy lining shall be applied directly to the steel surface as specified in Section 09 90 00, Protective Coatings.
b. Immersion System specified in Section 09 90 00, shall be modified to three coats, minimum, at a total coating thickness of 20 mils dry film thickness.

2. Pipe Lining, Insulating Joints:
   a. Coating applied over cement mortar lining shall be applied in a manner that will minimize gassing and pinholes in the completed lining.
   b. Clean and coat the interior of cement mortar lined pipe at insulating joints with two coats of epoxy coating.
   c. Epoxy coating applied at insulating joints shall be applied to both sides of the insulating joint for a minimum of one pipe diameter. If only one side of the joint can be coated the coating shall be applied for a minimum of two pipe diameters.
   d. Mortar lining shall be allowed to cure 15 days or steam cured not less than 7 days prior to surface preparation of the mortar and epoxy coating application. Hand applied mortar lining shall be allowed to cure a minimum of 15 days or as required to meet the coating manufacturer's requirements for application on cement or concrete, whichever is greater.
   e. Prepared mortar lining by abrasive blasting to remove all laitance and create a suitable anchor profile
   f. Mortar lining shall be dry during epoxy lining application.

3.5 COATING AND LINING HOLDBACK

A. All coating and lining holdback areas shall be prepared as specified for the pipeline coating and protected from corrosion during storage and installation with a specified holdback coating system.

B. Internal holdback for cement mortar lined pipe shall be left unprepared and unprimed.

C. Internal holdbacks for dielectrically lined pipe shall be left bare and prepared and lined in the field as specified for field lining of joints after joint assembly.

D. External holdbacks shall be as listed below with all dimensions based on end of bell or spigot. Pipe manufacturer may adjust holdback limits as required for special joint assemblies, and with consideration for the joint coating provided and joint welding requirements. All dimensions from end of pipe.

Tape wrap coating	
Push-on joint, spigot	1-inch, minimum after centerline of gasket.
Push-on, bell	Flush with bell end
Welded, spigot	1 inches, minimum
Welded, Bell	Stab Depth + 2-inches, minimum

Epoxy coating	
Push-on joint, spigot	1-inch after centerline of gasket
Push-on, bell	Flush with bell end
Welded, spigot	3 inches, minimum
Welded, Bell	Stab Depth + 2-inches, minimum
Extruded polyolefin	
Welded joints, spigot	3-inch Minimum
Welded joints, Bell	Stab Depth + 2-inches, Minimum
Push-on joints	Not applied to bell or spigot

E. Coating holdbacks shall be straight and cut through the full thickness of the coating.

F. Cutbacks shall be completed in a manner that permits field coating of joints in accordance with the manufacturer's recommendations and as specified herein.

3.6 FIELD COATING JOINTS

A. General:
   1. Joint bonds shall be installed before application of joint coating as specified in Section 26 42 14, CORROSON MONITORING.
   2. Joint bonds shall be low profile bonds and all gaps and crevices around the bonds shall be filled with filler mastic.
   3. Filler mastic shall be placed under copper strap bonds and extended ½ inch minimum beyond edges of bond to allow for sealing with heat shrink sleeve.
   4. Contractor to electrically test completed joint coating for holidays with high voltage spark tester at Engineer's direction or if damage to the joint coating occurs.

B. Field Surface Preparation:
   1. Pipe joints with hold back corrosion protection:
      a. Perform salt contamination removal as specified under Surface Preparation.
      b. Field prepare joint in accordance with SSPC-SP1, solvent cleaning, and SP3, Power tool cleaning, to remove all dirt, mud, oil, and grease prior to application of heat shrink sleeve.
      c. Any visible rusting areas shall be spot prepared in accordance with SP-11, power tool to bare metal.
   2. Pipe joints without hold back corrosion protection:
      a. Perform salt contamination removal as specified under Surface Preparation.
      b. Abrasively blast joint in field in accordance with SSPC-SP5, white metal blast.
      c. Sweep blast epoxy coating for 2-inches for 80-grit sandpaper equivalent profile for coating adhesion.
   3. All loose or damage coating shall be removed and repaired per specified coating repair procedures.

C. Weld After Backfill' Joint Requirements:
   1. Post-welded or 'Weld after Backfill' joints are defined as welded pipe joints that have been coated and backfilled prior to completing interior welds.
   2. Post welded joints shall be coated and protected as follows:
      a. Joint coating shall be heat shrink joint sleeves only with a minimum coating thickness over the weld heat affected zone of not less than 120 mils before welding. Tape wrapped joints or heat resistant tape will not be acceptable.
      b. Manufacturer's recommendations for heat shrink sleeves selection and application and this specification shall govern WAB joints. If a conflict occurs, the more stringent requirement shall apply.
      c. Hold back primer shall be suitable for post weld conditions as specified this section and shall not exhibit any binder breakdown in the heat affected zone that causes loss of joint coating adhesion to the holdback primer.
      d. Filler mastic materials shall be high temperature material with 500 degree F melting point.
      e. Joints shall be fully buried prior to welding, with not less than 12-inch soil cover or flowable fill material on all sides. Sand or flowable fill backfill is preferred for weld after backfill joints. Crush rock or angular gravel backfill can be detrimental to the heat shrink sleeve when using WAB procedures.
      f. Heat shrink sleeves after WAB shall exhibit no holidays, burn through of coating, creasing, carbonization of the sleeve adhesive, or disbondment of the sleeve or holdback primer.
   3. Welding of the joints shall be in conformance with Section 33 11 11, Steel Pipe, and as modified herein:
      a. All welding shall be with two or more weld passes as required to meet the specified AWS qualified welding procedures and maximum coating temperature limitations. 'Weld after Backfill' procedures on wall thicknesses of ¼ inch or less must be approved by the Engineer based on field testing demonstrating the welding procedures can comply with the requirements of this specification.
      b. Welding speed, amperage, and voltage shall be as required to maintain a maximum heat input of 23,000 joules or a maximum surface temperature at the coating/steel interface of 750 degrees F, whichever is least.
      c. Maximum weld temperature and duration shall not result in carbonization of the joint coating adhesive. Carbonization is defined as the loss of volatile organic compounds that result in loss of tackiness, adhesion to the steel, and corrosion protection properties.
      d. Finished joint coating shall not have any visual creases or folds in the joint coating backing material that extends through both the inner protective layer and outer joint sleeve.
   4. If Contractor elects to post-weld any joints, Contractor shall demonstrate that the joint welding procedures will not significantly damage the coating by fully excavating the first two joints for evaluation of the joint coating condition. Engineer will randomly select up to three additional post-welded joints for excavation by Contractor for evaluation of joint coating condition. Joint coating will be destructively evaluated by the Engineer. Contractor will remove and replace joint heat shrink sleeve upon completion of the evaluation.
   5. If any excavated post welded joint exhibits any heat related damage as defined herein, Contractor shall modify and test a new post welding procedure prior to

completing any additional post-welded joints. Contractor shall demonstrate that the revised joint welding procedure will not significantly damage the coating by repeating the weld after backfill evaluation requirements defined this Section, including excavation of the three additional randomly selected joints for destructive evaluation.

D. Heat Shrink Sleeve Joint Coating:
   1. Store, handle, and apply field heat shrink sleeve coatings in accordance with AWWA C216 and these specifications.
   2. Store sleeves in shipping box until use is required. Keep dry and sheltered from exposure to direct sunlight. Store off the ground or concrete floors and maintain at a temperature between 60 and 100 degrees as recommended by the sleeve manufacturer.
   3. Joint shall be prepared as specified in Pipe Joint Surface Preparation.
   4. Preheat pipe uniformly as recommended by the sleeve manufacturer. Monitor pipe temperature using a surface temperature gauge, infrared thermometer, or color changing crayons. Protect preheated pipe from rain, snow, frost, or moisture with tenting or shields and do not permit the joint to cool.
   5. Apply filler material as specified in Field Applied Coating Systems.
   6. Apply heat shrink sleeve when sleeve has a minimum temperature of 60 degrees and while maintaining the pipe temperature above the preheat temperature specified. Apply sleeve in accordance with the manufacturer's instructions and center the sleeve over the joint to provide a minimum 2-inch overlap onto the existing pipe coating.
   7. Acceptable joint sleeve installations shall meet the following requirements:
      a. Shall be fully bonded to the pipe and existing coating surface without tenting or voids.
      b. Mastic beading shall be visible along the full circumference of the sleeve.
      c. There shall be no wrinkling or excessive burns on the sleeves.
   8. Sleeves that do not meet these requirements shall be removed and the joint recoated as directed by the Engineer. Minor repairs may be repaired using heat applied patch material specified for minor coating repairs.
   9. Allow the sleeve to cool before backfilling. Water quenching will be allowed if permitted by the sleeve manufacturer.
   10. Heat shrink joint coatings which have become wrinkled or disbonded because of prolonged exposure to UV light or thermal cycling shall be removed and replaced.
   11. Double coating of defective or damaged heat shrink coatings will not be permitted. Any double coated heat shrink sleeves shall be immediately rejected and Contractor shall remove the existing coating and recoat the joint.

E. Cement Mortar Overcoat Coating:
   1. Joints of cement mortar coated pipe shall be cement mortar coated in accordance with AWWA C205.
   2. Polyethylene Foam Joint Diapers:
      a. Cut into strips wide enough to match uncoated field joint area.
      b. Slit to thickness of 1/4 inch that will expose a hollow or open cell surface on one side.
      c. Foam liner shall be attached to fabric backing with open or hollow cells facing towards pipe.

d. Foam strip shall cover full interior circumference of grout band with sufficient length to permit 8-inch overlap of foam at or near top of joint.
e. Splices to provide continuity of material will be permitted.
f. Protect polyethylene foam material from direct sunlight.

3. Field repair cement mortar coating in accordance with AWWA C205.

3.7 FIELD APPLIED INTERIOR JOINT LINING

A. Mortar Lining:
1. After backfilling pipe, interior joint recess shall be filled with grout.
2. The grout shall be tightly packed into the joint recess and troweled flush with the interior surface. Excess material shall be removed from pipe.
3. At no point shall there be an indentation or projection of the mortar exceeding 1/16-inch.
4. On pipe smaller than 24-inches in diameter, bell shall be daubed with grout before the spigot is inserted into the bell. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed.

3.8 REPAIR OF COATING AND LININGS

A. General:
1. All areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects, shall be repaired. Areas where no holidays are detected, but are visually damaged shall also be repaired.
2. Maximum defects allowable shall be as specified herein for the coating system.

B. Tape Wrap Coating Repairs:
1. General:
a. No more than five repairs per joint of pipe will be permitted with tape wrap coating, excluding adhesion test damage. The coating on any pipe with more than five coating repairs or with more than two areas of coating damage greater than five square feet will be rejected.
b. Pipes exceeding the maximum number or size of coating defects shall be stripped, reblasted, and recoated.
c. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the Contractor's expense.
d. The number of layers and total thickness of the tape repair coating shall be the same as the shop-applied coating; unless heat applied coating materials is used.
e. Wipe the area to be repaired with solvent for a minimum distance of 4 inches outside the damaged area.
2. Defect Size:
a. Minor repairs - repairs that are less than 8 inches in the greatest dimension, measured after cutout of damaged tape layers. Damage to the inner tape layer will be considered minor only if repairs are made using heat applied patch materials.

b. Major repairs - repairs that exceed 8-inches in the greatest dimension or where damage to the inner tape layer has occurred and hand applied tape repairs will be used.

3. Minor Repairs:
   a. Complete minor repairs using a heat applied coating patch material.
   b. Cut patch material to overlap onto the undamaged coating a minimum of 2 inches on all sides with 1-inch radius on each corner of the patch.
   c. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
   d. Cut middle and outer layers in stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.
4. Major Repairs (Over 24-inches Diameter):
   a. Cigarette wrap coating repairs shall be with heat shrink sleeves as specified for joints.
   b. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
   c. Holiday test the inner wrap and if a holiday is detected cut outer layers back to fully exposed the holiday(s) and retest for holidays.
   d. Cut middle and outer layers in stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.
   e. Width of sleeve shall be the width of the damaged area plus 4-inch overlap. Multiple sleeves may be used for larger repairs, but must be overlapped a minimum of 2 inches.
5. Major Repairs (24-inch Diameter or Less)
   a. Cigarette wrap repairs on pipe less than 24-inches with either hand applied tape wrap or heat shrink sleeves as specified at the Contractor's option.
   b. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
   c. Holiday test the inner wrap and if a holiday is detected apply one extra layer of repair tape.
   d. Clean surfaces by solvent wiping and applying primer over the inner tape layer for a minimum of 6-inches onto the outer wrap in all directions.
   e. Apply first layer of repair coating, over lapping 1-inch or more onto undamaged coating in all directions. On larger areas, lap the repair tape within a minimum of 1-inch overlap, offsetting the overlap from the previous layer overlap, until the area is properly covered.
   f. Repeat for each tape layer damaged with each succeeding layer applied at 90 degrees to the preceding layers and overlapping onto the undamaged coating a minimum of 2-inches.
   g. Apply the last tape layer, use the cigarette wrap method for the full pipeline circumference covering all previous repair layers and overlapping a minimum of 2-inches onto undamaged coating. The ends of the cigarette wrap shall be pointed downward.

C. Epoxy Coating or Lining Repairs
   1. General
      a. Complete coating or lining repairs in accordance with the coating manufacturers written instructions and these specifications, whichever is stricter.

2. Defect Size:
    a. Minor repairs - repairs that are less than 8-inches in the greatest dimension.
    b. Major repairs - repairs that exceed 8-inches in the greatest dimension.
3. Maximum Quantity of Defects Allowed:
    a. Coating or lining repairs on any joint of pipe shall not exceed 1.5 per 100 square feet of surface area.
        (1) Two or more minor repairs within a 8-inches diameter circle will be considered a single repair.
        (2) Repairs for adhesion testing will not be included in the total number of repairs.
    b. Major repairs shall not exceed three per pipe joint and the combined area shall not be greater than 30 percent of the pipe.
    c. Pipes exceeding the maximum number or size of coating defects shall be stripped of coating, reblasted, and recoated.
    d. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the contractor's expense.
4. Minor Repairs:
    a. Minor repairs
        (1) Surface Preparation: Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coat and feather the edges of the defect for a minimum of 2-inches around the defect.
        (2) Shop repair Materials:
            (a) Single use coating kits to match the pipe coating.
            (b) Two component, fast cure epoxy coating, in controlled mix ratio packaging.
                a) Protal 7125, North American Denso Inc, or equal
                b) Or equal.
            (c) Coating Manufacturer's coating repair products are subject to Engineer approval.
        (3) Field Repair Materials:
            (a) Heat applied coating materials; CRP Patch, Canusa; PERP Patch, Tyco Adhesives, or approved equal.
            (b) Two component, fast cure epoxy coating, in controlled mix ratio packaging.
                a) Protal 7125, North American Denso, Inc,
                b) Or equal.
            (c) Single use coating kits to match pipe coating.
            (d) Coating Manufacturer's coating repair products are subject to Engineer approval.
        (4) Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coating and feather defect edges minimum of 2-inches.
        (5) Apply a single coat of the specified patch coating material at the specified coating thickness.
        (6) Repair coating adhesion shall be 50 percent of the specified coating adhesion.
5. Major Repairs:

a. Major repairs:
   (1) Surface Preparation:
      (a) The metal surface and surrounding coating shall be abrasively blasted in accordance with SSPC-SP10, near white metal, or to equal in cleanliness and profile as the original surface preparation.
      (b) Existing coating shall be feathered and roughened to the equivalent of 40 grit sandpaper.
   (2) Shop Repair Materials:
      (a) Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.
   (3) Field Repair Materials:
      (a) Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.
      (b) Heat shrink sleeves as specified for pipeline joints.
b. One coat of the specified original coating material shall be applied over the repaired surface at the specified thickness.
c. Repair adhesion shall be equal to the specified coating adhesion.

D. Cement Mortar Coating
1. Cement mortar coating that is cracked or disbonded shall be repaired in accordance with AWWA C205, except for mortar overcoat on tape wrapped steel.
2. Disbonded mortar coating shall be removed and patched.
3. Mortar coating with disbondment greater than 25 percent of the pipe surface shall be rejected and recoated.
4. Cracks in mortar coating shall be repaired in accordance with AWWA C205.

3.9 QUALITY CONTROL TESTING AND INSPECTION

A. General
1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
2. Quality control testing as specified in AWWA standards are minimum industry standards and it is the intent of this specification to provide a higher level of quality control for the objective of achieving maximum coating performance. If any conflict between this specification and referenced standards occurs, the more stringent requirement shall apply and any interpretation of this requirement or results shall be with the objective of achieving maximum coating performance.
3. The frequency of the testing shall be determined by the applicator, but shall not be less than the requirements of this specification.

B. Soluble Salt Contamination (SSC) Testing
1. Residual soluble salt contamination (SSC) shall be verified using an Elcometer Model E130-TC Salt Contamination Meter before and after surface preparation.
2. Testing after blasting is not required if the preblast test passes the maximum soluble salt contamination criteria.
3. Maximum soluble salt contamination levels shall be:
   a. 2.0 $\mu g/cm^2$ – Immersion or buried
   b. 5.0 $\mu g/cm^2$ – non-immersion

4. Compliance with SSC limits shall be based on the average of three tests at three locations, which can be on multiple pipes or components at the Engineer's discretion.

C. Surface Profile Testing
   1. Surface profile of abrasive blasted surfaces to be tested with "Press-O-Film" tester tape or equivalent in accordance with NACE RP287.
   2. Tester tape shall be suitable for the intended profile height.
   3. Profile shall be measured to a minimum tolerance of 0.1 mils, maximum.
   4. Electronic surface profilometer shall be used, where deemed necessary, to verify tester tape measurements.

D. Adhesion Testing
   1. General
      a. Adhesion testing shall be conducted at the shop prior to shipment. Pipe shipped without adhesion testing will be field-tested. Pipe rejected in the field will be returned to the shop for repair at the sole expense of the Contractor.
      b. Coating adhesion testing shall be conducted on each pipe lot coated. The quantity of coating adhesion tests shall be the greater of the following:
         (1) Two pipes will be tested for the first 3,000 square feet of coating application plus on additional pipe for each. increment of 2,000 square feet of coating application in excess of the first 3,000 square feet
         (2) Not less than 33 percent of each pipe produced within a lot.
      c. A pipe lot is defined as the quantity of pipe that is coated by a single crew within a 12 hour or less work shift.
      d. The pipe coating applicator shall repair all coating damage from shop adhesion testing. Contractor shall be responsible for coating repairs for all field adhesion testing.
      e. Adhesion tests will be performed not less than 24 hours after coating application. Tests conducted prior to 24-hours will be acceptable only if the test meets or exceeds the adhesion criteria specified and the test was requested by the pipe fabricator.
      f. Pipe will be randomly selected for adhesion testing.
      g. Owner or the Owner's Representative has the right to conduct additional adhesion testing as deemed necessary to assure the pipe meets or exceeds the requirements of this specification at any time and location.
      h. Prior to beginning any QA/QC testing, the pipe fabricator, coating manufacturer, and Engineer shall review dolly attachment procedures, adhesion test procedures, and data recording requirements for the project and ensure that test personnel are qualified and capable of performing the testing in accordance with required test standards and these specifications.
   2. Rejection of Pipeline Coating or Lining
      a. Each pipe that fails the adhesion criteria, as defined this section, shall be rejected.
      b. If any pipe within a lot that fails to meet the adhesion criteria specified for the coating type, the pipe coating will be rejected and all pipes within the lot will be classified as rejected. Each remaining pipe within the rejected pipe lot will then be individually tested and rejected on a pipe-by-pipe basis in

conformance with the test procedures and criteria specific to the coating type.

c. All rejected pipe shall have the coating fully removed from the pipe and the pipe abrasive blasted and recoated.

3. Tape Coating Adhesion Testing:
   a. Adhesion Acceptance Criteria:
      (1) Inner tape coating shall have an adhesion to substrate of 20 pounds per inch width, minimum, for steel pipe when tape is pulled in a continuous manner at an angle of 180 degrees to the pipe surface.
      (2) Inner tape coating shall have an adhesion to substrate of 15 pounds per inch width, minimum, for ductile iron pipe when tape is pulled in a continuous manner at an angle of 180 degrees to the pipe surface.
      (3) extruded polyolefin coating shall have an adhesion to substrate of 30 pounds per inch width, minimum, when coating is pulled in a continuous manner at an angle of 180 degrees to the pipe surface. Adhesion testing for extruded polyolefin shall be performed as specified for tape wrap coating.
   b. Test Procedures
      (1) Adhesion testing shall be conducted prior to application of the cement mortar overcoat, where applicable. Pipe that has been mortar coated prior to adhesion testing shall have the mortar coating removed by the Contractor as directed by the Engineer and of sufficient dimensional area to permit the adhesion test to be conducted.
      (2) Adhesion tests shall be conducted at temperatures above 60 degrees and less than 75 degrees.
      (3) Pulling tension shall be continuous, without stopping, and monitored throughout the length of the pull, which shall be not less than 12-inches in length.
      (4) Adhesion test shall be prepared by making two parallel cuts through the coating, 1-inch apart, of sufficient length for the test pull. Peel the coating back at one end and attach the tension scale to the coating with a suitable clamp. Mark the coating at one (1) inch increments from 0 to 12-inches.
      (5) The pull tension shall be recorded for each inch of pull. The two highest and two lowest readings shall be discarded and the remaining values averaged. Pull speed shall be not less than 5 seconds per inch or greater than 10 seconds per inch. If significant elongation of the tape backing occurs, pull speeds may exceed 10 seconds per inch provided the minimum adhesion rating can still be achieved.
   c. Adhesion Pull Records and Evaluation
      (1) Failure shall be by cohesive failure of the adhesive only. Delamination failure, defined as separation of the adhesive from the backing material, will result in rejection of the tape lot.
      (2) Intermittent skip failures will be counted as zero pounds of adhesion and included in the calculations for average coating adhesion.
      (3) Adhesive failure, defined as separation of the adhesive from the metal substrate, will be rejected.
      (4) Pipe that fails the test by delamination will be retested on two other pipes within the same lot of coated pipe. Failure of any two pipes within

the lot will result in rejection of all pipes coated with the rejected tape lot.

4. Plural Component Epoxy Adhesion Testing:
   a. Adhesion testing shall be performed in accordance with this specification section. Adhesion testing procedures and evaluations per AWWA C210 or C222 are specifically excluded under this specification.
   b. Test Procedures
      (1) Coating adhesion testing shall be with self-aligning pneumatic pull off equipment, such as the Delfesko Positest AT-A, and test procedures in accordance with ASTM D4541, except as modified in this section.
         (a) All adhesion tests shall be performed at an applied load rate of 100 psi per second, plus or minus 10 psi. Automatic adhesion test equipment shall be used.
         (b) Tests shall be performed to coating or glue failure or maximum test load, whichever is greater.
         (c) Adhesion tests shall be based on the ASTM D4541 using standard 20 mm dollies.
         (d) Adhesion testing shall be based on three tests. All three tests shall be conducted by the same person, test equipment, and test procedure, and must be completed within a 30 minute period.
         (e) All adhesion tests shall be conducted within an area not to exceed 6-inches by 6-inches.
         (f) All coatings with more than 10 percent elongation or 25 mils thick shall be scored around dolly to metal substrate using manual methods and tools, normal to the pipe surface, and in a manner that does not stress or over heat the coating.
         (g)
         (h) All adhesion tests shall be performed to coating or glue failure or test termination, whichever comes first.
      (2) Dollies for adhesion testing shall attached to the coating surface using an two part epoxy or cyanoacrylate glue and allowed to cure for a minimum of 12 hours before testing or until full cure, whichever is greater. Glue type used shall be determined by the pipe fabricator and coating manufacturer for the pipe diameter, temperatures, and environmental conditions.
      (3) Adhesion testing shall be performed at temperatures between 55 and 90 degrees F or at temperatures as recommended by the coating manufacturer. Testing up to 115 degrees F or below 55 degrees will be permitted if tests can demonstrate no statistically detectable effect on test results and with coating manufacturer and Engineer approval.
   c. Epoxy Coating and Lining Adhesion Criteria
      (1) Coating is acceptable if first dolly pull test exceeds 1,750 psi, minimum.
      (2) If first dolly pull is less than 1,750 psi, two additional tests shall be performed with acceptance based on “Best of Three” evaluation method as defined herein.
   d. Pipe Lot Performance Criteria:
      (1) Each lot of coated pipe shall be evaluated for general coating application based on a median value for all coating or lining adhesion tests performed on a lot of pipe, which shall be greater than 2,000 psi.

(2) Any pipe lot failing the Pipe Lot Performance Criteria shall be classified as rejected until 100 percent of the pipe within the pipe lot has been tested for adhesion. Each pipe that fails the coating adhesion criteria shall be rejected.

e. Adhesion Test Evaluation and Records
   (1) The "Best of three" evaluation method shall be defined as two of three test values less than the Acceptance Criteria, which shall result in rejection of the pipe coating.
   (2) All adhesion tests shall be considered as valid and suitable for acceptance or rejection of the coating, except where retesting is allowed.
   (3) Adhesion test failure shall be by adhesive or substrate and cohesive failure as defined below:
      (a) Adhesive or substrate failure is defined as a percentage of separation of the coating from the steel substrate or between distinct coating layers.
      (b) Cohesive failure is defined as a percentage of failure within the coating, resulting in coating remaining both on the steel substrate and test dolly.
   (4) Retesting of coating adhesion tests will be allowed when any test is glue failure at 25 percent or more of dolly surface area and the test value is less than the Acceptance Criteria or the Minimum Criteria.
   (5) All coating adhesion retesting shall be within the same 6-inch by 6-inch test area as the original adhesion testing.
   (6) Disputed adhesion tests shall be retested as defined for adhesion retesting. Dolly attachment and adhesion retesting shall be witnessed by the Owner's representative.
   (7) Adhesion tests will be conducted on pipe coating and lining independently and will be accepted or rejected independently.
   (8) Records of all adhesion tests shall be maintained in an electronic spreadsheet that includes the following information:
      (a) Pipe identification,
      (b) Pipe coating date,
      (c) Adhesion test date,
      (d) Surface tested (interior or exterior),
      (e) Surface temperature at time of test,
      (f) Coating thickness,
      (g) tensile force applied,
      (h) Applied load rate per second,
      (i) Mode of failure, and
      (j) Percentage of failure types, previously defined, relative to dolly surface area,
      (k) Dolly size and attachment glue used.
      (l) If different coatings are tested, the records shall include coating manufacturer and product number.

f. Adhesion Test Repairs
   (1) Fabricator or contractor to complete adhesion repairs as specified this section.
   (2) Repair patches on epoxy coating shall be randomly selected for adhesion testing in a manner as described herein and at the discretion of the

coating inspector conducting the adhesion tests. Adhesion of repairs shall be as specified for the type of repair.

E. Holiday Testing
   1. Holiday test the inner layer of tape wrap coatings after application and prior to subsequent tape layer in accordance with AWWA C214 and NACE RP-0274.
   2. Holiday test extruded polyolefin coating after application in accordance with AWWA C215 and NACE Standard RP-0274, whichever is more stringent.
   3. Holiday tests on epoxy coatings or linings over 15 mils DFT shall be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE SP0274 and these specifications.
   4. Holiday testing on epoxy coatings or linings less than 15 mils DFT shall be high voltage spark tested in accordance with NACE SP0188, except as modified herein.
   5. High voltage setting shall be the average measured coating thickness in mils times 125 volts, minimum.
   6. Wet sponge or low voltage holiday testing will not be permitted.

F. Dry Film Thickness Testing
   1. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off, eddy current, or ultrasonic equipment.
   2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

G. Salt Contamination Testing
   1. Engineer shall perform salt contamination testing with an Elcometer Model E130-TC Salt Contamination meter as defined under Surface Preparation.
   2. Quantity of tests performed shall be determined the Engineer based on prevailing field conditions.
   3. Objective is to assess and remove wind borne salts contamination on surfaces to be coated. Because wind and environmental conditions can change the frequency and location of testing may need to be varied.
   4. At a minimum, tests should be performed daily before and after pressure washing of surfaces to be coated.
   5. Surfaces identified to be excessively contaminated shall be cleaned by the Contractor to meet the acceptance criteria specified under Surface Preparation.

3.10 HANDLING, TRANSPORTATION, AND STORAGE

A. Pipe shall be handled in such a manner as to protect the pipe and coating from damage.

B. Coated pipe shall not be shipped or installed until coating has developed full adhesion and cure.

C. During coating application, storage, loading, transportation, unloading, laying and installation, every precaution shall be taken to protect and prevent damage to pipe, lining, and coating. Forklift equipment shall have all bearing surfaces padded with suitable padding material. Lift pipe with web slings a minimum of 12-inch wide and of

a type that will not damage the coating. Metal chains, cable, tongs, forklifts or other equipment likely to damage the coating will not be permitted. Dragging or skidding of pipe on grade or in the trench will not be permitted.

D. Provide transportation vehicles with padded bolsters between each layer of pipe and heavy padding under load ties. Bolsters shall be curved to fit the outside of the pipe and 12 inches wide, minimum. All pipe contact locations shall be heavily padded with carpet and strips of the outer tape wrap material (adhesive side against the carpet) during shipment to the project site and from the storage yard to the point of installation.

E. Pipe shall not be stored on rocks, gravel, or other hard materials that might damage the coating. Provide padded 12-inch wide skids and chucks, sand bags, select loamy or sand berms, or suspended from cutback ends, where possible, to minimize coating damage. Pipe shall not be laid on asphalt without suitable padding at all contact points.

F. Pipe shall be inspected by the Contractor at the project site for damage. Any damage to the pipe, lining, or coating shall be repaired as directed if, in the opinion of the Engineer, a satisfactory repair can be made; otherwise, the damaged section shall be replaced at the sole expense to the Contractor.

G. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk on the coating except when necessary and approved by the Engineer. When permitted, shoes with rubber or composition soles and heels or other suitable footwear that will not damage coating shall be used.

H. Long-term Exposure:
   1. Pipe shall either be provided with UV inhibitor for lengthy of above grade exposure or covered to prevent UV degradation of outer wrap.
   2. Amount of UV stabilizers required will depend on the project location, laying schedule, anticipated length of exposure, and type of coating.
   3. Manufacturer shall be consulted for recommended UV inhibitors requirements.
   4. Protective covering can be colored plastic sheeting, canvas, or other UV blocking material. Clear plastic sheets are not acceptable.
   5. Areas of coating that display UV degradation shall be removed and repaired at sole cost of the Contractor.

END OF SECTION

DIVISION 10
SPECIALTIES

SECTION 10 44 13
FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install fire protection cabinets for the following:
   1. Portable, hand-carried fire extinguishers.

1.2 RELATED SECTIONS

A. Section 10 44 16 Fire Extinguishers

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM A1008	Specification s for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM D4802	Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet

B. National Association of Architectural Metal Manufacturer's (NAAMM) standards, most recent editions:

AMP 500	Metal Finishes Manual

C. National Fire Protection Association (NFPA) standards, most recent editions:

NFPA 70	Standard for Electrical Safety in the Workplace and Handbook

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: Furnish for each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for cabinets.
   1. Include rough-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

C. Shop Drawings: Furnish drawings for fire protection cabinets indicating plans, elevations, sections, details, and attachments to other Work.

D. Operation and Maintenance Data: Submit operation and maintenance data suitable for inclusion in facility operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: When such are used, listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Delivery Schedule: For fire protection cabinets, coordinate final fire extinguisher cabinet schedule with fire extinguisher schedule to ensure proper fit and function.

C. Acceptance at Site: Inspect all boxes and packages upon delivery to the Project Site. Notify Engineer, in writing, if any loss or damage exists to products or components. Replace loss and repair damage to new condition in accordance with manufacturer's original specifications and specific instructions.

1.7 COORDINATION

A. Coordinate type and capacity of fire protection cabinets with fire extinguishers to ensure fit and function.

B. When fire protection cabinets are to be recessed into walls, coordinate sizes and locations of cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with Contract Documents, the following manufacturers are acceptable:
   1. Fire Extinguishers:
      a. Amerex Corporation.
      b. J.L. Industries, Inc.
      c. Larsen's Manufacturing Company.
      d. Potter Roemer, LLC.
      e. Engineer approved equal.

2.2 MATERIALS

A. Steel Sheet: ASTM A1008, Commercial Steel (CS), Type B.

B. Stainless Steel Sheet: ASTM A666, Type 304

C. Transparent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), 1/4 inch, with Finish 1 (smooth or polished).

2.3 FIRE PROTECTION CABINET

A. Cabinet Type: Surface mounted, suitable for fire extinguisher.

B. Cabinet Construction: Non-rated.

C. Cabinet Material: Stainless Steel sheet.

D. Trim Style: Rounded edges, stainless steel sheet.

E. Identification: Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
   1. Location: Applied to cabinet door:
   2. Application Process: Engraved or decal.
   3. Lettering Color: Black or Red.
   4. Orientation: Vertical.

F. Door Style: Vertical duo panel with frame.

G. Door Glazing: Clear transparent acrylic sheet.

H. Door Hardware
   1. Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
   2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

2.4 FABRICATION

A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.
   2. Provide factory-drilled mounting holes.
   3. Prepare doors and frames to receive locks.
   4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 FINISH

A. General
   1. Comply with NAAMM's AMP 500 for applying and designating finishes.
   2. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping,
   3. Finish fire protection cabinets after assembly.

4. Notable variations in finish of same piece are not acceptable. Variations in appearance of adjoining components are acceptable if approved by Engineer and they are assembled or installed to minimize contrast.

B. Stainless Steel Finishes
   1. Surface preparation: Remove tool and die marks and stretch lines, or blend into finish.
   2. Grind and polish surfaces to produce uniform finish, free of cross scratches
      a. Directional satin finish, No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.

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

3.2 PREPARATION

A. Prepare recesses for recessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. Install fire protection cabinets in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Fasten cabinets to structure, square and plumb, at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory finished appearance, subject to approval of Engineer. Use only materials and procedures recommended or furnished by fire protection cabinet manufacturer.

E. At direction of Engineer, replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install portable, hand-carried fire extinguishers.

1.2 RELATED SECTIONS

A. Section 10 44 13 Fire Extinguisher Cabinets

1.3 REFERENCES

A. National Fire Protection Association (NFPA) standards, most recent editions:

NFPA 10	Portable Fire Extinguishers

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: Furnish for each type of product indicated. Include information on rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguishers.

C. Operation and Maintenance Data: Submit operation and maintenance data suitable for inclusion in facility operation and maintenance manuals.

D. Warranty Documentation: Submit sample of manufacturer's warranty.

1.5 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10.

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

C. UL Listing: Provide fire extinguishers with UL Rating as noted for each type and size.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Delivery Schedule: For fire extinguishers, coordinate final fire extinguisher schedule with fire extinguisher cabinet schedule to ensure proper fit and function.

C. Acceptance at Site: Inspect all boxes and packages upon delivery to the Project Site. Notify Engineer, in writing, if any loss or damage exists to products or components. Replace loss and repair damage to new condition in accordance with manufacturer's original specifications and specific instructions.

1.7 COORDINATION

A. Coordinate type and capacity of fire extinguishers with Fire Protection Cabinets to ensure fit and function.

1.8 WARRANTY

A. Special Warranty: Provide manufacturer's stand form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within warranty period.

B. Failures include, but are not limited to, the following:
   1. Failure of hydrostatic test according to NFPA 10.
   2. Faulty operation of valves or release levers.

C. Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with Contract Documents, the following manufacturers are acceptable:
   1. Fire Extinguishers:
      a. Amerex Corporation.
      b. J.L. Industries, Inc.
      c. Larsen's Manufacturing Company.
      d. Potter Roemer, LLC.
      e. Engineer approved equal.

2.2 FIRE EXTINGUISHERS

A. Provide only new extinguishers of type, size, and capacity for each fire extinguisher cabinet and mounting bracket indicated.

B. Multipurpose Dry-Chemical in Steel Container: UL-rated 4A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

C. Valves: Manufacturer's standard.

D. Handles and Levers: Manufacturer's standard.

E. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Provide manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
      a. Orientation: Vertical

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine surfaces, areas, and finishes for compliance with conditions affecting fire extinguisher mounting.

B. Preinstalling Testing: Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers

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

3.2 INSTALLATION

A. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

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DIVISION 11
EQUIPMENT

SECTION 11 00 00
EQUIPMENT GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing, and operation of all equipment and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise indicated.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as indicated in each Section of these Specifications:

American Gear Manufacturers Association (AGMA).

American Society for Testing and Materials (ASTM).

American Public Health Association (APHA).

American National Standards Institute (ANSI).

American Society of Mechanical Engineers (ASME).

American Water Works Association (AWWA).

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).

Mechanical Power Transmission Association (MPTA).

American Welding Society (AWS).

National Fire Protection Association (NFPA).

Federal Specifications (FS).

National Electrical Manufacturers Association (NEMA).

Manufacturer's published recommendations and specifications.

General Industry Safety Orders (OSHA).

Rubber Manufacturers Association (RMA).

B. The following standards have been referred to in this Section of the Specifications:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys
ANSI B46.1	Surface Texture
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ANSI/ASME B1.20.1	General Purpose Pipe Threads (Inch)
ANSI/ASME B31.1	Power Piping
ANSI/AWWA D100	Welded Steel Tanks for Water Storage
AWWA C206	Field Welding of Steel Water Pipe
ASTM A 48	Specification for Gray Iron Castings
ASTM A 108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall furnish complete shop drawings for all equipment specified in the various Sections, together with all piping, valves, and controls for review by the Engineer in accordance with Section 01 33 00 - Contractor Submittals.

B. Tools: The Contractor shall supply one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. All tools shall be of best quality hardened steel forgings with bright, finish wrench heads shall have work faces dressed to fit nuts. All tools shall be suitable for professional work and manufactured by a recognized supplier of professional tools such as Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled tool box of suitable design provided with a hinged cover. For each microprocessor-based equipment system requiring a handhold device for configuration, furnish one handhold device.

C. Spare Parts: The Contractor shall obtain and submit from the manufacturer a list of suggested spare parts for each piece of equipment. After approval, Contractor shall furnish such spare parts suitably packaged, identified with the equipment number, and labeled. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the OWNER only, after expiration of the guaranty period.

D. Torsional Analysis: The Contractor shall submit to the Engineer a torsional and lateral vibration analysis of the following equipment, in accordance with Section 01 33 00 - Contractor Submittals. The analysis has to be performed by a specialist experienced in this type of Work and approved by the Engineer.
   1. All engine drives.
   2. All blowers and compressors with drives of 100 horsepower and over.
   3. All vertical pumps with universal joints and extended shafts.
   4. All other equipment where indicated.
   5. The torsional natural frequency of the drive train must be avoided by plus and minus 25 percent by any exciting frequency of the equipment, throughout the entire operating range.

E. Vibration Analysis: In the bid price the Contractor shall include at least two site visits of the above mentioned specialist, during construction and testing of the equipment, to analyze and measure the amount of equipment vibration and make his written recommendation for keeping the vibration at a safe limit.

F. Operation and Maintenance Manuals: Submit in accordance with Section 01 33 20 – Contractor Submittals.

1.4 QUALITY ASSURANCE

A. Inspection, Startup, and Field Adjustment: The Contractor shall demonstrate that all equipment meets the specified performance requirements. Contractor shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment who shall visit the site to perform the following tasks:
   1. Assist the Contractor in the installation of the equipment.
   2. To inspect, check, adjust if necessary and approve the equipment installation.
   3. To start-up and field-test the equipment for proper operation, efficiency, and capacity.
   4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.
   5. To instruct the Owner's personnel in the operation and maintenance of the equipment. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.

B. Costs: The costs of all inspection, startup, testing, adjustment, and instruction Work performed by said factory-trained representatives shall be borne by the Contractor. The Owner will pay for costs of power and water. When available, the Owner's operating personnel will provide assistance in the field testing.

C. Public Inspection: It shall be the responsibility of the Contractor to inform the local authorities, such as building and plumbing inspectors, Fire Marshall, OSHA inspectors, and others, to witness all required tests for piping, plumbing, fire protection systems, pressure vessels, and safety systems to obtain all required permits and certificates, and pay all fees.

D. Tolerances: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine Work shall in all cases be of high-grade workmanship and finish,

with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30 feet or less in length, and not greater than 1/8-inch for members over 30 feet in length.

E. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:
   1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
   2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
   3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
   4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

F. Manufacturer's Experience: Unless otherwise directed by the ENGINEER, all equipment furnished shall have a record of at least 5 years of successful, trouble free operation in similar applications, from the same manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. High Noise Level Location: The Contractor shall provide one personal hearing protection station, as indicated herein, at each high noise level location. Said locations are defined as follows:
   1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise level requirements for a 2-hour exposure. Where such equipment is separated by a distance of more than 20 feet, measured between edges of footings, each group of equipment shall be provided with a separate hearing protection station.
   2. Indoor Location
      a. Any single equipment item, or any group of equipment items, located within a single room not normally occupied, that produces noise exceeding OSHA noise level requirements for a 2-hour exposure.
      b. Any single equipment item, or any group of equipment items, located within a single room normally occupied by workers, that produces noise exceeding OSHA noise level requirements for an 8-hour exposure.
   3. Personal Hearing Protection: The Contractor shall supply, in their original unopened packaging, three pairs of high attenuation hearing protectors. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, furnished by the Contractor and mounted in an approved location near the noise protection station.

B. Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	Load Classification
Blower:	
Centrifugal or vane	Uniform
Lobe	Moderate Shock
Reciprocating Air Compressor:	
Multi-Cylinder	Moderate Shock
Single-Cylinder	Heavy Shock
Pump:	
Centrifugal or Rotary	Uniform
Reciprocating	Moderate Shock
Mixer:	
Constant Density	Uniform
Variable Density	Moderate Shock
Crane or Hoist	Moderate Shock

C. For service factors of electric motors, see Division 26. Where load classifications are not indicated, best modern practice shall be used.

D. Welding: Unless otherwise indicated, all welding shall conform to the following:
1. Latest revision of ANSI/AWWA D100.
2. Latest revision of AWWA C206.
3. All composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.

E. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

F. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All

sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

G. Protective Coating: All equipment shall be painted or coated in accordance with Section 09 90 00 – Protective Coatings and Linings, unless otherwise indicated. Nonferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

H. Protection of Equipment: All equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage by methods recommended by the manufacturer. All equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided, to prevent accumulation of condensate in gears and bearings.

I. Identification of Equipment Items: Each item of equipment shipped shall have a legible identifying mark corresponding to the equipment number indicated for the particular item.

J. Vibration Level: All equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations.

K. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Engineer-approved shop drawings.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: All equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10 percent of gravity. Submitted design calculations for equipment supports must bear the signature and seal of an Engineer registered in Utah.

B. Equipment Foundations: Equipment foundations shall be as per manufacturer's written recommendations. All mechanical equipment, tanks, and control cabinets shall be mounted on concrete bases as shown on standard structural details.

C. Shop Drawings: Shop drawings shall be submitted to the Engineer for review in accordance with the requirements of Section 01 33 00 – Contractor Submittals. Shop drawings will be considered incomplete unless clear, concise calculations are presented showing equipment anchorage forces and the capacities of the anchorage elements provided by the Contractor.

2.3 PIPE HANGERS, SUPPORTS, AND GUIDES

A. All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with the requirements of Section 40 05 07 - Pipe Supports.

2.4 FLANGES AND PIPE THREADS

A. All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise indicated. All pipe threads shall be in accordance with ANSI/ASME B1.20.1, and with requirements of Section 40 05 00 - Piping, General.

2.5 COUPLINGS

A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed.

B. The CONTRACTOR shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

C. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.

D. Where universal type couplings are shown, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

2.6 SHAFTING

A. General: All shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. All shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.
   1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.
   2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.
   3. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

C. Differential Settlement: Where differential settlement between the driver and the driven equipment may be expected, a shaft of sufficient length with two sets of universal type couplings shall be provided.

2.7 2.7 BEARINGS

A. General: Bearings shall conform to the standards of the AFBMA.

B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.

C. All re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. Bearing Life: Except where otherwise indicated, all bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life (years)*	L-10 Design Life (hours)*
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000
* = Design Life in years or L-10 Design Life in hours, whichever occurs first		

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated, or as recommended in the published standards of the manufacturer if not indicated. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. Sleeve-type bearings shall have a Babbitt or bronze liner.

2.8 GEARS AND GEAR DRIVES

A. Unless otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used, unless specifically approved by the Engineer.

B. All gear speed reducers or increases shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, arranged for easy reading.

C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have two positive seals to prevent oil leakage.

E. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.

F. Where gear drive input or output shafts have to connect to couplings or sprockets supplied by others, the Contractor shall have the gear drive manufacturer supply matching key taped to the shaft for shipment.

2.9 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains and meet ANSI Standards.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.

D. Chain and attachments shall be of the manufacturer's best standard material and suitable for the process fluid.

2.10 SPROCKETS

A. General: Sprockets shall be used in conjunction with all chain drives and chain-type material handling equipment.

B. Materials: Unless otherwise indicated, materials shall be as follows:
   1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.
   2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
   3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.

C. All sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be furnished complete with keyseat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with taper-lock bushings as required.

F. Idler sprockets shall be furnished with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws may be provided in both sides of the hub.

2.11 V-BELT DRIVES

A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.

B. Unless otherwise indicated, sheaves shall be machined from the finest quality gray cast iron.

C. All sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.

D. To facilitate installation and disassembly, sheaves shall be furnished complete with taper-lock or QD bushings as required.

E. Finish bored sheaves shall be furnished complete with keyseat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.12 DRIVE GUARDS

A. All power transmission, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform with the OSHA Safety and Health Standards (29CFR1910). The guards shall be constructed of minimum 10 gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.13 FLEXIBLE CONNECTORS

A. General: Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with Section 40 05 00 - Piping, General.

2.14 INSULATING CONNECTIONS

A. General: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the Section 40 05 00 - Piping, General.

2.15 GASKETS AND PACKINGS

A. Gaskets shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal," or equal.

C. Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the ENGINEER, in accordance with Section 43 20 10 - Pumps, General.

2.16 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.17 SAFETY REQUIREMENTS

A. Where Work areas are located within a flammable or toxic gas environment, suitable gas detection, ventilating, and oxygen deficiency equipment shall be provided. Workers shall be equipped with approved breathing apparatus.

2.18 OVERLOAD PROTECTION

A. General: Unless otherwise indicated in individual equipment Sections, all equipment drives incorporating overload protection shall be provided with an overload protection device.

B. Mechanical Torque Monitoring System: The overload protection shall be a mechanical device to provide for reliable protection in the event of excessive overload. It shall be a ball detent type designed for long term repeatability and life. It shall be infinitely adjustable by a single adjusting nut. Once set it shall be tamperproof, and incorporate a torque monitoring and control system. It shall activate an alarm set for 85 percent, and a motor cutout switch set for 100 percent of maximum continuous running torque. A visual torque indication shall be provided and oriented so that it may be read from the walkway. The dial shall be calibrated from 0 to 100 percent of maximum continuous running torque. The design of the torque limiter should initiate the mechanical disengagement of the drive upon overload. Each unit shall be suitable for outdoor/corrosive environments with a protective finish, corrosion inhibiting lubricants and a stainless steel cover.

C. Electronic Torque Monitoring System:
   1. As an alternative to the mechanical system, the overload protection may be an Electronic Torque Monitoring Control System capable of displaying torque, rpm's, one level of overload, and two levels of overload of the drive system. It shall incorporate a time-delay for start-up and a voltage monitoring and compensation circuit for up to $\pm$15 percent variation.
   2. The overload device shall be housed in an enclosure with NEMA rating in accordance with the area designations of Section 26 00 00 - Electrical General Provisions. A visual torque dial shall be provided and oriented so that it can be easily read from the walkway.
   3. The torque monitoring system shall be calibrated to: alarm and shut down the system in the event the torque drops to 50 percent of normal running; alarm at 85 percent of maximum continuous running torque and shut down the motor at maximum continuous running torque of the equipment. The system shall be calibrated at the factory of the equipment manufacturer and it shall be capable of monitoring twice the maximum continuous running torque of the equipment.

D. Manufacturers, or Equal
   1. American Autogard Corporation;
   2. Ferguson Machine Company.

PART 3 - EXECUTION

3.1 COUPLINGS

A. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application; installation shall be per equipment manufacturer's printed recommendations.

3.2 INSULATING CONNECTIONS

A. All insulating connections shall be installed in accordance with the manufacturer's printed instructions.

3.3 PIPE HANGERS, SUPPORTS, AND GUIDES

A. Hangers, supports, seismic bracing and guides shall be spaced in accordance with ANSI/ASME B.31.1 standard, and with tables in Section 40 05 07 - Pipe Supports.

3.4 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate with subcontractors all necessary space and structural requirements, clearances, utility connections, signals, and outputs.

B. If the packaged system has any additional features (for example, safety interlocks), other than indicated, the Contractor shall coordinate such features with the Engineer and furnish all material and labor necessary for a complete installation as required by the manufacturer, at no additional cost to the Owner.

END OF SECTION

DIVISION 13
SPECIAL CONSTRUCTION

SECTION 13 66 50
BLADDER SURGE TANKS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes: HYDROPNEUMATIC BLADDER STYLE SURGE TANKS.

B. Related Sections:
1. Section 01 33 00 – Contractor Submittals
2. Section 09 90 01 – Protective Coatings
3. Section 40 05 10 – Mill Piping

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. A 36 - Specification for Structural Steel.

B. American Society of Mechanical Engineers (ASME):
1. ASME Code – Latest revision of Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels, Division 1.

C. Code of Federal Regulations (CFR):
1. 49 CFR 173.315 - Code of Federal Regulations, Part 173, Section 315 - Compressed Gases in Cargo Tanks and Portable Tanks.
2. 49 CFR 178 - Code of Federal Regulations, Part 178, Subpart J - Specifications for Containers for Motor Vehicle Transportation.

D. All local Plumbing Codes shall be met.

E. The system and anchorage of the surge tank shall conform to the International Building Code (IBC).

F. The National Electric Code (NEC) shall be used for all wiring.

1.3 SYSTEM DESCRIPTION

A. The surge control system shall be designed, fabricated, installed and warranted by a single supplier to meet the functional and performance requirements specified herein.

B. The work included in this section consists of the furnishing of all labor, materials, equipment, testing and appurtenances for surge protection at each location specified to prevent column separation and/or to limit surge under the conditions specified.

C. The bladder type surge tank shall consist of a cylindrical pressure tank for surge control, including: bladder, shell assembly, gas plate assembly, rupture disc, pressure gauges, accessories, valves, connection piping, and other miscellaneous appurtenances

1.4 SUBMITTALS

A. General: Supply the information required below in accordance with Section 01 33 00 – Contractor Submittals.

B. Product Data: List of materials and coatings used. All materials in contact with water shall be NSF certified.

C. Shop Drawings and Calculations:
1. Detail drawings or manufacturer's literature to indicate compliance with the specified requirements.
2. Dimensional drawings indicating vessel dimensions, wall thickness, mounting, and anchorage requirements.
3. Hydraulic calculations as required herein.
4. Copy of structural, seismic, and wind loading calculations for the support system signed by a Structural Engineer registered in the state where the Project is located.
5. Layout drawings showing dimensions of equipment and accessories.
6. Manufacturer's catalog data on all appurtenances.
7. Submit electrical schematic and wiring diagrams showing wiring, monitoring, and terminals. Label each terminal, showing which control or electrical power wire connects to which terminal.

D. Owner's Manual:
1. Certification and ASME Code data reports in accordance with the ASME Code and as applicable 49 CFR 178.337 or other similar codes. The certification shall include certification of joint radiography, and hydrostatic testing.
2. Fabrication drawings.
3. Operation and maintenance data and instructions.
4. Certificate of installation, signed by authorized supplier/manufacturer representative following field inspection, functional testing and performance testing of systems.

E. Manufacturer's Warranty
1. Manufacturer warranty or warranties for the surge tank and all appurtenances. Said warranties shall be issued to Owner and shall be valid for a period of 2 years following installation.

PART 2 – PRODUCTS

2.1 GENERAL

Provide two Hydropneumatic Bladder Style Surge Tanks as outlined in the following sections.

A. Hydraulic Design:
1. Hydraulic surge tank design as shown in the contract documents is as follows:

Tank # TNK-201	**Value**
Service	Finished Water (Culinary)
Volume	1,500 gallons

Dimensions	As shown in drawings
Initial Pre-charge Pressure	35 psi
Hydraulic Resistance Out of Tank (Including connection piping)	0.06 ft/cfs^2
Hydraulic Resistance Into Tank (Including connection piping)	2.0 ft/cfs^2

Tank # TNK-301	**Value**
Service	Finished Water (Culinary)
Volume	1,500 gallons
Dimensions	As shown in drawings
Initial Pre-charge Pressure	64.5 psi
Hydraulic Resistance Out of Tank (Including connection piping)	0.06 ft/cfs^2
Hydraulic Resistance Into Tank (Including connection piping)	2.0 ft/cfs^2

2. System Parameters:

Tank # TNK-201: The system for which the surge control is to be provided consists of a finished water pump station rated at 350 psig. Additional information related to the pump station include:

Tank # TNK-201	**Value**
Service	Finished Water (NSF)
Maximum Flow rate through pump station	3,000 gpm (future max)
Elevation of Tank Connection	4990.50
System static pressure	62 psig
Maximum steady operating pressure	80 psig
Maximum pressure due to surge	90 psig (at surge tank)
Minimum pressure due to surge	21 psig (at surge tank)
Water temperature range	0-30°C

Tank # TNK-301: The system for which the surge control is to be provided consists of a finished water pump station rated at 350 psig. Additional information related to the pump station include:

Tank # TNK-301	**Value**
Service	Finished Water (NSF)
Maximum Flow rate through pump station	5,400 gpm
Elevation of Tank Connection	4990.50
System static pressure	125.32 psig
Maximum steady operating pressure	150 psig
Maximum pressure due to surge	170 psig (at surge tank)
Minimum pressure due to surge	50 psig (at surge tank)
Water temperature range	0-30°C

The two pressure vessels are to be connected to the pipelines as shown on the drawings. The hydraulic and pressure surge analysis is available on request from the Engineer.

B. Pressure Vessel:

1. Materials for the tank, design, and shop fabrication and inspection shall comply with Section VIII of the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels, with only the plate steels in Table UCS-23 of said code being used. The design pressure rating of the vessel shall be at least the lesser of 50 percent or 50 pounds per square inch gauge above the maximum allowable pressure due to surge. A 1/16 inch corrosion allowance shall be included in all shell, heads, and attachment thicknesses.
2. Provide ASME Code stamp and pressure rating on pressure vessel.
3. Welding: Weld reinforcement shall be in accordance with ASME Code. Excessive reinforcement shall be ground down to within the ASME Code requirements, and as required to install the lining systems. All internal corners and edges shall be ground to a 1/8 inch radius, or a greater radius if required by the lining system.
4. Protective Lining: Interior surfaces of the tank shall be factory-coated with a polyamide epoxy coating, NSF certified, percent of volume solids 75% minimum, (Devoe Bar-Rust 233H or Equal). Apply minimum of 3 coats, with a minimum dry film thickness of 18 mils (total thickness all coats). See Section 09 90 01.
5. External Coating: Finished coating to be factory-coated with a polyamide epoxy coating, NSF certified, percent of volume solids 75% minimum, (Devoe Bar-Rust 233H or Equal). Apply minimum of 3 coats, with a minimum dry film thickness of 18 mils (total thickness all coats). The finish coat is to be shop applied with touch up painting as necessary in the field. See Section 09 90 01.
6. Tank shall be equipped with an anti-extrusion grid which prevents the bladder from being sucked out of the tank in case of loss of line pressure. Head loss associated with the anti-extrusion grid shall be included in the calculation of total connection resistance.
7. All submerged, wetted, or internal items shall be Type 304 or 316 stainless steel.
8. Provide minimum 20" round opening for access manhole, flanged outlet for pipe connection to manifold header, threaded couplings for connecting gages, valves, air piping and drain. Couplings shall be 3,000-pound, WOG forged stainless steel, per ASTM A 182 F 304. Threads shall comply with ANSI B2.1. Joint lubricant shall be Teflon joint compound or Teflon tape.
9. Structural Design: Design tank for seismic, wind load, and other design criteria consistent with other component of the project and as required by local regulations, which may require an external structure to support the tank.
10. Vertical tanks shall be supported laterally for seismic restraint, which may include separate structural supports. These supports along with the tank legs, saddle supports, and anchor nuts/bolts shall be sized appropriately to resist movement in a seismic event per the current codes. Seismic design calculations shall be stamped by a licensed structural engineer in the state of Utah and submitted for review.
11. Environmental Service Conditions: As shown on the Drawings, General and/or Structural Notes.
12. Install air lines to drain condensate traps/drains as required and/or shown on the Drawings.

13. Tank to be equipped with a Parker B17 Quick Disconnect (or equal) air valve fitting with a ½" ball valve charging connection to facilitate the on-site charging of the tank. Tank to be precharged with nitrogen gas per the precharge pressure specified.
14. Tank to include a replaceable heavy-duty butyl rubber bladder (IIR) (or equal) designed for both the precharge and system pressures specified. In no case shall the bladder have a thickness less than 0.100".
15. The tank shall be fitted with a 304 or 316 stainless steel perforated plate to prevent the bladder from escaping through the fluid port. The presence of this plate shall be included in the resistance calculations for surge tank system.
16. The bladder surge tank shall be equipped with a non-intrusive volume indicator device to monitor gas volume levels without disrupting tank operations.

C. Connection piping:
1. All piping, fittings, flanges, valves, and other connection piping appurtenances shall be rated for a pressure of no less than the design pressure for the tank.
2. All connection piping to the tank shall be designed such that total hydraulic resistance into and out of the tank is within the range specified. Supplier shall provide resistance calculations for the piping and tank system. Any orifice plate or other head loss device required to meet resistance specifications shall be designed and furnished as part of the overall connection piping and tank system. Where resistance requirements cannot be obtained using a single connection pipe, tank supplier shall design and furnish a manifold system (including check valve, bypass piping, etc.) to obtain the required resistance.
   a. Manifold System. Contract drawings assume a drilled check valve (preferred system) which is desired to save space compared to bypass piping. Manufacturer shall show that a drilled check valve system will meet specified resistance requirements using a Mueller 72 or equal. If manufacturer cannot meet resistance with drilled check valve, the Manufacturer is to provide a 2-inch diameter bypass piping system with mechanical coupling and must show that it can meet specified resistance requirements.
3. Coating: Coat connection piping and appurtenances as specified in Section 09 90 01.

D. Safety-Relief Valve: Safety-relief valve shall comply with the ASME Boiler and Pressure Vessel Code. Valve shall be bronze, and shall have a pressure rating of appropriate for the pressure rating of the tank. Valve shall have a bottom NPT inlet, and shall have incorporated a calibrated spring set to allow the valve to open at the tank design pressure. Valve shall be a Kunkle Model 919 or approved equal.

2.2 MONITORING DEVICES

A. Differential Pressure Transmitters (via two pressure transmitters), provided by tank supplier. See Drawings and Division 40 for equipment specification. Contractor to ensure that transmitter model is consistent throughout the project.

B. Bladder Monitoring Device: magnetic level gage (MLG) provided by tank supplier.

2.3 COMPONENTS

A. Lifting Lugs: Provide lifting lugs.

B. Anchor Bolts: Anchor bolts shall have a nominal diameter of at least 3/4 inch, unless otherwise indicated on the Drawings, and shall be anchored to concrete foundations using methods designed to transfer the full ultimate strength of the anchor bolt to the concrete foundation. Attach anchor bolts to the tank by use of anchor bolt chairs or rings, as required. Chairs or rings shall be designed to transfer 125 percent of the ultimate strength of the bolt, or 150 percent of the calculated load, whichever is less, to the tank shell.

C. Nameplates and Code Stamps: Design, fabricate, and test tanks in accordance with the ASME Code. Each tank shall bear a stainless steel ASME nameplate. Each nameplate shall bear the applicable code symbol. Manufacturer shall be authorized by ASME to apply the applicable code symbols.

D. Fittings and Attachments: Fittings larger than 1 inch shall be flanged. Fittings 1 inch and smaller shall be National Pipe Thread. Reinforce openings in accordance with the ASME Code. Access openings shall be flanged, and, unless otherwise indicated on the Drawings, have a nominal diameter of at least 20 inches. The cover plate and flange of access openings shall each have a net thickness, after machining, of at least 1/2 inch or as required to meet the vessel design pressure.

E. Attachments: Weld shell attachments for pipe supports, tank gages, instruments, and other items as indicated on the Drawings before application of the tank lining.

2.3 SOURCE QUALITY CONTROL

A. Tests: After fabrication, but prior to application of linings each tank shall be tested in accordance with the ASME Code.

2.4 MANUFACTURERS

A. Experience: The manufacturer shall be experienced for at least 5 years in the design and operation of surge control systems and shall provide a list of similar installations for review by the Engineer.

B. Surge Tanks: One of the following or equal:

1. Pulsco
2. Charlatte Tanks
3. Young Engineering

PART 3 – EXECUTION

3.1 INSTALLATION

A. Special Techniques: Install in accordance with the recommendations of the manufacturer, shop drawings, applicable codes and Contract Documents. Tanks shall be installed level and plumb and shall be secured via their anchor bolt system to transfer all vertical and horizontal

loads to their concrete foundations. All appurtenances shall be configured and oriented for easy access as required for tank operation and maintenance.

B. Air Charging: Fully charge with air in accordance with the manufacturer's instructions prior to field testing the system. Final adjustments in pressure shall be made after installation.

C. Contractor is to obtain the required OSHA Pressure Vessel operating permit.

D. Manufacturer's Services: Trained personnel representing the surge tank manufacturer shall check the installation and instruct the Owner's personnel in the operation of the surge control system. A field test of the equipment by the manufacturer's representative shall also be performed in conjunction with this site visit.

END OF SECTION

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DIVISION 22
PLUMBING

SECTION 22 00 00
PLUMBING

Part 1 - **GENERAL**

1.1 SUMMARY

A. The Contractor shall provide plumbing piping systems, complete and operable, in accordance with the Contract Documents.

B. All work shall be in strict accordance with the International Plumbing Code, and codes of the State of Utah, City of Riverton, and any other authorities having jurisdiction. The Contractor shall have required certifications and be thoroughly familiar with the local codes. The Contractor shall obtain and pay for all necessary permits.

C. This section covers the following plumbing piping systems and associated accessories:
1. Sanitary Drains, Vent Piping and Specialties
2. Potable Water Piping
3. Processed Water Piping

D. This section covers the following plumbing specific items:
1. Hangers and pipe supports
2. Pipe insulation for potable water
3. Floor drains and cleanouts
4. Transition fittings
5. Access doors and covers

E. Related sections include: Section 01 33 00 – Contractor Submittals and Section 40 05 10 – Mill Piping.

1.2 REFERENCE STANDARDS

A. General Standards

ASME Boiler and Pressure Vessel Code, Section IX

ASME B16 – Standards of Pipes and Fittings

National Fire Protection Agency 70, Article 100

AWS B2.2 – Brazing Procedure and Performance Qualification

ASME B31.3 - Process Piping

B. Natural Gas Piping

ASTM A 53/ 53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ANSI Z21.21	Connectors for Gas Appliances
ANSI Z21.80	Line Pressure Regulators

C. Sanitary Drain and Vent

ASTM C 1277	Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings
ASTM C 564	Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
Cast Iron Soil Pipe Institute	"Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

D. Potable Water Piping

ASTM B88	Standard Specification for Seamless Copper Water Tube
ASTM A 106/A 106M	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

1.3 CONTACTOR SUBMITTALS

A. Submit product data for components of each pipe system indicated in accordance with Section 01 33 00 – Contractor Submittals.
   1. Fuel Gas Piping. Provide product data for the following fuel gas piping:
      a. Piping material.
      b. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
      c. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
   2. Sanitary Drain, Vent Piping and Specialties. Provide product data for the following sanitary drain, vent and accessories:
      a. Cast-Iron Pipe and Fittings
      b. Cleanouts
      c. Floor drains
      d. Sand Oil Interceptors including layout drawings with dimensions, list of materials of construction, and manufacturer installation instructions.
   3. Potable Water Piping. Provide product data for the following potable water system:
      a. Hard and Soft Copper tubing product data.
      b. Piping insulation

B. The Contractor shall submit information on the following items in accordance with Section 01 33 20 – Contractor Submittals.
   1. Pipe joining materials
   2. Pipe transition fittings including dielectric fittings;
   3. Wall sleeves and sleeve sealant systems.

4. Shock Absorbers
5. Pipe hangers.
6. Access doors and covers

C. The Contractor shall submit information on all valves in accordance with Section 40 05 51 – Valves, General.

D. LEED Submittals: Submit Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content and chemical components.

E. Provide brazing certificates as required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain pipe, fittings, and joining materials for each piping system through one source from a single manufacturer.

B. Comply with ASME B31.3, "Process Piping," for piping conveying fluid at a pressure of 15 psig or greater.
1. Exception: Piping from different manufacturers may be used in same system if indicated and suitable transition fittings matching both piping materials are used.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of chemical-waste specialties and are based on the specific system indicated.

D. Piping materials shall bear label, stamp, or other markings of specified testing laboratory. Comply with ASME B31.3, "Process Piping."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

Part 2 - **PRODUCTS**

2.1 GENERAL

A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.

2.2 NATURAL GAS PIPING

A. Steel Pipe: Provide and install steel pipe for natural gas piping in accordance with requirements of Section 40 05 10 – Mill Piping.

B. Protective coating: Furnish pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use in contact with materials that may corrode the pipe.

C. Piping specialties: Flexible Connectors: ANSI Z21.24, copper alloy; Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

D. Specialty valves: Valves, NPS 2 and Smaller shall have threaded ends according to ASME B1.20.1 for pipe threads. Valves NPS 2-1/2 and Larger shall have flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges. The following specialty valves shall be provided where indicated.
   1. Appliance Connector Valves: ANSI Z21.15 and CSA International listed.
      a. Available Manufacturers: American Valve Inc.; B&K Industries, Inc.; Brass Craft Manufacturing Co.; Conbraco Industries, Inc.; Apollo Div.; Jomar International Ltd.; Mueller Co.; Mueller Gas Products Div.; Robert Manufacturing Co.; Watts Industries, Inc.; Water Products Div.
   2. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.
   3. Gas Valves, NPS 2 and Smaller: ASME B16.33 and CSA International-listed bronze body and 125 psig pressure rating.
      a. Available Manufacturers: Crane Valves; Grinnell Corp.; Honeywell International Inc.; Milwaukee Valve Company.; Mueller Co.; Mueller Gas Products Div.; NIBCO INC.; Red-White Valve Corp.; Watts Industries, Inc.; Water Products Div.
      b. Tamperproof Feature: Include design for locking.
   4. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125 psig pressure rating.
      a. Available Manufacturers: Flow Control Equipment, Inc.; Milliken Valve Co., Inc.; Nordstrom Valves, Inc.; Olson Technologies, Inc.; Homestead Valve Div.; Walworth Co.
      b. Tamperproof Feature: Include design for locking.
   5. General-Duty Valves, NPS 2-1/2 and Larger: ASME B16.38, cast-iron body, suitable for fuel gas service, with "WOG" indicated on valve body, and 125 psig pressure rating.
      a. Gate Valves: MSS SP-70, OS&Y type with solid wedge.
      b. Butterfly Valves: MSS SP-67, lug type with lever handle.

E. Pressure regulators: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.
   1. Available Manufacturers: – Service Pressure Regulators: American Meter Company.; Fisher Controls International, Inc.; Division of Emerson.; Invensys.; National Meter Industries, Inc.; Schlumberger Limited; Gas Div.
   2. Line Pressure Regulators: American Meter Company; Fisher Controls International, Inc.; Division of Emerson; Maxitrol Company; National Meter Industries, Inc.; Richards Industries, Inc.; Jordan Valve Div.; Schlumberger Limited; Gas Div.
   3. Appliance Pressure Regulators: Eaton Corporation; Controls Div.; Harper Wyman Co.; Maxitrol Company; SCP, Inc.
   4. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

5. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
6. Line Pressure Regulators: ANSI Z21.80 and see drawings for inlet to outlet pressure and coordinate with local natural gas utility company.
7. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

F. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
   a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
   b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
   c. Aboveground Portion: PE transition fitting.
   d. Outlet shall be threaded or flanged or suitable for welded connection.
   e. Tracer wire connection.
   f. Ultraviolet shield.
   g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated and leak tested.
   a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
   b. Outlet shall be threaded or flanged or suitable for welded connection.
   c. Bridging sleeve over mechanical coupling.
   d. Factory-connected anode.
   e. Tracer wire connection.
   f. Ultraviolet shield.
   g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
   a. Manufacturers: Subject to compliance with requirements**,** available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Lyall, R. W. & Company, Inc.
      2) Mueller Co.; Gas Products Div.
      3) Perfection Corporation; a subsidiary of American Meter Company.
   b. PE body with molded-in, stainless-steel support ring.
   c. Buna-nitrile seals.
   d. Acetal collets.
   e. Electro-zinc-plated steel stiffener.
6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1) Lyall, R. W. & Company, Inc.
   2) Mueller Co.; Gas Products Div.
   3) Perfection Corporation; a subsidiary of American Meter Company.
b. Fiber-reinforced plastic body.
c. PE body tube.
d. Buna-nitrile seals.
e. Acetal collets.
f. Stainless-steel bolts, nuts, and washers.

7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Dresser Piping Specialties; Division of Dresser, Inc.
      2) Smith-Blair, Inc.
   b. Steel flanges and tube with epoxy finish.
   c. Buna-nitrile seals.
   d. Steel bolts, washers, and nuts.
   e. Factory-installed anode for steel-body couplings installed underground.

2.3 SANITARY DRAIN, VENT PIPING AND SPECIALTIES

A. Hub-and-Spigot, Cast-Iron Pipe and Fittings: ASTM A 74, Service class.
   1. Gaskets: ASTM C 564, rubber.

B. Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.
   1. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
   2. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
      a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
      b. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

C. Exposed Cast-Iron Cleanouts: Cleanouts shall conform to ASME A112.36.2M for cast iron for cleanout test tee.
   1. Size: Same as connected drainage piping
   2. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch, hubless, cast-iron soil pipe test tee as required to match connected piping.
   3. Closure: Countersunk, Countersunk or raised-head.
   4. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
   5. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

D. Cast-Iron Floor Cleanouts: Cleanouts shall conform to ASME A112.36.2M for adjustable housing, cast-iron soil pipe with cast-iron ferrule, heavy-duty, adjustable housing, threaded, adjustable housing cleanout.
1. Size: Same as connected branch.
2. Type: Adjustable housing Cast-iron soil pipe with cast-iron ferrule Heavy-duty, adjustable housing.
3. Body or Ferrule: Cast iron.
4. Closure: Brass plug with straight threads and gasket, Brass plug with tapered threads, Cast-iron plug.
5. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
6. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
7. Frame and Cover Shape: Round.
8. Top Loading Classification: Heavy Duty.
9. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Josam Company; Josam Div.
b. Sioux Chief Manufacturing Company, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group

E. Cast-Iron Wall Cleanouts: Wall cleanouts shall conform to ASME A112.36.2M. Include wall access.
1. Size: Same as connected drainage piping.
2. Body: Hub-and-spigot, cast-iron soil pipe T-branch, hubless, cast-iron soil pipe test tee as required to match connected piping.
3. Closure: Countersunk or raised-head brass or cast-iron plug.
4. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
5. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
6. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group.

F. Floor Drains: Cast-Iron Floor Drains shall conform to the following, see schedules on drawings:
   1. Top or Strainer Material: Bronze, Gray iron, nickel bronze.
   2. Top of Body and Strainer Finish: Nickel bronze, Polished bronze, Rough bronze
   3. Top Shape: Round.
   4. Top Loading Classification:
   5. Trap Material: Cast iron.
   6. Trap Pattern: Standard P-trap.
   7. Trap Features: Cleanout, Trap-seal primer valve drain connection, Cleanout and trap-seal primer valve drain connection.
   8. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group.

G. Miscellaneous Sanitary Drainage Piping Specialties
   1. Open Drains: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets. The size shall be the same as connected waste piping with increaser fitting of size indicated.
   2. Floor-Drain, Trap-Seal Primer Fittings: Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection. The size shall be the same as floor drain outlet with NPS 1/2 side inlet.
   3. Vent Caps: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe. The size shall be the same as connected stack vent or vent stack.
   4. Air-Gap Fittings: Fittings shall conform to ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
      a. Body: Bronze or cast iron.
      b. Inlet: Opening in top of body.
      c. Outlet: Larger than inlet.
      d. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

H. Sand Oil interceptors: Construct sand oil interceptor per detail on drawings equipped with inlet, outlet and vent connections (type and sizes shown), with traffic rated heavy duty gasketed non-skid covers. Prior to fabrication, Contractor shall obtain approval of the South Valley Sewer District regarding design and installation of interceptor.
   1. Material: Concrete body.
   2. Finish: Coat interior surfaces only.
   3. Type: Recessed, with grade leveling rings as needed.
   4. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Oldcastle Precast
b. Jensen Precast
c. Monarch Products Co.

2.4 POTABLE WATER PIPING AND ACCESSORIES

A. Hard Copper Tube and Fittings: As specified in Section 40 05 10 – Mill Piping.

B. Soft Copper Tube and Fittings: As specified in Section 40 05 10– Mill Piping.

C. Galvanized-Steel Pipe and Fittings: As specified in Section 40 05 10 – Mill Piping.

D. Insulation: All hot and cold water piping, valves, fittings, and exposed horizontal sanitary, storm, and vent piping shall be provided with insulation in accordance with Section 40 05 00 – Piping, General.

1. Cover all valves, flanges, fittings and ends of insulation with a pre-molded high and low temperature PVC fitting cover or end cap, or similar preformed units. The pre-molded cover shall be sized to receive the same thickness of insulation as used in the adjacent piping and shall be in accordance with Section 40 05 00 – Piping, General.
2. Exposed supply and drain piping for lavatories shall be insulated under the wash basins to prevent burns and abrasions to handicapped persons. Removable insulated covers shall be Plumberex Specialty Products Handy-Shield type, or equal.

2.5 TRANSITION FITTINGS

A. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

B. Sleeve-Type Transition Coupling: AWWA C219.

C. Dielectric Fittings: Install per Section 23 05 00 – Common Results for Plumbing and HVAC.

2.6 MISCELLANEOUS PIPE FITTINGS

A. Escutcheons: Manufactured ceiling, floor, and wall escutcheons and floor plates in accordance with Section 23 05 00 – Common Results for Plumbing & HVAC.

B. Sleeves: Provide sleeves in accordance with Section 23 05 00 – Common Results for Plumbing and HVAC.

1. Where pipes pass through floors, sleeves shall extend 3 inches above the finished floor. Where pipes pass through walls, sleeves shall be flush with the wall surface.

C. Sleeve Seals: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve in accordance with Section 23 05 00 – Common Results for Plumbing.

D. Shock Absorbers: All cold and hot water piping in buildings connecting to self-closing faucets, quick-action valves, water closets, emergency showers, washers, and dishwashers shall be protected by shock absorbers located at each fixture or battery of fixtures. Shock absorbers shall be corrosion-resistant, permanently sealed, and shall be sized and installed to the

manufacturer's printed recommendations. When absorbers are in concealed locations provide architectural access doors to facilitate inspection and maintenance.

1. Manufacturers, or Equal
    a. Josam "SHOKTROLS"
    b. Jay R. Smith "HYDROTROL"
    c. Zurn, Model Z-1022

2.7 PIPE HANGERS, SUPPORTS AND MISCELLANEOUS METALWORK

A. Support plumbing pipe systems in accordance with Section 40 05 07 – Pipe Supports and Section 23 05 00 – Common Results for Plumbing and HVAC.

2.8 PLASTIC VALVES

A. Install all plastic valves in accordance with Section 40 05 10 – Mill Piping, Exposed and Buried respective valve specifications:
    1. Section 40 05 63 – Ball Valves
    2. Section 40 05 65 - Valves for Pump Control and Pump Service
    3. Section 40 05 64 - Butterfly Valves

2.9 METAL VALVES

A. All water shut off valves shall be the gate type, except on fixture supply piping where globe valves shall be used.

B. All interior hose valves shall be provided as indicated. The globe valve shown shall be as given herein before for valves. The hose nipple shown on the detail shall be a female iron pipe thread inlet with hose thread outlet. All hose bibbs shall be 3/4-inch in size, except as noted on the Construction Drawings.

C. Gate, globe, check, plug, and angle valves shall be in accordance with the following:
    1. Section 40 05 61 - Gate Valves
    2. Section 40 05 63 – Ball Valves
    3. Section 40 05 65 - Valves for Pump Control and Pump Service
    4. Section 40 05 51 – Valves, General
    5. Section 40 05 64- Butterfly Valves

D. The Contractor shall provide shutoff valves on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shut-off control on the water system. Shut off valves shall be placed on all hot and cold water connections to equipment and fixtures. Lavatory and sink stops with wheel handle shall be brass with chrome plating. Extra long barrel stops shall be used where supply piping is concealed behind partitions.

E. All valves shall open by turning counterclockwise and shall have suitable handwheels or nuts as required.

F. Provide a temperature and pressure relief valve for each water heater. Provide pressure relief valves at other locations where indicated. Relief valves shall be equipped with manual

test levers. The Contractor shall provide piping to convey relief valve discharge to the nearest floor drain, the building exterior, or as approved by the Engineer.

2.10 ACCESS DOORS AND COVERS

A. Access doors, where required in ceilings for access to valves, controls, and other equipment, shall be Karp Assoc., Maspeth, N.Y., Style DSC-210, Inryco-Milcor, Milwaukee, Wisconsin, Style AT, or equal. Doors shall be of sufficient size to allow access but shall be not less than 12 inches by 12 inches. Ceilings with lay-in acoustical tile will not require access panels. Valves and equipment located above ceiling tile shall have a 3/4-inch diameter blue plastic button with a letter "V" set in tile.

B. Floor access covers in unfinished concrete floors not exposed to chemicals shall be galvanized cast iron with a clear opening of not less than 8 inches by 8 inches, and shall be as manufactured by Alhambra Foundry Company, Model A-2015; Neenah Foundry Co., No.R-6687, or equal. In traffic or chemical areas, access covers shall be as manufactured by Alhambra Foundry Company, Model A-1240; Neenah Foundry Co., Model R-1977, or equal, with clear opening of not less than 10 inches in diameter.

2.11 PAINTING

A. All ferrous metal, except finished, galvanized and stainless steel surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09 90 00 – Protective Coatings and Linings. Prime colors shall be compatible with finish coats to be applied in the field.

B. Self-contained units such as wall-mounted hose racks shall be supplied with factory applied finish coats of baked enamel.

C. All field painting shall comply with Section 09 90 00 –Protective Coatings and Linings.

2.12 PIPE

A. Carbon Steel Pipe: Fully annealed, seamless C 1010 carbon steel hydraulic tubing with feroluk “Bite Type” compression fittings rated at 6,000 psi (minimum) working pressure manufactured by Parker Hannifan Corp. or Equal.

Size (in)	Working Pressure (psi)	Wall Thickness
5/8	2550	0.058
3/4	2350	0.065
7/8	2200	0.072
1	2250	0.083
1-1/4	2350	0.109
1-1/2	2450	0.134

B. Steel Pipe - Hydraulic Fluid: Pipe shall be double pass welded, ASTM A-106 Grade B seamless (pickled, oiled and plugged) with socket weld forged steel fittings. Pipe shall be kept meticulously clean. Welding shall be done with low hydrogenrod 7018. System shall be installed with SAE 4 bolt flanges and SAE weld adaptors with absolute minimum of NPT connections.

2.13 SPECIALTY VALVES:

A. Ball Valves: For hydraulic system shall be threaded end ball valves, carbon steel body, carbon steel end cap or insert, carbon steel ball, carbon steel stem with special nylon seat, Teflon body and stem steel, nylon stem bearing 303 SST compression ring and stem pin, minimum pressure rating 3,000 psi. Valves shall be Marpac Tripac C325 with socket weld or SAE O-ring ends. Approved alternate – Jamesbury Threaded HP2200GT.

B. Drain Valves: Bronze ball vales, complying with MSS SP-110 and having outlet connection according to ASME B1.20.7 for garden-hose thread with cap.

Part 3 - **EXECUTION**

3.1 WORKMANSHIP

A. Care shall be taken at all times to protect floors, stairways, and walls during the make-up, erection of piping, and placing of equipment. The Contractor shall remove all stains and repair all damage before final acceptance of the work.

B. If, during the construction of this project, the Engineer finds materials that have identifying marks removed or lack such marks completely, he may reject such items until the Contractor has furnished proof that said items conform to the Specifications. Adequacy and extent of such proof shall be determined by the Engineer.

3.2 PREPARATION

A. The Contractor shall coordinate roughing-in with provisions for wall-and floor sleeves, pipe inserts, cutting of roof and floor penetrations so that drain lines will have the required invert elevations and slopes.

B. If factory-cleaned and -capped laboratory ai piping is not available or if precleaned piping must be recleaned because of exposure, perform the following procedures:
   1. Clean laboratory air tubes and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
   2. Wash laboratory air piping and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
      a. Scrub to ensure complete cleaning.
      b. Rinse with clean, hot water to remove cleaning solution.

3.3 OPENINGS

A. The Contractor shall provide all necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the buildings. All openings shall be as indicated on the Contract Drawings or as required to provide passage for the plumbing work.

B. Sleeve Installation: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.
3. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
4. Install sleeves in new partitions, slabs, and walls as they are built.
5. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 7.
6. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 7.
7. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.
8. Seal space outside of sleeves in concrete slabs and walls with grout.
9. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
10. Install sleeve materials according to the following applications:
    a. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe or Stack sleeve fittings.
        1) Extend sleeves 2 inches above finished floor level.
        2) For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
    b. Sleeves for Piping Passing through Gypsum-Board Partitions:
        1) Steel pipe sleeves for pipes smaller than NPS 6.
        2) Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
        3) Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
    c. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
    d. Sleeves for Piping Passing through Exterior Concrete Walls:
        1) Steel pipe sleeves for pipes smaller than NPS 6.
        2) Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
        3) Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
11. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 for firestop materials and installations.

C. Sleeve Seal Installation: Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 INSTALLATION AND APPLICATION

A. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

B. Install piping indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

C. Install piping above accessible ceilings to allow sufficient space for removal of ceiling panel, and coordinate with other services occupying that space.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Install piping to permit valve servicing.

F. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure ratings unless otherwise indicated.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. The Contractor shall provide all plumbing specialties in accordance with manufacturer's printed instructions.

J. All pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.

K. All pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.

L. All piping in buildings shall be as close to the ceilings or walls as possible unless indicated otherwise.

M. Screwed joints shall be made with joint compound and be tight and leakproof. A sufficient number of brass to ferrous metal seat unions shall be placed in lines so that any pipe, valve or piece of equipment may be easily disconnected.

N. All drainage and sanitary lines shall be properly run, trapped, and be vented to conform with Code requirements. All changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe. Changes in pipe size shall be made with reducing fittings. Minimum depth of cover shall be 3 feet.

O. Horizontal soil, vent, drain and waste pipes shall be given a slope of at least 1/4-inch per foot unless indicated otherwise.

P. Floor drains and cleanouts shall be installed so the tops of the drains are flush with the finished floor.

Q. Vent piping passing through the roof shall be flashed. Flashing shall extend a minimum 12 inches from the outer surface of the pipe in all directions. Flashing shall be fabricated from 4-pound lead sheet. If lead flashing is not allowed by local Plumbing codes, then EDPM rubber flashing shall be used.

R. Floor drains or floor sinks shall be provided for all equipment drains. No equipment drains shall discharge to floor slabs.

3.5 NATURAL GAS PIPING AND VALVE SCHEDULE AND INSTALLATION

A. Natural Gas Service and Installation: The Contractor shall provide the natural gas system and valves as indicated. The Contractor shall pay any fees or charges levied by the Gas Company for installation or inspection.

1. All gas piping shall be installed in strict conformance with the requirements of the local or state regulations and the following. Joints for exposed piping shall be of the screwed type, with an adequate number of unions to facilitate removing of equipment and dismantling of piping for cleaning and inspection. Screw fittings shall be malleable cast iron and shall conform to ANSI.
2. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building. Exterior fuel gas distribution system piping, service pressure regulator and service meter will be provided by gas utility.

B. Joint Compounds: Joint compounds shall be resistant to the action of gas, be non-hardening, and be used sparingly on the male threads only.

C. Locating Leaks: Test for leaks shall be made with approved leak detectors or by soap and water solution while the system is under pressure.

D. Purging: After pressure testing, all new piping shall be fully purged with inert gas from the most distant point from the point of entry of the gas. Each major branch line shall be similarly purged from its far end. Purging shall be done only by personnel experienced in this particular operation.

E. Pressure Regulating Valves: The pressure regulating valves shall be Fisher; Rockwell; or equal. Inlet pressure of 2.0 psig, outlet pressure setting of 7 to 11 inches WC and a capacity port diameter as required, and vented to the outside.

F. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting.

G. Install strainer upstream from each earthquake valve.

H. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.

I. Natural Gas Piping, 2 psig or Less:

1. NPS 1/2 and Smaller: NPS 3/4 steel pipe, malleable-iron threaded fittings, and threaded joints.
2. NPS 3/4 and NPS 1: Steel pipe, malleable-iron threaded fittings, and threaded joints.
3. NPS 1-1/4 to NPS 2: Steel pipe, malleable-iron threaded fittings, and threaded and steel welding fittings, and welded joints.
4. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.

J. Natural Gas Piping 2 to 5 psig:
1. NPS 4 and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded and steel welding fittings, and welded joints.
2. Larger Than NPS 4: Steel pipe, steel welding fittings, and welded joints.

K. Containment Conduits: Steel pipe, steel welding fittings, and welded joints.

L. Valves: Valves shall be used in accordance with the service recommendation of the manufacturer. Valves shall conform to the requirements of ANSI B 31.8. Unless otherwise indicated, full opening non-lubricated plug valves shall be used in sizes larger than 2 inches, or for pressure greater than 0.5-psig. No unions or valves shall be installed on pipe lines that will be concealed in partitions, ceilings, etc. Every union or valve shall be readily accessible for inspection and repair.
1. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.
2. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.
3. Appliance Shutoff Valves for Pressure 2 to 5 psig: Gas valve.
4. Piping Line Valves, NPS 2 and Smaller: Gas valve.
5. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.
6. Valves at Service Meter, NPS 2 and Smaller: Gas valve.
7. Valves at Service Meter, NPS 2-1/2 and Larger: Plug valve.

M. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.
1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
3. Exception: Tubing passing through partitions or walls.
4. In Walls: Gas piping with welded joints and protective wrapping may be installed in masonry walls, subject to approval of authorities having jurisdiction.
5. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    a. Exception: Accessible above-ceiling space specified above.

N. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
2. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down. Connect branch piping from top or side of horizontal piping.

P. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

Q. Install corrugated, stainless-steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

R. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

S. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.

T. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

U. Use materials suitable for natural gas.
1. Brazed Joints: Make with brazing alloy with melting point greater than 1000 deg F. Brazing alloys containing phosphorus are prohibited.

V. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.6 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.7 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:
1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Copper Tubing with Protective Coating:
1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

F. Install fittings for changes in direction and branch connections.

G. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 15 Section "Meters and Gages for HVAC Piping."

3.8 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:
1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
3. Annealed-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

B. Aboveground natural-gas piping shall be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.

C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.9 SANITARY DRAIN AND VENT PIPING SCHEDULE AND INSTALLATION

A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

C. Aboveground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
   1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.
   2. Hubless cast-iron soil pipe and fittings and sovent stack fittings; standard, heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   3. Steel pipe, drainage fittings, and threaded joints.

D. Aboveground, soil, waste, and vent piping NPS 5 and larger shall be the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and compression joints.
   2. Hubless cast-iron soil pipe and fittings and solvent stack fittings; standard, heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   3. Steel pipe, drainage fittings, and threaded joints.

E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
   1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.
   2. Hubless cast-iron soil pipe and fittings; standard, or heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

F. Underground, soil and waste Piping NPS 5 and larger shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and compression joints.
   2. Hubless cast-iron soil pipe and fittings; standard, or heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

G. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

H. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.10 POTABLE WATER PIPING SCHEDULE AND INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves.

G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install seismic restraints on piping.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping adjacent to equipment and specialties to allow service and maintenance.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump.

T. Install thermostats in hot-water circulation piping.

U. Joint Construction:
   1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
   2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
   3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
      a. Apply appropriate tape or thread compound to external pipe threads.
      b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
   4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
   5. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
   6. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
   7. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
   8. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
   9. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

V. Valve Installation:
   1. General-Duty Valves: Comply with requirements in Division 15.
   2. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

3. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 15 Section "Domestic Water Piping Specialties."
    a. Hose-End Drain Valves: At low points in water mains, risers, and branches.
    b. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
4. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for balancing valves.

W. Transition Fitting Installation:
1. Install transition couplings at joints of dissimilar piping.
2. Transition Fittings in Underground Domestic Water Piping:
    a. NPS 1-1/2 and Smaller: Fitting-type coupling.
    b. NPS 2 and Larger: Sleeve-type coupling.
3. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

X. Dielectric Fitting Installation:
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

Y. Connections:
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to equipment and machines to allow service and maintenance.
3. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
4. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
    a. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
    b. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 15 plumbing fixture Sections for connection sizes.
    c. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

Z. Escutcheon Installation: Install escutcheons for penetrations of walls, ceilings, and floors. Escutcheons for New Piping shall conform to the following:
1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish or stamped steel with set screw or stamped steel with set screw or spring clips or stamped steel with spring clips.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish or One piece or split casting, cast brass with polished

chrome-plated finish or Split casting, cast brass with polished chrome-plated finish or One piece, stamped steel with set screw or One piece or split plate, stamped steel with set screw.

4. Bare Piping in Equipment Rooms: One piece, cast brass or stamped steel with set screw or stamped steel with spring clips.
5. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.11 FIELD TESTING

A. Contractor shall make such tests as are required by the local ordinances and codes in the presence of a local governing authority inspector to show that all piping is tight, leak free and satisfactory, and shall also perform such tests as the Engineer may direct to ensure that all fixtures and equipment operate properly. The Contractor shall pay all costs in making such tests and the costs of making all changes or repairs until the Work is acceptable to the governing authorities.

B. Chemical-Waste Piping Inspection:
   1. Do not enclose, cover, or put drainage and vent piping into operation until it is inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping system before concealing after system roughing-in and before setting fixtures and equipment.
      b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspections: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Chemical-Waste Piping Testing: Test systems according to procedures of authorities having jurisdiction or, in absence of published procedure, according to the following:
   1. Test for leaks and defects in new piping systems and parts of existing systems that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of system tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Rough Plumbing Test Procedure: Test piping at completion of piping roughing-in. Tightly close all openings in piping system, and fill with water to point of overflow, but not less than 10 foot head of water. From 15 minutes before test starts through completion of test, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures and equipment have been set and their traps filled with water, test connections and prove gastight and watertight. Plug stack openings on roof and building drain where it leaves building,

and introduce air into system equal to pressure of 1 inch wg. Use U-tube or manometer inserted in trap of fixture to measure pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

D. Sanitary Drain and Vent: During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
5. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.
    a. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
    b. Prepare reports for tests and required corrective action.

E. Potable Water Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.
7. Domestic water piping will be considered defective if it does not pass tests and inspections.
8. Prepare test and inspection reports.

F. Natural Gas Piping: Before the gas piping is approved, a test for tightness shall be made and be witnessed by the Engineer. The system shall be subject to a test pressure of at least 1.5 times the proposed maximum operating pressure, but never less than 6 inches of mercury column or 30 psig for 24 hours with no leakage. The system shall hold pressure after

disconnecting the pressure source for a period of at least 24 hrs without showing any drop in pressure after the test gas in the pipe has been given time to come to equilibrium at the ambient temperature. Longer runs of piping shall be tested for 48hrs.

1. Test Medium: For test purposes, air or an inert gas such as carbon dioxide or nitrogen shall be used as the pressurizing medium. Under no circumstances shall oxygen or natural gas be used to test for tightness or to locate leaks.

G. Pressure Washer Piping Test: hydryostatic test pressure washer piping at 2,000 psi for two hours without loss of pressure.

3.12 DISINFECTION

A. After potable water supply lines are tested, they shall be disinfected by introducing into the line HTH solution, liquid chlorine, or chlorine solution of sufficient strength. Then the line shall be filled with water and maintained under not less than 10 pounds per square inch pressure, for not less than 48 hours, during which period all valves on the lines shall be opened and closed several times, after which it shall be flushed clean, and then tested by the Owner. This procedure shall be repeated as often as necessary until the line is pronounced safe for use, by the Owner. No cross connection between the water mains and any pipe not yet disinfected will be permitted.

END OF SECTION

SECTION 22 45 16
EYEWASH EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following emergency plumbing fixtures:
   1. Eye/face wash equipment.
   2. Combination units.
   3. Water-tempering equipment

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Cooled Water: Cooled potable water produced by water cooler.

C. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

D. PVC: Polyvinyl chloride plastic.

E. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

F. Tepid: Approximately 85 deg F temperature.
   1. Allowable Variation: Plus or minus 5 deg F.

1.4 QUALITY ASSURANCE

A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; about plumbing fixtures for people with disabilities.

1.5 REFERENCES

A. American National Standards Institute (ANSI):

Z358.1	Emergency Eyewash and Shower Equipment
Z535.1	Safety Color Code

B. NIOSH Schedule 13F.

1.6 SUBMITTALS

A. Submit shop drawings in accordance with Section 01 33 00 – Contractor Submittals.

B. Product Data:

C. Submit manufacturer's product literature information for products specified.

D. Manufacturer's Installation Instructions.

E. Product Data: Include flow rates and capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each product indicated.

F. Operation and Maintenance Data.

G. Operating and Maintenance Information for Safety Detectors and Breathing Apparatus; 6 complete sets.

H. Warranty.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Show evidence that the firm has been engaged in producing such materials and products for at least 5 years and that the product submitted has a satisfactory performance record of at least 5 years.

B. Installer Qualifications; Installer shall have 3 years' experience in installing these materials for similar projects and shall be approved by the manufacturer prior to bidding of the project.

C. Regulatory Requirements:
   1. As applicable, equipment of this Section shall comply with requirements of public agencies of the State of Utah including OSHA, Underwriters Laboratories, NFPA, and ASME.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver to the job site in manufacturer's original containers.

B. Delivery: After wet operations in building are completed.

C. Storage and Protection: Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

D. Keep materials dry until ready for use. Keep packages of material off the ground, under cover, and away from sweating walls and other damp surfaces.

E. Protect finished surfaces from soiling and damage during handling and installation. Keep covered with a protective covering.

PART 2 - PRODUCTS

2.1 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Equipment: Plumbed, adjacent-to-sink, swivel, counter-mounting type.
   1. Available Manufacturers.
   2. Manufacturers.
      a. Bradley Corporation.
      b. Encon Safety Products.
      c. Guardian Equipment Co.
      d. Acorn Safety.
      e. Haws Corporation.
      f. Lab Safety Supply, Inc.
      g. Speakman Co.
   3. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   5. Control-Valve Actuator: Paddle.
   6. Omit receptor and drain.

2.2 COMBINATION UNITS

A. Combination Units: Plumbed, accessible, freestanding type with emergency shower and eye/face wash equipment.
   1. Available Manufacturers.
      a. Bradley Corporation.
      b. Encon Safety Products.
      c. Guardian Equipment Co.
      d. Acorn Safety.
      e. Haws Corporation.
      f. Lab Safety Supply, Inc.
      g. Speakman Co.
   2. Piping: Stainless steel.
      a. Unit Supply: NPS 1-1/4 minimum from top.
      b. Unit Drain: Outlet at side near bottom.
      c. Shower Supply: NPS 1 with flow regulator and stay-open control valve.
      d. Eye/Face Wash Supply: NPS 1/2 with flow regulator and stay-open control valve.
   3. Shower Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
      a. Control-Valve Actuator: Pull rod.
      b. Shower Head: 8 inch minimum diameter, stainless steel.
   4. Eye/Face Wash Equipment: With capacity to deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
      a. Control-Valve Actuator: Paddle.
      b. Receptor: Stainless-steel bowl.

2.3 WATER-TEMPERING EQUIPMENT

A. Hot and Cold-Water-Tempering Equipment,: Factory-fabricated equipment including water thermostatic mixing valve designed to provide 85 deg F potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, corrosion-resistant metal piping, and enclosure.
   1. Available Manufacturers.
      a. Bradley Corporation.
      b. Encon Safety Products.
      c. Guardian Equipment Co.
      d. Acorn Safety.
      e. Haws Corporation.
      f. Lab Safety Supply, Inc.
      g. Speakman Co.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturers' recommendations.

B. Install fixed equipment in accordance with manufacturer's instructions.

C. Plumbing work shall be in accordance with Section 22 00 00 – Plumbing.

D. Electrical connections and distribution shall be in accordance with Section 26 00 00 – Electrical General Provisions.

3.2 PROTECTION

A. Repair or replace defective equipment with new.

END OF SECTION

DIVISION 23
HVAC

SECTION 23 01 00
GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

A. General Conditions and Division 01 apply to this Division.

1.2 SCOPE

A. Includes -

1. Furnish all labor, materials, and equipment necessary for the completion of the mechanical and plumbing scope of work.
2. Furnish and install all motors specified in this Division and be responsible for the proper operation of electrical powered equipment furnished by this Division.
3. Furnish exact location of electrical connections and information on motor controls to Division 26.
4. Mechanical Contractor shall obtain the services of independent Test and Balance Agency.
5. Placing the air conditioning, heating, ventilating, and exhaust systems into full operation and continuing their operation during each working day of testing and balancing.
6. Making changes in pulleys, belts, and dampers, or adding dampers, as required for the correct balance as recommended by Balancing Contractor at no additional cost to Owner.
7. Air balance, final adjustment and test run.
8. The satisfactory performance of the completed systems is a requirement of this specification.

B. Related Work Specified Elsewhere

1. Conduit, line voltage wiring, outlets, and disconnect switches specified in Division 26.
2. Magnetic starters and thermal protective devices (heaters) not a factory mounted integral part of packaged equipment are specified in Division 26.

1.3 SITE OBSERVATION

A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS

A. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc; however, locations are to be regarded as shown diagrammatically only. Follow as closely as actual building construction and work of other trades will permit.

B. Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate existing structural and finished conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.
If changes in location of piping, equipment, ducts, etc. are required due to lack of coordination of work under this division, such changes shall be made without charge. Contractor shall review drawings with local and state agencies having jurisdiction and any changes required by them shall be brought to the attention of the Engineer prior to bidding or commencement of work. It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for the installation of systems according to the true intent and meaning of the Contract Documents. Anything not clear or in conflict will be explained by making application to the Engineer in writing. Should conditions arise where certain changes would be advisable, secure Owner's and Engineer approval for these changes before proceeding with work.

1.5 COORDINATION OF WORK:

A. Coordinate work of various trades in installing interrelated work. Before installation of mechanical items, make proper provision to avoid interferences in a manner approved by Engineer. Changes required in work specified in Division 22 and 23 caused by neglect to secure approval shall be made at no cost to Owner.

B. Arrange piping, ductwork, and equipment to permit ready access to valves, unions, starters, motors, control components, and to clear openings of doors and access panels. Contractor shall provide all necessary access doors and/or panels to provide complete access to all mechanical equipment, dampers, or accessories. Doors for dampers, etc. shall be minimum 12" x 12" and doors for mechanical equipment shall be minimum 24" x 24".

C. Furnish and install inserts and supports required by Division 22 and 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions involved in sufficient time to be built into the construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Contractor.

D. Be responsible for required digging, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Owner and Architect. Cut

carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.

1. Patch and repair walls, floors and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
2. This Division shall bear expense of cutting, patching, repairing, and replacing of work of other Divisions because of its fault, error, tardiness, or because of damage done by it.
3. Provide the necessary cutting, patching, repairing, and replacing pavements, sidewalks, etc. to permit installation of work of this Division.

E. Adjust locations of piping, ductwork, equipment, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and cut prior to fabrication.

1. Make offsets, transitions, and changes in direction of piping, ductwork, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.

F. Slots and openings through floors, walls and roofs shall be provided by this Division.

G. This Contractor shall schedule his work, store his equipment and materials, and work in harmony with other Contractors so as to not delay or jeopardize the construction.

H. This Division shall coordinate with electrical contractor to insure that all required components of control work are included and fully understood. Any discrepancies shall be called to the attention of the Engineer before completion of bids. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.6 EQUIPMENT & MATERIALS:

A. Requests for substitution shall be received in writing a minimum of seven days prior to bidding. Prior acceptance shall be by Manufacturer's name only. Items not listed in this specification or subsequent addendums shall not be considered. No oral approvals will be acceptable. Manufacturers listed in this specification are acceptable only for items listed. All other items manufacturer wishes to bid must be prior approved. All equipment shall be subject to final review in accordance with "Project Submittals".

B. Product Approvals -

1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.

2. In the event other than specified equipment is used and will not fit job site conditions, this Division assumes responsibility for replacement with items named in Specification.

C. Use domestic made pipe, pipe fittings, and motors on Project.

D. Motor and equipment name plates as well as applicable UL labels shall be in place when Project is turned over to Owner.

E. Insure that items to be furnished fit spaces available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. Do not scale off drawings.

F. All materials shall be of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended. Materials shall be new unless specifically excepted.

G. Equipment catalog or model numbers shown define the basic equipment types and quality standard only. Catalog numbers shall not be considered as all inclusive and shall be verified to include all devices, controls, operators, and appurtenances necessary for the satisfactory and complete operation of the equipment.

H. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.

1. Promptly notify Engineer in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain Engineer's written instructions before proceeding with work. Contractor shall bear all expenses arising from correcting deficiencies of work that does not comply with Manufacturer's directions or such written instructions.

I. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in a dry, heated space.

1.7 PROJECT SUBMITTALS:

A. Furnish complete catalog data for manufactured items of equipment to be used in the Work to for review within 15 days after award of Contract.

B. Submittal shall include, but not be limited to the following:

1. equipment scheduled
2. balancing contractor
3. insulation
4. grilles, and diffusers
5. automatic temperature controls
6. certificates of guarantee
7. valves
8. plumbing fixtures, accessories, and specialties
9. any item for which more than one manufacturer is mentioned

C. Submit a minimum of five copies of data in binders and index in same order and name as they appear in Specification. - Optional: Provide electronic submittals. Electronic submittals shall be in .pdf format, and shall be compiled into a single file, with bookmarks for each piece of equipment.

1. State sizes, capacities, brand names, motor HP, electrical requirements, accessories, materials, gauges, dimensions, and other pertinent information.
2. List on catalog covers page numbers of submitted items.
3. Underline or highlight applicable data.

D. If material or equipment is not as specified or submittal is not complete, it will be rejected.

E. Catalog data or shop drawings for equipment which are noted as approved shall not supersede Contract Documents.

F. Review comments shall not relieve this Division from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.

G. Check work described by catalog data with Contract Documents for deviations and errors.

H. All items other than first named specified equipment shall show and state all exceptions and deviations taken and shall include design calculations and drawing layouts.

I. The Contractor shall review the submittals prior to submission to make sure that the submittals are complete in all details. No submittal will be reviewed which does not bear the contractor's notation that such checking has been made.

J. No partial submittals will be considered unless approved by the Engineer.

K. Manufacturers' names shall be mentioned as acceptable prior to bidding.

L. Contractor shall verify equipment dimensions to fit the spaces provided with sufficient clearance for servicing the equipment.

M. Contractor shall review equipment submittals for compliance with schedules, specifications, and drawing plans and details. Equipment submittal shall show the proper arrangements to suit installation and maintenance such as motor location, access doors, filter removal, piping connections, etc.

N. Equipment submittal sheets shall be clearly marked indicating equipment symbol and exact selection of proposed equipment. Submittals shall clearly indicate name of manufacturer of each item.

O. For unacceptable items, the right shall be reserved to require the first named specified items.

P. Where submittals are sent with any of the above listed information missing or are incomplete they will be returned to the contractor unchecked to be completed and resubmitted. No additional time or money shall be allowed for failure to provide complete submittals on the first review.

Q. If an item requiring submittal review is ordered, purchased, shipped, or installed prior to the submittal review the item shall be removed from the job site and replaced with an approved item at contractors expense.

1.8 CLEANING & FINISHING:

A. Contractor shall, at all times, keep the premises free from waste material and rubbish. Upon completion of this Section of the work, Contractor shall remove all surplus materials and rubbish; clean all spots resulting from the mechanical work from hardware, floors, glass, walls, etc.; do all required patching up and repair all work of other trades damaged by Contractor under this Section of the work, and leave the premises in a clean orderly condition. Clean heating and cooling coils, internally and externally, and replace all air filters prior to final mechanical inspection. Remove rust, plaster, dirt, grease and oil before painting, insulating, or exposing to view the equipment, piping, ductwork, etc. in completed structure. Refinish any damaged surfaces and leave in proper working order at final completion.

1.9 EQUIPMENT SERVICING:

A. Prior to starting mechanical equipment, all motors, bearings and moving parts shall be properly oiled, greased and lubricated as required. Full and adequate maintenance service shall be given and upon completion all equipment shall be cleaned and checked and placed in perfect condition for the Owner.

B. Amount and type of lubricant shall be per manufacturer's specification.

1.10 SUPERVISION:

A. The Contractor shall supervise and direct the work with his best skill and attention. He will be solely responsible for the means, methods, techniques, sequences and procedures of construction. The Contractor will be responsible to see that the finished work complies accurately with the Contract Documents.

1.11 SAFETY REGULATIONS:

A. Contractor shall provide equipment, supervision, construction, procedures, and everything necessary to assure safety of life or property.

B. Refer also to General Condition and Special Conditions for protection clauses.

1.12 LEAK DAMAGE:

A. Contractor shall be responsible for damages to the work of other Contractors or to the building, or to its contents, people, etc., caused by leaks in any of the equipment or piping installed by him through equipment or material failures, leaking joints or disconnected pipes, fittings, or by overflows and shall make at his own expense all repairs to fixtures, building interior, contents, paint, rugs, furniture, ceiling tile, and equipment so damaged.

1.13 TOOLS AND STORAGE OF EQUIPMENT:

A. The Contractor shall furnish all necessary tools, staging and whatever may be necessary for the installation of this work and shall at all times protect this work and others, and the materials to be used therein from damage by the weather, accident and other causes, and shall repair and make good any damage thus occurring.

1.14 WORKMANSHIP:

A. Workmanship shall be the best quality of its kind for respective industries, trades, crafts and practices and shall be acceptable in every respect to the Owner and Engineer. Nothing contained herein shall relieve the Contractor from performing good work, perfect in all details of construction.

1.15 TEMPORARY FACILITIES:

A. Furnishing of temporary water, space heating, sanitary facilities, drainage lines, light and power will be as specified in Division 01 General Conditions. Contractor shall arrange to bring facilities to required location of premises. All expenses involved shall be paid by the Contractor as described in General and Special Conditions.

1.16 PAINTING BY CONTRACTOR:

A. See section 09900 for painting requirements. See also section 22 and 23 for color code requirements.

B. Painting shall be by persons experienced in painting.

C. All exposed, insulated, and bare piping, equipment, metal stands and supports shall be painted as follows:

1. The prime coat on equipment shall be factory applied. The finish coats shall be applied under Section 09900 of these specifications.
2. All equipment which is to be furnished in finished painted condition by Contractor shall be left without mark, scratch or impairment to finish upon completion and acceptance of job. Any necessary refinishing to match original shall be done by Contractor. Do not paint over name plates, serial numbers or other identifying marks.
3. All new piping shall be painted as required in Section 22 and 23. Paint colors shall conform to color code requirements as specified in "Identification of Piping and Equipment".

1.17 EQUIPMENT BASES:

A. Provide reinforced concrete bases under boilers, chillers, pumps, air handling units, and other equipment as necessary or as indicated on the drawings. Coordinate work with Division 03.

B. Bases shall be 6" high, above the finish floor. The base shall extend beyond the equipment 6" in all directions, where possible. Inserts and vibration isolation systems shall be provided and installed by the Mechanical Contractor at the time the concrete is poured to accommodate and anchor the equipment used. Coordinate with vibration isolation manufacturer's requirements and Section 22 and 23. Provide a one inch beveled edge all around.

1.18 BELT GUARDS:

A. Shall be provided, properly enclosing each belt drive system. Guards shall be easily removable, constructed of expanded metal with suitable frames corresponding with SMACNA standard and with tachometer openings. Coordinate with equipment suppliers to avoid duplication of belt guards supplied with equipment. Guards shall comply with OSHA Regulations.

1.19 ELECTRICAL WORK:

A. Power wiring to all electrically driven apparatus shall be done under the electrical contract. See Electrical Specifications.

B. Unless specifically noted otherwise on documents, Electrical Contractor shall furnish and install all magnetic starters including properly sized heaters, and disconnect switches as indicated on drawings or required by code.

C. The Contractor shall verify the proper operation of equipment furnished by him. Costs for repair, replacing, re-wiring and retesting shall be borne by the Contractor without additional costs to the Owner.

D. Motors shall be as specified.

1.20 CONTRACTOR'S USE OF BUILDING EQUIPMENT:

A. The Contractor may use equipment such as electric motors, fans, filters, etc. when permanently installed as part of the project and with the written permission of the Owner. As each piece of equipment is used, maintenance procedures approved by the manufacturer shall be followed, a careful record shall be kept of the time used, maintenance procedure following and of any difficulty experienced with equipment. The Contractor's records on the equipment shall be submitted to the Owner upon acceptance of project. All fan belts and filter media shall be new at the beginning of the Mechanical System Operating Test Run and System Balancing. Wearing surfaces (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement.

1.21 INSPECTION NOTICE:

A. The following is a basic list of guideline items so that the Architect, district building inspector/Owner's representative can be at job site for these inspections as the building progresses. Mechanical Contractor shall inform these people one week in advance of test time.

1. Water tests on all sewer, waste, and rainwater piping prior to piping being concealed.
2. Pressure tests on all water service piping.
3. Pressure tests on hot, chilled, and condenser water supply and return piping.
4. All duct work prior to installation of finished ceilings, including ductwork pressure testing.
5. The initial start-up of mechanical equipment, etc.
6. Any changes or problems occurring at job site.
7. Inspect all vent flashings on roof prior to roofing.
8. Periodic inspection at their discretion will be made to insure compliance to Contract Documents and codes. Contractor shall provide ladders, access and other assistance as requested during inspections.
9. Control piping pressure tests.
10. Final inspection before giving approval for final payment.

1.22 EXCAVATION AND BACKFILLING:

A. Trench for the underground gas pipe line shall be excavated to the required depth. Rocks, trash, or other debris will not be allowed in trench or backfill and shall be removed before pipe is laid in place. After piping has been tested, inspected and approved, piping shall be backfilled. All landscaping, concrete, etc., damaged by this Contractor shall be replaced by him to the satisfaction of Owner's Representative.

1.23 WARRANTY GUARANTEE:

A. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications as represented by manufacturer's published data.

B. The Contractor shall guarantee that the installation and operation of the equipment shall be free from defects for a period of one year beginning at date of substantial completion and acceptance. The Contractor shall replace or repair any part of the installation that is found to be defective or incomplete within the guarantee period.

C. The one year guarantee on equipment and systems shall commence when equipment has been demonstrated to work and has been accepted. (Example: If an equipment item fails to perform and it takes 9 months after substantial completion to correct, then the guarantee shall commence after the item has been demonstrated to perform and has been accepted.)

D. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.24 COMPLETION SCHEDULE:

A. Start-up and verification of basic equipment items shall be done prior to the date of substantial completion with sufficient time to allow balancing and adjusting to be performed.

B. At the time of the final inspection a date shall be agreed upon for completion of any remaining items. At least double the estimated cost of the work will be withheld from the Contractor's payment.

1.25 CODE REQUIREMENTS, FEES, AND PERMITS

A. The work shall be installed in accordance with the following applicable codes, ordinances and standards unless otherwise specified. The codes and standards shall include but not be limited to and be of the latest and current editions.

1. American Boiler and Affiliated Industries (AB and AI)
2. American Gas Association (AGA)
3. Air Movement and Control Association (AMCA)
4. American National Standards Institute (ANSI)
5. Air Conditioning & Refrigeration Institute (ARI)
6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - ASHRAE 90.1-2010
7. American Society of Mechanical Engineers (ASME)
8. American Society of Testing Materials (ASTM)
9. American Standards Association (ASA)
10. American Water Works Association (AWWA)
11. American Welding Society (AWS)
12. Associated Air Balance Council (AABC)
13. Heat Exchange Institute (HEI)
14. Hydraulic Institute (HI)
15. BR
16. National Electrical Code (NEC)
17. National Fire Protection Association (NFPA)
18. Sheet Metal and Air Conditioning contractors National Association (SMACNA)
19. Underwriters Laboratories (UL)
20. International Building Code (IBC) 2012 Ed
21. International Mechanical Code (IMC) 2012 Ed
22. International Plumbing Code (IPC) with Utah Amendments 2012 Ed
23. International Energy Conservation Code (IECC) 2012 Ed
24. Utah State Safety Orders (OSHA/UOSH)
25. Utah Fire Rating Bureau
26. Utah Boiler and Pressure Vessel Law
27. Utah Air Conservation Regulations/Waste Disposal regulations.
28. ASHRAE Ventilation STD.62-2010

B. Should drawings conflict with any code, the code shall govern. If drawings and specifications establish a quality exceeding the code, the drawings and specifications shall govern. If conflicts do exist among the drawings, specifications and codes, the same shall be brought to the attention of the Engineer in writing prior to bidding, otherwise Contractor shall comply with applicable codes.

C. The latest edition of all codes shall be used.

D. Contractor shall give all notices, obtain all necessary permits, file necessary plans, prepare documents and obtain approvals, and pay all fees required for completion of the mechanical and plumbing work outlined in this Division of the specifications and shown on the Mechanical Drawings.

1.26 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. Upon completion of work and before final payment, Contractor shall furnish and deliver to the Owner, through the Engineer, installation, operation and maintenance manuals with

instructions for all new materials and equipment used in the building. The contractor shall provide three (3) hard copies of the manuals, and three (3) CD's with electronic copies of the manuals. Electronic information shall be .PDF format. The CD's shall include the same information as the hard copies, and shall be organized in the same manner with electronic bookmarks for each section. CD case and the CD itself shall be labeled the same as the hard copies of the manuals.

B. Bind Operation and Maintenance Manual for Mechanical Systems in a hard-backed piano hinge loose-leaf binder with strong sturdy cover. The project name shall be on the spine and the front of the binder. The front of the binder shall include the following information:

OPERATION
AND
MAINTENANCE
MANUAL
for MECHANICAL SYSTEMS of
(Name of Project)
(Location of Project)
(Date of Project Award)
(Name of Architect)

C. Introduction

1. Title page including name of project, project number, date awarded and date of substantial completion.
2. Second page shall contain the names, phone numbers and addresses of Architect, Consulting Engineers, Mechanical Contractor, and General Contractor.
3. Third page shall include a Table of Contents for the entire manual.

D. First Section - Summary information including:

1. First page shall contain the contractor's warranties.
2. Second page shall contain a list of names, addresses and phone numbers of contractors and all sub-contractors and work to which each was assigned.
3. Final page or pages shall contain an equipment list. The list shall contain each item of equipment or material for which a submittal was required giving ID or tag no as contained on the drawings make and model No. Serial No. Identification No. Location in building, function along with the name, address, and phone number of the supplier.

E. Second Section - Mechanical Equipment O&M data including:

1. Mechanical maintenance schedule, including a lubrication list when necessary.
2. Mechanical Equipment Operation and Maintenance Data including:

a. Equipment descriptions
b. Detailed installation instruction, operating and maintenance instructions. Instructions include in a step by step manner identifying start-up, operating, shutdown and emergency action sequence sufficiently clear so a person unfamiliar with the equipment could perform its operations.
c. Equipment drawings, performance curves, operating characteristics, etc.
d. Name addresses and phone number of manufacturer, fabricator and local vender clearly printed or stamped on cover.
e. Complete parts listing which include catalog number, serial number, contract number or other accurate provision for ordering replacement and spare parts.
f. Certified drawings, where applicable, showing assembly of parts and general dimensions.

3. Approved Mechanical submittals

F. Third Section - Plumbing Equipment O&M data including:

1. Section shall contain general product catalog cuts, as well as exploded view drawings with parts lists for all valves and other items with multiple parts.
2. Approved Plumbing submittals

G. Fourth Section - Controls O&M data including:

1. Sequence of Operation
2. Description of each operating system included location of switches, breakers, thermostats, and control devices. Provide a single line diagram, showing set points, normal operating parameters for all loads, pressures, temperatures and flow check points; Describe all alarms and cautions for operation.
3. Provide schematic control diagrams, panel diagrams, wiring diagrams, etc. for each separate fan system, chilled water system, hot water system, exhaust air system**,** pumps, etc. Each control diagram shall show a schematic representation of mechanical equipment and location of start-stop switches, insertion thermostats, thermometers, pressure gauges, automatic valves, etc. The correct reading for each control instrument shall be marked on the diagram.

H. The Fifth Section shall contain a complete air and water test and balance report. The report shall contain the name, address and phone number of the agency. It shall also include:

1. Floor plans showing all air openings and thermometer locations clearly marked and cross referenced with data sheets. Format may be 8 1/2 x 11 or 11x14 if legible.
2. Data sheets showing amount of air and water at each setting. See sections 22 and 23.
3. List of equipment with date of last calibration.

I. Drawings and reproducible masters of drawings as required in individual specification sections, are not to be bound in volumes but are to be delivered separate with the maintenance manuals.

J. See the following checklist for assistance in assembling manual:

Item #	Description	Y, N, or NA
1.	3 ring heavy duty binder with Project name, number and date on cover and project name on spine.	
2.	O&M manual on CD (with label on CD matching label on manual). Electronic copy shall be a PDF file with bookmarks that match the tabs in the hard copy.	
3.	Title Page [including project name, number, address, date awarded, date of substantial completion]	
4.	Second Page Contact List [including architect (if applicable), mechanical engineer, mechanical contractor, and general contractor (if applicable)]	
5.	Table of Contents	
6.	**Section 1 - Summary**	
A.	Warranty	
B.	Mechanical's Sub-contractor List	
C.	Vendor List	
D.	Equipment List	
7.	**Section 2 – Mechanical Equipment**	
A.	Maintenance Schedule (including lubrication list)	
B.	Mechanical Equipment O&M Data (for each piece of equipment submitted) per specifications	
C.	Approved mechanical submittals	
8.	**Section 3 – Plumbing Equipment**	
A.	Plumbing equipment O&M data	
B.	Approved plumbing submittals	
9.	**Section 4 - Controls**	
A.	Sequence of Operation	
B.	Controls diagrams	
C.	Controls Equipment	
10.	**Section 5 – Test and Balance Report**	
A.	Complete Test and Balance Report per specifications	

1.27 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems utilizing the Operation and Maintenance Manual when so doing.

B. Minimum instruction periods shall be as follows -

1. Mechanical - Two hours.
2. Plumbing - Two hours.
3. Temperature Control - Two hours.

C. Instruction periods shall occur before final site observation when systems are properly working and before final payment is made.

D. None of these instructional periods shall overlap each other.

E. An additional four hours of instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and answer questions.

1.28 RECORD DRAWINGS

A. Contractor shall keep an up-to-date set of mechanical and plumbing drawings in his custody showing all changes in red, clearly defined and neatly drafted by him. At the end of construction, he shall turn these drawings over to the Engineer. Record drawings must be completed and submitted prior to final site observation

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PART 2 - PRODUCTS
(Not Used)

PART 3 - EXECUTION
(Not Used)

END OF SECTION

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SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Mechanical demolition.
7. Equipment installation requirements common to equipment sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. All materials, piping, etc. shall be new, and domestically made of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended unless specifically approved in writing prior to bid.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 and 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.
h. Prior Approved Equal.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
e. Linkseal.
f. Prior Approved Equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

E. PVC Pipe: ASTM D 1785, Schedule 40.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw or spring clip**s** and chrome-plated finish.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 and 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Drawings do not show every offset, or bend that may be required. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors where indicated on drawings and where penetrating will be visible to public.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 and 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION

SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Freestanding and restrained spring isolators.
3. Seismic snubbers.
4. Restraining braces and cables.

1.3 SCOPE

A. Provide letter of design intent.

B. Provide full set of seismic submittals.

C. Provide a minimum of 2 on site observations.

D. Provide final letter of compliance completion.

1.4 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.5 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: Per owner's design standards.
2. Building Classification Category: As defined in the IBC.
3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class: As defined in the IBC.
2. Assigned Seismic Use Group or Building Category: As defined in the IBC.

a. Component Importance Factor: 1.0.

1.6 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Letter of Design intent, stating company, design criteria, compliance with specifications and only exceptions that will apply. Letter shall be stamped and signed by a licensed and qualified professional engineer in this jurisdiction.

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

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic- and Wind-Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing's. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.
d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Welding certificates.

F. Qualification Data: For professional engineer and testing agency.

G. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Provide a minimum of 2 site observations, and additional observations if required.

F. Upon project completion provide a final letter of acceptance for seismic restraints system and installation.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Vibro-acoustics.
3. ISAT
4. Mason Industries.
5. Prior approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Hilti, Inc.
3. ISAT
4. Kinetics Noise Control.
5. Mason Industries.

6. Vibro-acoustics.
7. Unistrut; Tyco International, Ltd.
8. Prior approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: -steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior

applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Leave a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 23 05 53
MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment signs.
3. Access panel and door markers.
4. Pipe markers.
5. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

a. Manufacturer, product name, model number, and serial number.
b. Capacity, operating and power characteristics, and essential data.
c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.
2. Engraving: Manufacturer's standard letter style, 1/4” or larger with terms to match equipment identification.
3. Thickness: 1/8 inch, unless otherwise indicated.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

C. Access Panel and Door Markers: 1/16” thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8” center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

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

a. Bradley.
b. Kolbi.
c. Prior approved.

2. Colors: Comply with ASME A13.1, unless otherwise indicated.

3. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, furnaces, heaters, etc.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HVAC central-station and zone-type units.

B. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with black equipment markers with white lettering.
2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
4. Include signs for the following general categories of equipment:

    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.

b. Fuel-burning units, including boilers, furnaces, heaters, etc.
c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
e. Fans, blowers, primary balancing dampers, and mixing boxes.
f. Packaged HVAC central-station and zone-type units.
g. Tanks and pressure vessels.
h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.4 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

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SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:

    a. Constant-volume air systems.

2. HVAC equipment quantitative-performance settings.
3. Verifying that automatic control devices are functioning properly.
4. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

    a. Submittal distribution requirements.
    b. The Contract Documents examination report.
    c. TAB plan.
    d. Work schedule and Project-site access requirements.
    e. Coordination and cooperation of trades and subcontractors.
    f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. Approved TAB agencies:

1. Bonneville Test and Balance.
2. BTC Services.
3. Certified Test and Balance.
4. Intermountain Test and Balance.
5. Mechanical Testing Corporation
6. RS Analysis.
7. Tempco
8. Testing and Balancing, Inc.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.7 PROCEDURES FOR HEAT-TRANSFER COILS

A. Refrigerant Coils: Measure the following data for each coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.8 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.9 PROCEDURES FOR TESTING DUCT SYSTEMS

A. Perform duct leakage tests and duct cleanliness tests.

B. Duct system will be considered defective if it does not pass initial tests and inspections. The sheet metal contractor shall be responsible to make corrections and repairs as necessary to pass the tests. TAB contractor shall include initial test and 1 follow up test. Any additional follow up tests required due to system not passing shall be performed by the TAB contractor at the Division 22 and 23 contractor's expense.

3.10 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.11 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.12 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Provide final report on standard AABC or NEBB forms.

3.14 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.

2. Randomly check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.
    b. Measure water flow of at least 5 percent of terminals.
    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    d. Measure sound levels at two locations.
    e. Measure space pressure of at least 10 percent of locations.
    f. Verify that balancing devices are marked with final balance position.
    g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 00
HVAC AND PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Mineral fiber.

2. Insulating cements.
3. Adhesives.
4. Lagging adhesives.
5. Factory-applied jackets.
6. Field-applied jackets.
7. Tapes.
8. Securements.
9. Corner angles.

B. Related Sections:

1. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 and 23 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors. Provide a weather protective sheet metal jacket for outdoor installation.

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

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; All-Service Duct Wrap.
f. Prior approved equal.

G. Mineral-Fiber, Preformed Pipe Insulation:

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

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
f. Prior approved equal.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

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

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
c. Prior approved equal.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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

a. Childers Products, Division of ITW; CP-127.
b. Foster Products Corporation, H. B. Fuller Company; 85-60/ 85-70.
c. Marathon Industries, Inc.; 225.
d. Mon-Eco Industries, Inc.; 22-25.
e. Prior approved equal.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

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

a. Childers Products, Division of H.B. Fuller; CR 50 AHV2.
b. Foster Products Corporation, H. B. Fuller Company; 30-36.
c. Vimasco Corporation; 713 and 714.
d. Prior approved equal.

2. Service Temperature Range: Minus 50 to plus 180 deg F.
3. Color: White.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
8. Adhesion: 64 ounces force/inch in width.
9. Elongation: 500 percent.
10. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.
e. Prior approved equal.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

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

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.
d. Prior approved equal.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.8 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to

structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and

around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-

clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded

valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return, Air.
4. Indoor, exposed return, Air.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, concealed exhaust.
7. Indoor, exposed exhaust.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Concealed, low pressure, round rectangular, and flat-oval exhaust-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Rectangular, low pressure, supply-air duct insulation shall be lined per Section “Metal Ducts”.

D. Rectangular, return-air duct insulation shall be lined per Section “Metal Ducts”.

E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

F. Exposed or medium pressure, round and flat-oval, supply-air, and return air duct insulation shall be a perforated linear. See Section “Metal Ducts”.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
4. Vertical roof drain piping.

C. Piping System insulation:
1. Domestic Cold Water Piping -Mineral Fiber, ½”
2. Domestic Hot Water Piping -Mineral Fiber, per chart
3. Horizontal Roof Drain Piping - Mineral Fiber, 1/2”.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2016, with modifications per 2018 IECC

Fluid Operating Temperature Range and usage (F°)	**Insulation Conductivity**		**Nominal Pipe or Tube Size (inches)**				
	Conductivity Btu-in./(h-ft²-F°)	**Mean Rating Temp. F°**	**<1**	**1 to <1-1/2**	**1-1/2 to <4**	**4 to <8**	**≥8**
Heating Systems (Steam, Steam Condensate, and Hot Water)							
>350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.21-0.28	100	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine, and Refrigerant)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20-0.26	50	0.5	1.0	1.0	1.0	1.5

3.12 DUCT INSULATION SCHEDULE

A. Minimum Duct Insulation R-Value, Cooling and Heating Supply Ducts and Return Ducts ANSI/ASHRAE/IES Standard 90.1-2016.

Duct Location							
Climate Zone	**Exterior**	**Ventilated Attic**	**Unvented Attic Above Insulated Ceiling**	**Unvented Attic with Roof Insulation**	**Unconditioned Space**	**Indirectly Conditioned Space**	**Buried**
Heating- Only Ducts							
5	R-6	R-3.5	none	none	none	none	R-3.5
Cooling-Only Ducts							
5,6	R-3.5	R-1.9	R-3.5	R-1.9	R-1.9	none	none
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none
Combine Heating and Cooling							
Supply Ducts							
5	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

1. PVC: 20 mils thick.

3.14 OUTDOOR, FIELD APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Exterior piping, Exposed:

1. Aluminum jacket.

END OF SECTION

SECTION 23 33 00
DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. High Efficiency Take-Offs.
4. Motorized control dampers.
5. Turning vanes.
6. Duct-mounting access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

B. Related Sections include the following:

1. Division 22 and 23 Section "HVAC Instrumentation and Controls" for electric and pneumatic damper actuators.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. High Efficiency Take-Offs.
4. Motorized control dampers.
5. Turning vanes.
6. Duct-mounting access doors.
7. Flexible connectors.
8. Flexible ducts.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. CESCO Products.
4. Duro Dyne Corp.
5. Greenheck.

6. Penn Ventilation Company, Inc.
7. Prefco Products, Inc.
8. Ruskin Company.
9. Tamco
10. Vent Products Company, Inc.
11. Air Rite.
12. Prior approved equal.

B. Description: Multiple-blade, parallel action gravity balanced, with blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

D. Blades: 0.025-inch- thick, roll-formed aluminum.

E. Blade Seals: Neoprene.

F. Blade Axles: Galvanized steel.

G. Tie Bars and Brackets: Galvanized steel.

H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Clifco
4. Flexmaster U.S.A., Inc.
5. Leader
6. McGill AirFlow Corporation.
7. METALAIRE, Inc.
8. Nailor Industries Inc.
9. Penn Ventilation Company, Inc.
10. Ruskin Company.
11. Vent Products Company, Inc.
12. Air Rite.
13. Greenheck.
14. Prior approved equal.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Standard Volume Dampers: Opposed-blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel.
7. Bearings: Oil-impregnated bronze.
8. Tie Bars and Brackets: Aluminum.
9. Tie Bars and Brackets: Galvanized steel.

D. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 HIGH EFFICIENCY TAKE-OFF

A. Factory-manufactured rectangular-to-round or round-to-round 45 degree leading tap fabricated of 24 ga zinc-coated lockforming quality steel sheets meeting requirements of ASTM A 653, with G-90 coating.

B. One inch wide mounting flange with die formed corner clips, pre-punched mounting holes, and adhesive coated gasket.

C. Manual Volume Damper:

1. Single blade, 22 ga minimum.
2. 3/8 inch minimum square rod with brass damper bearings at each end.
3. Heavy duty locking quadrant on 1-1/2 inch high stand-off mounting bracket attached to side of round duct.

D. Approved Manufacturers:

1. HETD-L by Daniel Manufacturing.
2. STO by Flexmaster USA Inc.
3. HET by Sheet Metal Connectors Inc.
4. Hercules.
5. Clifco
6. Air-Rite.
7. Prior approved equal.

2.6 MOTORIZED CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. CESCO Products.
4. Duro Dyne Corp.
5. Greenheck.
6. McGill AirFlow Corporation.
7. METALAIRE, Inc.
8. Nailor Industries Inc.
9. Penn Ventilation Company, Inc.
10. Ruskin Company.
11. Tamco
12. Vent Products Company, Inc.
13. Air Rite.
14. Prior approved equal.

B. General Description: AMCA-rated, opposed-blade design; minimum of 0.1084-inch- thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch- thick, galvanized-steel damper blades with maximum blade width of 8 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Provide closed-cell neoprene edging.

2.7 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Available Manufacturers:

a. Ductmate Industries, Inc.
b. Duro Dyne Corp.
c. METALAIRE, Inc.
d. Ward Industries, Inc.
e. Prior approved equal.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.8 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:

a. American Warming and Ventilating.
b. CESCO Products.
c. Ductmate Industries, Inc.
d. Flexmaster U.S.A., Inc.
e. Greenheck.
f. McGill AirFlow Corporation.
g. Nailor Industries Inc.
h. Ventfabrics, Inc.
i. Ward Industries, Inc.
j. Air Rite.
k. Prior approved equal.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:

a. Less Than 12 Inches Square: Secure with two sash locks.
b. Up to 18 Inches Square: Two hinges and two sash locks.
c. Up to 24 by 48 Inches: Three hinges and two compression latches.
d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

D. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.
5. Prior approved equal.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.10 FLEXIBLE DUCTS

A. Manufacturers:

1. Flexmaster U.S.A., Inc.
2. Hart & Cooley, Inc.
3. McGill AirFlow Corporation.
4. Themaflex.
5. Quietflex
6. Prior approved equal.

B. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
3. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
4. On sides of ducts where adequate clearance is available.

I. Install the following sizes for duct-mounting, rectangular access doors:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body Plus Ladder Access: 25 by 17 inches.

J. Install the following sizes for duct-mounting, round access doors:

1. One-Hand or Inspection Access: 8 inches in diameter.
2. Two-Hand Access: 10 inches in diameter.
3. Head and Hand Access: 12 inches in diameter.

4. Head and Shoulders Access: 18 inches in diameter.
5. Body Access: 24 inches in diameter.

K. Label access doors according to Division 22 and 23 Section "Mechanical Identification."

L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

M. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with adhesive.

Q. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 22 and 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION

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SECTION 23 34 23
EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Centrifugal roof ventilators.
   2. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

   1. Wiring Diagrams: Power, signal, and control wiring.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Manufacturing Corporation.
2. Breidert Air Products.
3. Broan-NuTone LLC.
4. Carnes Company.
5. Greenheck Fan Corporation.
6. JencoFan.
7. Loren Cook Company.
8. PennBarry.
9. Prior approved equal.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Downblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Direct Drives:

1. Resiliently mounted to housing.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.

2. Overall Height: 8 inches.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Mounting Pedestal: Galvanized steel with removable access panel.
7. Vented Curb: Unlined with louvered vents in vertical sides.

G. Capacities and Characteristics: See schedules on drawings

2.2 PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Manufacturing Corporation.
2. Broan-NuTone LLC; NuTone Inc.
3. Carnes Company.
4. Chicago Blower Corporation.
5. JencoFan.
6. Loren Cook Company.
7. PennBarry.
8. Prior approved equal.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

F. Fan Drive:

1. Resiliently mounted to housing.
2. Statically and dynamically balanced.
3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
4. Extend grease fitting to accessible location outside of unit.
5. Service Factor Based on Fan Motor Size: 1.4.
6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

    a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.

8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.

9. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

H. Capacities and Characteristics: See schedules on drawings.

1. Vibration Isolators:

a. Type: Elastomeric hangers.
b. Static Deflection: 1 inch.

2. Spark Arrestance Class: A.

2.3 MOTORS

A. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops Insert device having a static deflection of 1 inch. Vibration-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Division 22 and 23 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 22 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION

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SECTION 23 37 13
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections include the following:

1. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 GRILLES AND REGISTERS

A. Fixed Face Ceiling Return, Exhaust, or Transfer Air Grille:

1. Products:

a. Carnes; RSLA.

b. Krueger; S85H.
c. Price Industries; 535.
d. Titus; 355RL.
e. Tuttle & Bailey; T70D.
f. Or equal by:

1) A-J Manufacturing Co., Inc.
2) Anemostat; a Mestek Company.
3) Dayus Register & Grille.
4) Hart & Cooley, Inc.; Hart & Cooley Div.
5) Nailor Industries of Texas Inc.

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2 inch horizontal blade spacing.
5. Frame: 1-1/4 inches wide.

2.3 CEILING DIFFUSER OUTLETS

A. Rectangular and Square Ceiling Diffusers:

1. Products:

a. Carnes.
b. Krueger.
c. METALAIRE, Inc., Metal Industries Inc.
d. Price Industries; SPD or equal by.
e. Titus.
f. Tuttle & Bailey.
g. A-J Manufacturing Co., Inc.
h. Anemostat; a Mestek Company.
i. Hart & Cooley, Inc.; Hart & Cooley Div.
j. Nailor Industries of Texas Inc.
k. Prior approved equal.

2. Material: Steel.
3. Finish: Baked enamel, white.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, provide lay-in ceiling module. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 37 14
LOUVERS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fixed, extruded-aluminum louvers.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Vertical Louver: Louver with vertical blades; i.e., the axes of the blades are vertical.

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

E. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 PERFORMANCE REQUIREMENTS

A. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 SUBMITTALS

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

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
2. Show mullion profiles and locations.
3. Wiring Diagrams: For power, signal, and control wiring for motorized adjustable louvers.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of metal finish required.

E. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

D. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.

D. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
4. For fastening stainless steel, use 300 series stainless-steel fasteners.
5. For color-finished louvers, use fasteners with heads that match color of louvers.

E. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Include supports, anchorages, and accessories required for complete assembly.

C. Provide subsills made of same material as louvers or extended sills for recessed louvers.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Nondrainable-Blade Louver:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ruskin Company; Tomkins PLC. Model ELF811 or equa by.
b. Airolite Company, LLC (The).
c. American Warming and Ventilating, Inc.; a Mestek company.
d. Arrow United Industries; a division of Mestek, Inc.
e. Carnes Company, Inc.
f. Cesco Products; a division of Mestek, Inc.
g. Greenheck Fan Corporation.
h. NCA Manufacturing, Inc.
i. Pottrof

j. Prior approved equal.

2. Fabrication: Continuous blade style.

a. Frame:

1) Frame Depth: 4 inches (102mm).
2) Material: Extruded aluminum, Alloy 6063-T5.
3) Wall Thickness: 0.125 inch (3.2mm), nominal.

b. Blades:

1) Style: Horizontal "K".
2) Material: Formed aluminum, Alloy 6063-T5.
3) Wall Thickness: 0.125 inch (3.2 mm), nominal.
4) Angle: 45 degrees.
5) Centers: 4-1/2 inches (114 mm), nominal.
6) Continuous Blade Style – Design incorporates visible mullions or frames at the perimeter of the louver only. Rear-mounted hidden blade supports are utilized at section joints and at intermediate locations as needed. Louver blade sightlines are not interrupted at section joints or blade support locations. The rear-mounted blade support depth varies depending on louver height and the design windload.

c. Assembly:

1) Factory assembled louver components. Mechanically fastened construction.

B. Performance Data:

1. Performance Ratings:

a. Based on testing 48 inch by 48 inch (1219 mm by 1219 mm) size unit in accordance with AMCA 500.

2. Free Area: 44 percent, nominal.
3. Maximum Recommended Air Flow through Free Area: 707 feet per minute (214 m/min).
4. Air Flow: 5027 cubic feet per minute (142 cu. m/min).
5. Maximum Pressure Drop (Intake): .06 inches w.g. (14.9 Pa).
6. Water Penetration: Maximum of 0.01 ounces per square foot (3.1 g/sm) of free area at an air flow of 707 feet per minute (214 m/min) free area velocity when tested for 15 minutes.

C. Design Load: Incorporate structural supports required to withstand wind load of:

1. 20 lb/sf (0.96 kPa).
2. Per Code.
3. Louvers shall be factory engineered to withstand the specified seismic loads.

a. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction.

2.4 ACCESSORIES

A. Aluminum Insulated Blank-Off Panels: 1 inch (25 mm), aluminum skin, insulated core, factory installed with removable screws and neoprene gaskets.

B. Hinged Frame: Continuous piano hinge attached to angle subframe.

C. Hinged Frame: Continuous piano hinge attached to channel subframe.

D. Bird Screen:

1. Aluminum: Aluminum, 3/4 inch by 0.051 inch (19 mm by 1.3 mm), expanded, flattened.
2. Aluminum: Aluminum, 5/8 inch by 0.040 inch (16 mm by 1 mm), expanded, flattened.
3. Aluminum: Aluminum, 1/2 inch mesh by 0.063 inch (13 mm mesh by 1.6 mm), intercrimp.
4. Steel: Galvanized steel, 1/2 inch mesh by 19 gage (13 mm mesh by 1.1 mm), intercrimp.
5. Frame: Removable, rewireable.

2.5 FINISHES

A. Kynar:

1. Coating shall conform to AAMA 2605. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
2. Standard 2-coat.
3. Pearledize 70 (2-coat mica).

B. 50 percent Floropolymer-Based Painted Finishes:

1. Coating shall conform to AAMA 2604, sections 4.2 and 4.3. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
2. Baked Enamel.
3. Pearledize 50 (2-coat mica).

C. Color for Kynar Finish:

1. Color: Custom. Refer to Drawings.

D. Anodized Finishes:

1. Class 2 Clear Anodized.

a. Comply with Aluminum Association AA-C22A41. Clear anodized finish 215-R1.
b. Apply finish following chemical etching and pretreatment.
c. Minimum Thickness: 0.7 mils (0.018 mm), 60 minute anodizing process.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 23 74 13
PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Electric-heating coils.
3. Economizer outdoor- and return-air damper section.
4. Integral, space temperature controls.
5. Roof curbs.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during

heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. VVT: Variable-air volume and temperature.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design RTU supports to comply with seismic performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

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

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Seismic-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which RTUs will be attached.
2. Roof openings
3. Roof curbs and flashing.

B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Seismic Qualification Certification: Submit certification that RTUs, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set of filters for each unit.

1.9 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. AAON, Inc.
2. Addison Products Company.
3. Carrier Corporation.
4. Engineered Air.
5. Lennox Industries Inc.
6. McQuay International.
7. Trane; American Standard Companies, Inc.
8. YORK International Corporation.
9. Prior approved equal.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.052 inch (1.3 mm) thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.034 inch (0.86 mm) thick.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1/2 inch (13 mm).
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches (50 mm) deep.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Relief-Air Fan: Forward curved, shaft mounted on permanently lubricated motor.

E. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when fan-mounted frame and RTU-mounted frame are anchored to building structure.

F. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Baked phenolic coating.
5. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections.

B. Electric-Resistance Heating:

1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:

a. Magnetic contactors.
b. Step Controller: Pilot lights and override toggle switch for each step.
c. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
d. Time-delay relay.
e. Airflow proving switch.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: One.

B. Compressor: Hermetic, reciprocating, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.

C. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Refrigerant: R-407C or R-410A.
3. Expansion valve with replaceable thermostatic element.
4. Refrigerant filter/dryer.
5. Manual-reset high-pressure safety switch.
6. Automatic-reset low-pressure safety switch.
7. Minimum off-time relay.
8. Automatic-reset compressor motor thermal overload.
9. Brass service valves installed in compressor suction and liquid lines.
10. Low-ambient kit high-pressure sensor.
11. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
12. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
13. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber: Minimum 80 percent arrestance, and MERV 5.
2. Pleated: Minimum 90 percent arrestance, and MERV 7.

2.7 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with motorized damper filter.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.8 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.9 CONTROLS

A. Basic Unit Controls:

1. Control-voltage transformer.
2. Wall-mounted thermostat or sensor with the following features:

    a. Heat-cool-off switch.
    b. Fan on-auto switch.
    c. Fan-speed switch.
    d. Automatic changeover.
    e. Adjustable deadband.
    f. Exposed set point.
    g. Exposed indication.
    h. Degree F indication.
    i. Unoccupied-period-override push button.
    j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.

2.10 ACCESSORIES

A. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature.

B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

C. Low-ambient kit using staged condenser fans for operation down to 35 deg F (1.7 deg C).

D. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

E. Coil guards of painted, galvanized-steel wire.

F. Hail guards of galvanized steel, painted to match casing.

G. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

2.11 ROOF CURBS

A. Roof mounted curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C 1071, Type I or II.
b. Thickness: 1 inch (25 mm).

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C 916, Type I.
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
d. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Curb Height: Minimum 8 inches above roof. Sloped roof.

D. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

2.12 CAPACITIES AND CHARACTERISTICS: See Schedules

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Install RTUs on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Roof Curb: Install on roof structure or concrete base, level and secure, according to ARI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

C. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. Install normal-weight, 3000-psi (20.7-MPa), compressive strength (28-day) concrete mix inside roof curb, 4 inches (100 mm) thick. Concrete, formwork, and reinforcement are specified with concrete.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.

a. Start refrigeration system.
b. Do not operate below recommended low-ambient temperature.
c. Complete startup sheets and attach copy with Contractor's startup report.

18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.

    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

27. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

a. High-temperature limit on gas-fired heat exchanger.
b. Low-temperature safety operation.
c. Filter high-pressure differential alarm.
d. Economizer to minimum outdoor-air changeover.
e. Relief-air fan operation.
f. Smoke and firestat alarms.

29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 23 82 39
UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes cabinet unit heaters with centrifugal fans and electric-resistance heating coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

E. Samples for Verification: Finish colors for each type of cabinet unit heater indicated with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which cabinet unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

B. Seismic Qualification Certificates: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Airtherm; a Mestek company.
2. Berko; Marley Engineered Products.
3. Carrier Corporation; a UTC company.
4. Engineered Air.
5. Indeeco.
6. International Environmental Corporation.
7. Markel Products Company; TPI Corporation.
8. Marley Engineered Products.
9. McQuay International.
10. QMark; Marley Engineered Products.
11. Trane Inc.
12. USA Coil & Air.
13. Prior approved equal.

2.2 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Seismic Performance: Cabinet unit heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 COIL SECTION INSULATION

A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have aluminum-foil facing to prevent erosion of glass fibers.

1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Insulation Materials: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.

1. Thickness: 3/8 inch.
2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 CABINETS

A. Material: Steel with factory prime coating, ready for field painting.

1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-thick galvanized sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick galvanized sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessed Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.

6. Extended Piping Compartment: 8-inch-wide piping end pocket.
7. False Back: Minimum 0.0428-inch-thick steel, finished to match cabinet.

2.6 FILTERS

A. Minimum Arrestance: According to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Washable Foam: 70 percent arrestance and MERV 3.
2. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.
3. Pleated: 90 percent arrestance and MERV 7.

2.7 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

2.8 CONTROLS

A. Fan and Motor Board: Removable.

1. Fan: Forward curved,double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Basic Unit Controls:

1. Control voltage transformer.
2. Wall-mounted thermostat with the following features:

    a. Heat-off switch.
    b. Fan on-auto switch.
    c. Manual fan-speed switch.
    d. Adjustable deadband.
    e. Exposed set point.
    f. Exposed indication.
    g. Deg F indication.

3. Wall-mounted temperature sensor.
4. Unoccupied period override push button.
5. Data entry and access port.

a. Input data includes room temperature and occupied and unoccupied periods.
b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

C. Electrical Connection: Factory-wired motors and controls for a single field connection.

2.9 CAPACITIES AND CHARACTERISTICS: See schedules

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in forelectrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

C. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."

F. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of cabinet unit heater. Steam specialties are specified inSection 232216 Steam and Condensate Piping Specialties."

G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

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DIVISION 26
ELECTRICAL

SECTION 26 00 00
ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide electrical and appurtenant Work necessary for a complete and operable electrical system, in accordance with the Contract Documents.

B. Make all field connections and terminations to all motors, switchgear, panels, control equipment and devices, instruments, and to all vendor-furnished packaged equipment. The requirements of this Section shall apply to all electrical items indicated in the various Sections of Division 26 unless otherwise indicated.

C. Provide all materials and incidentals required to complete the electrical Work. Typical materials which may be incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and all control wires required by vendor-furnished equipment to interconnect with other equipment all specifically indicated on the Contract Documents.

D. All concrete Work required for encasement, installation, or construction of the Work specified in the various Sections of Division 26 shall be 4,000-psi concrete conforming to the the applicable requirements of Section 03 30 00 – Cast-in-Place Concrete:
   1. If encasement concrete around duct banks is required, the following exceptions and supplementary requirements shall apply:
      a. Consolidation of encasement concrete around duct banks shall be by hand puddling, and no mechanical vibration shall be permitted.
      b. A Workability admixture shall be used in encasement concrete, which shall be a hydroxylated carboxylic acid type in liquid form. Admixtures containing calcium chloride shall not be used.
      c. Concrete for encasement of conduit or duct banks shall contain an integral red-oxide coloring pigment in the proportion of 8 pounds per cubic yard of concrete.

1.2 INTERFACE TO EQUIPMENT, INSTRUMENTS, AND OTHER COMPONENTS:

A. The contract drawings, specifications, and overall design are based on non-certified information furnished by various equipment manufacturers. This “equipment” includes, but not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.

B. The electrical specifications, ladder logic diagrams, and installation details are based on non-certified vendor information and indicate minimum scope of supply from Manufacturers.

C. Include all labor, material, and others costs in the bid to add additional instrument, wiring, control system inputs/outputs, controls, conduit, interlocks, electrical hardware, etc., into the Work based on the Equipment Manufacturer’s final certified Drawings.

D. Revise or produce new loop diagrams to meet the Equipment Manufacturer's wiring requirements.

E. Incorporate such changes to Instrumentation and Electrical Work at no additional cost to the Owner considering the Contractor's knowledge that non-certified vendor information has been used in the design, and due to the fact that the final selection of the vendor may have been by the Contractor.

F. Submit all such changes and additions to the Engineer for acceptance before starting field installation Work.

G. The Contractor is responsible for providing all material and labor needed to install the actual equipment furnished, as such the Contractor's bid includes all costs to add any additional conduit, wiring, terminals, or other electrical hardware to the design, which may be necessary to make a complete, functional installation based on the actual equipment furnished:
   1. Make all changes necessary to meet the Manufacturer's wiring requirements.
   2. Incorporate such changes to the electrical installation into the final "As-Built" Drawings.

H. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include any such items that appears on Drawings or Specifications from another discipline in the scope of Work and any costs for these items.

I. Loop drawings. Provide complete Loop Drawings for all systems, including packaged equipment furnished as part of a Vendor furnished package, and for all pre-purchased equipment.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes and Standards

NFPA 30	Flammable and Combustible Liquids Code.
NFPA 37	Installation and Use of Stationary Combustion Engines and Gas Turbines.
NFPA 70	National Electrical Code, latest edition.
NFPA 99	General Overall Requirements.
NFPA 110	Emergency and Standby Power Systems.

B. Government Standards

FS W-C-596E/GEN(1)	Connector, Plug, Receptacle and Cable Outlet, Electrical Power
FS W-S-896E/GEN(1)	Switches, Toggle (Toggle and Lock), Flush Mounted (ac)
FS WW-C-563	Electrical Metallic Tubing (EMT)

FS WW-C-581D, E	Conduit, Metal, Rigid, and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit: Steel, Zinc Coated
OSHA	Safety and Health Standards, 29 CFR 1910 and 29 CFR 1926 as applicable

C. Commercial Standards

ANSI C80.1	Zinc Coated, Rigid Steel Conduit, Specification for
ANSI C80.4	Fittings for Rigid Metal Conduit and Electrical Metallic Tubing, Specifications for
ANSI/UL 467	Grounding and Bonding Equipment, Safety Standard for
ASTM B 3	Soft or Annealed Copper Wire
ASTM B 8	Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, and Soft
ASTM B 33	Specification for Timed Soft or Annealed Cooper Wire for Electrical Purposes
ICEA S-61-402	Thermoplastic - Insulated Wire and Cable
ICEA S-66-524, NEMA WC7	Cross-Linked, Thermosetting, Polyethylene Wire and Cable
ICEA S-68-516, NEMA WC8	Ethylene Propylene Rubber Insulated Wire and Cable
NEMA 250	Enclosures for Electrical Equipment (1,000 volts maximum)
NEMA PB-1	Panelboards
NEMA VE-1	Ventilated Cable Tray
UL 6	Rigid Metal Electrical Conduit
UL 44	Rubber - Insulated Wire and Cable.
UL 514	Electrical Outlet Boxes and Fittings
UL 886	Electrical Outlet Boxes and Fittings for Use in Hazardous Locations

D. All equipment furnished by the Contractor shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated, (UL) or an independent testing laboratory acceptable to the local Code-enforcement agency having jurisdiction.

E. The construction and installation of all electrical equipment and materials shall comply with all applicable provisions of the OSHA Safety and Health Standards (29CFR1910 and

29CFR1926, as applicable), State Building Standards, and applicable local codes and regulations.

1.4 PUBLIC UTILITIES REQUIREMENTS

A. Contact the serving agencies and verify compliance with their requirements before construction.

B. Electrical service shall be as indicated by the Contract Documents.

C. Verify, furnish, and install all service conduits, fittings, transformer pad, grounding devices, and all service wires not furnished by the serving utility.

D. Verify with the utility the exact location of each service point and type of service, and pay all charges levied by the serving utilities without additional cost to the Owner.

1.5 PERMITS AND INSPECTION

A. Permits shall be obtained, and inspection fees shall be paid for as indicated in Section 00 70 00 - General Conditions.

B. Pay for any service charges required by the utility company for connection and turn on.

1.6 CONTRACTOR SUBMITTALS

A. Shop Drawings and Catalog Data: Submit shop drawings and catalog data submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit complete material lists for the Work of this Section. Such lists shall state manufacturer and brand name of each item or class of material. Submit shop drawings for all grounding Work not specifically indicated.

C. Shop drawings are required for materials and equipment listed in other sections. Shop drawings shall provide sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications. The following shall be included:
   1. Front, side, rear elevations and top views with dimensional data.
   2. Location of conduit entrances and access plates.
   3. Component data.
   4. Connection diagrams, terminal numbers, wire numbers, internal wiring diagrams, conductor size, and cable numbers.
   5. Method of anchoring, seismic requirement; weight.
   6. Types of materials and finish.
   7. Nameplates.
   8. Temperature limitations, as applicable.
   9. Voltage requirement, as applicable.
   10. Front and rear access requirements.

D. Catalog data shall be submitted to supplement all shop drawings. Catalog cuts, bulletins, brochures, or the like or photocopies of applicable pages thereof shall be submitted for mass

produced, noncustom manufactured material. These catalog data sheets shall be stamped to indicate the project name, applicable Specification section and paragraph, model number, and options. This information shall be marked in spaces designated for such data in the stamp.

E. Materials and Equipment Schedules: Furnish within 30 days, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

F. Conduit Layout: Provide drawings for underground and concealed conduits, including but not limited to ductbanks, under floor slabs, concealed in floor slabs, and concealed in walls. Provide plan and section showing arrangement and location of conduit and duct bank required for: 1) low and medium voltage feeder and branch circuits, instrumentation and control systems, communication systems, empty conduit for future use. Layouts shall be of a reproducible scale not greater than 1 inch equals 20 feet.

G. O&M Manuals: Furnish manuals as part of the shop drawing submittals under "Operation and Maintenance Manuals" in Section 01 33 00 – Submittal Procedures.

H. Record Drawings: In addition to the record drawings as a part of the record drawing requirements specified in Section 01 33 00 – Submittal Procedures, show depths and routing of all duct bank concealed below grade electrical installations. Said set of record drawings shall be available to the Engineer during construction. After final inspection, transfer all record drawing information using a red pen to a set of drawings which shall then be delivered to the Engineer. In addition, the record drawings shall show all variations between the Work as actually constructed and as originally shown on the Drawings, based upon information supplied by the Contractor.

I. Submittal organization:
   1. First page:
      a. Specification Section Reference.
      b. Name and telephone number of individual who reviewed submittal before delivery to Engineer.
      c. Name and telephone number of individual who is primarily responsible for the development of the submittal.
      d. Place the Contractor‘s review stamp and comments.
   2. Next pages:
      a. Provide confirmation of Specification compliance in tabular form that individually lists each Specification section, paragraph, and subparagraph and unequivocally states compliance with said requirement or takes exception to the requirement and lists the reason for said exception and offers alternative means for compliance.
      b. Include a response in writing with each submittal packages which is re-submitted to each of the Engineer’s comments or questions:
         1) In the order that the comments and/or questions were presented throughout the submittal.
         2) Referenced by index section and page number on which the comment appeared.

3) Acceptable responses to Engineer's comments are either: (1) Engineer's comments or change is accepted and appropriate changes are made or (2) Explain why comment is not accepted or requested change is not made, (3) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.

c. Any re-submittal, which does not contain responses to the Engineer's previous comments shall be returned for Revision and Resubmittal.

d. No further review by the Engineer will be performed until a response for previous comments has been received.

3. Remaining pages:

a. Actual submittal data:

1) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification Section.

2) For Submittals that cover multiple devices used in different areas under the same Specification Section, the Submittal for the individual devices must list the area where the device is intended to be used.

b. Advise all Equipment Suppliers of submittal requirements outlined in Section 01 33 00.

c. Use equipment and instrument tags, as depicted on the P&IDs, for all submittals.

J. Engineer's review:

1. The Engineer has allowed for up to and including 2 reviews of each submittal. The time and expense for any reviews beyond the allotted 2 reviews will be borne by the Contractor. Reference 01 33 00.

K. Material and Equipment Schedules:

1. Deliver to the Engineer a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries proposed for use, including sizes, names of Manufacturers, catalog numbers, and such other information required to identify the items.

L. Schedule of Values:

1. In addition to completing all items referred to in the schedule of values, Section 01 29 73, submit per unit material and labor costs used in developing the final bid for the electrical system, for the express purpose of pricing and cost justification for any proposed change orders. In addition to the items shown on the schedule of values, provide per unit material and labor costs for conduit and wire installation for specific types, sizes, and locations as indicated on the Drawings and Conduit Schedule. It is the responsibility of the Electrical Contractor to prove to the Engineer's satisfaction that these per unit costs were used in the development of the final bid amount. The Owner will withhold all progress payments until said schedule of values is provided and accepted by the Engineer.

M. Roof Penetrations:

1. Submit details of all portions of the electrical installation that penetrate the roof. Include details showing support of the penetrating component, and the sealing means to be utilized.

N. Installation Recommendations:
   1. Submit the Manufacturer's printed recommendations for installation of electrical equipment.

O. Record Drawings:
   1. Furnish in accordance with Section 01 78 39.
   2. Electrical Drawings will be provided for the express purpose of being used for the Record Drawings. Maintain shop drawings for use as Record Drawings:
      a. Update Record Drawings weekly.
      b. Record Drawings must be fully updated as a condition of the monthly progress payments.
      c. Submit Record Drawings upon completions of the project for final review.
   3. Clearly and neatly show all changes;
      a. Additions or changes marked in red.
      b. Deletions marked in green.
      c. Comments marked in blue.
      d. Installed systems in yellow.
      e. Invert elevations of conduit and depth below grade or floor line.
      f. Dimensions of equipment.
      g. Exact locations of equipment, underground and concealed conduit, and ductbanks.
   4. Dimensioned with reference to the structures
      a. All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
   5. Upon completion of the Work, update all shop drawings to indicate the final As-Built configuration of the systems;
      a. Reference Section 01 33 00 for specific requirements.
      b. Provide As-Built shop drawings for all electrical equipment in accordance with Section 01 33 00.
      c. Provide electronic copies of these documents when required in Division 01 33 00.
   6. Furnish manuals, or portions thereof, written specifically for this project.
      a. Provide electronic copies of these documents as required in division 01 33 00.

P. O. Specific Submittal Requirements:
   1. Furnish the submittals required by each Section in Division 26 in accordance with the following requirements.
   2. Shop Drawings
      a. Required for materials and equipment listed in this and other Sections.
      b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
      c. Shop Drawings requirements:
         1) Front, side, and rear elevations, and top and bottom views, showing all dimensions.
         2) Locations of conduit entrances and access plates.
         3) Component layout and identification.
         4) Schematic and wiring diagrams with wire numbers and terminal identification.

5) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
6) Anchoring method and leveling criteria, including Manufacturer's recommendations of the seismic conditions specified in Section 01 81 10.
7) Weight.

Q. Calculations:
1. All required calculations to be stamped and sealed by a Professional Engineer registered in the State where the project is being constructed and specializing in the specific area required by the calculation.
2. By virtue of the fact that these calculations are being provided by a Registered Professional Engineer, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculations means.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements.
1. Perform all Work to meet the requirements of all legally constituted authorities having jurisdiction.
2. Perform all Electrical Work, whether needed for the power, control system, process, HVAC, telephone, security, etc. in accordance with all codes and standards required by Division 26.
3. Perform all Work so as to comply with the accepted editions, amendments, practices, and rulings of the applicable codes and standards, except where the Drawings and Specifications are more stringent.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Acceptance of material and equipment Furnished By Others (F.B.O.):
1. Where equipment or materials are to be F.B.O. to the Contractor for installation and connection, the Contractor must:
a. Upon receiving such equipment or materials, make a complete check of all items and provide a transfer of materials document.
b. Provide the transfer of materials document as a receipt detailing the products received and the condition of the products delivered to the Contractor.
c. After Receiving and accepting the material, assume full responsibility for the safe keeping, handling, and the installation of the materials and equipment, until completed installation and final acceptance by the Engineer.
2. Failure to issue said receipt assumes that all equipment and materials were then delivered to the Contractor in the proper quantities and in perfect condition.

B. Storage and Protection:
1. Provide for the safe storage and delivery of materials, whether furnished by the Contractor or by others.
2. Replace all equipment or material, damaged before final acceptance by the Engineer in a manner acceptable to the Engineer.
3. Meet all storage requirements of the Manufacturer and provide for the safe storage of all materials and equipment as recommended by the Manufacturer.

4. Protect electrical Work at all times from damage, defacement or deterioration from any cause whatever:
    a. Provide proper storage facilities and conduct operations to this effect.
    b. Perform electrical Work in a manner as to protect the Work of other trades.

1.9 PROJECT OR SITE CONDITIONS

A. Site Conditions:
1. Provide an electrical, instrumentation and control system, including all equipment, raceways and any other components required for a complete installation that meets the Environmental conditions for the Site as specified in the General Requirements and below.
2. Seismic Classification:
    a. Provide all electrical equipment and construction techniques suitable for the seismic requirements for the Site, as specified in Section 01 81 10.
3. Wind:
    a. Provide all electrical equipment and construction techniques suitable for the Site wind loading criteria, as specified in Section 01 81 11.
4. Altitude:
    a. The site is located at approximately 5,000 feet above mean sea level. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
5. Humidity:
    a. The facility is located in an area where the relative humidity is 100 percent non-condensing. Furnish all components and equipment fully rated for continuous operation at this relative humidity level.
6. Temperature:
    a. The facility is in an area where the temperature will vary from a minimum of 31 degrees Fahrenheit to a maximum of 102 degrees Fahrenheit.
    b. Provide additional temperature conditioning equipment to maintain all equipment in non-conditioned spaces subject to these ambient temperatures 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature as determined by the equipment Manufacturer's guidelines.
7. Outdoor installations:
    a. Provide all electrical, instrumentation and control equipment installed outdoors that are suitable for operation in the ambient conditions where the equipment is located.
    b. Provide heating, cooling, and de-humidifying devices incorporated into and included with electrical equipment, instrumentation and control panels located outdoors in order to maintain the enclosures within the rated environmental operating ranges as specified in this Paragraph for the equipment:
        1) Provide all wiring necessary to power these devices.
8. Site Security:
    a. Abide by all security and safety rules concerning the Work on the Site, as specified in Section 01 35 53.

1.10 AREA DESIGNATIONS

A. General:
   1. For purposes of delineating electrical enclosure and electrical installation requirements of this project, certain areas have been classified in the Contract Documents as defined below. Electrical installations within these areas shall conform to the referenced code requirements for the area involved.

B. Electrical Work Requirements by Area:
   1. Unless otherwise specifically indicated on the Drawings or in the Conduit Schedule enclosures, conduits and Electrical Work shall be in accordance with Table 1 and requirements 1.10 C-G:

Table 1 Plant Area Electrical Work Requirements

PLANT AREA	NEMA ENCLOSURE TYPE							CONDUIT TYPE				NOTES
	1	3R	4	4X	7	9	12	PVC	EMT	GRC	PCS	
Pump Room		X								X		UON on Drawings
Electrical Room	X									X		UON on Drawings
Chemical Room				X							X	UON on Drawings

C. Indoor Concealed Locations:
   1. It is the intent of the Specifications that all indoor conduit be concealed in walls, below slab, or in ceiling space to the extent possible. Conduit installed within masonry walls to be Schedule 40 PVC. Conduit installed within accessible ceilings where not exposed to damage may be EMT. No other EMT allowed.

D. Outdoor Locations:
   1. In outdoor exposed locations, raceway shall be galvanized rigid steel (GRC) conduit; entrances shall be threaded; and fittings shall have gasketed covers. Provisions shall be made to drain the fitting or conduit system. Threaded fastening hardware shall be stainless steel. Raceway supports such as hanger rods, clamps, and brackets shall be galvanized. Attachments or welded assemblies shall be galvanized after fabrication. Instruments and control cabinets, and panel enclosures shall be NEMA Type 4X. Switchboard and transfer switch shall be weatherproof NEMA Type 3R. Enclosures shall be mounted ¾ to 1 inch from walls to provide an air space. Locations which are indoors and 2 feet below grade elevation or which are classified as damp locations on the Drawings shall have electrical installations which conform to the requirements for outdoor locations. Underground conduit shall be Schedule 40 PVC.

1.11 SEQUENCING:

A. General:
   1. Testing requirements for equipment are specified in each section of Division 26 specifications.
   2. General scheduling requirements are specified in Section 01 32 16.
   3. Work restrictions and other scheduling requirements are specified in Section 01 14 40.

B. Pre-submittal Conferences:
   1. Before producing any submittals, schedule a Pre-submittal Conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.
   2. The Contractor, Instrumentation and Control System Contractor, Electrical Contractor, and all suppliers furnishing major pieces of equipment must attend, including but not limited to:
      a. Vendor Control Panels.
      b. Chemical Feed Suppliers.
      c. Motor Control Centers.
      d. Switchgear.
      e. Variable Frequency Drive.
      f. Lighting.

C. Factory Acceptance Testing:
   1. Where Factory Acceptance Testing is required for equipment covered by these Specifications, notify the Engineer in writing when the equipment is completed and ready for factory inspection and testing;
      a. Indicate the desired dates for inspection and testing.
      b. Furnish notice at least 10 Working days before the date of the test to allow the Engineer and Owner to arrange to attend.

D. Final Review and Notice of Completion:
   1. Notify the Engineer in writing that the Work is completed and ready for final review and test:
      a. State the desired dates for the review and testing.
      b. Furnish notice at least 10 Working days before the date of the test to allow the Engineer to arrange to attend.

1.12 WARRANTY

A. Warrant the performance and the hardware of the complete electrical systems including all lamps, lighting, switchgear, circuit breakers, transformers, MCCs. VFD, etc. as stated in individual Specification Sections, but in no case shall be less than 1 year following the date of substantial completion of the Work:
   1. To fulfill this obligation, provide technical service personnel designated by the Electrical Contractor and/ or Manufacturer.
   2. Perform services to correct any defect within 3 calendar days after notification by the Owner of a defect.

B. Warrant the satisfactory performance of the software, equipment, and materials under the specified operating conditions.
   1. If operations, tests, or inspections disclose latent defects or failure to meet the specified requirements, upon notification by the Owner, promptly correct or repair any such defects or non-conformance, or furnish such new equipment or parts as may be necessary for conformity to the specified requirements.

C. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements.

Following replacement or modifications retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

D. Provide all parts, material, labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period:
   1. Furnish spare parts and tools on site at inventory levels sufficient to meet the response and repair times specified.
      a. All spare parts and tools stored on-site become the property of the Owner upon completion of the warranty period.

1.13 MAINTENANCE

A. Provide similar items of same Manufacturer throughout the Electrical and Instrumentation portion of the project.

B. Furnish all spare parts as required by other sections of the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide similar items of same Manufacturer throughout the Electrical and Instrumentation portion of the project.

B. Allowable Manufacturers are specified in individual Specifications in other Sections.

2.2 MATERIALS

A. Furnish all materials under this contract, new, free from defects, and standard products produced by Manufacturers regularly engaged in the production of these products and that bear all approvals and labels as required by the Specifications.

B. Provide materials complying with the applicable industrial standard, except where these specifications are more stringent.

C. Stainless Steel:
   1. Where stainless steel is indicated or used for any portion of the electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
   2. Provide exposed screws of the same alloys
   3. Provide finished material free of any burrs or sharp edges.
   4. Use only stainless-steel hardware, when chemically compatible, in all areas that are or could be in contact with corrosive chemicals (sulfur dioxide, caustic, fluorides, or others).
   5. Use stainless steel hardware, when chemically compatible, in all areas designated Corrosive and Wet Areas Requiring NEMA 4X Construction.

2.3 EQUIPMENT

A. Provide all equipment that is new, free from defects, and standard products produced by Manufacturers regularly engaged in the productions of these products that bear all approvals and labels as required by the Specifications.

B. Alternative Equipment and Methods:
   1. Equipment or methods requiring redesign of any project details are not acceptable without prior written approval of the Engineer through the "or equal" process as defined in the Specifications.

2.4 SOURCE QUALITY CONTROL

A. Arrange with all Manufacturers of the equipment and fabricators of panels and cabinets, to allow the Owner and Engineer to inspect and witness the testing of the equipment at the site of fabrication:
   1. Testing includes the cabinets, special control systems, power equipment, and other pertinent systems and devices.
   2. Make no shipments without the Engineer's approval.

B. Factory Testing is specified in Divisions 26 and 40.

C. Furnish all equipment listed by and bearing the label of Underwriters' Laboratories, Incorporated (UL) or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Study all Drawings and Specifications and to report to the ENGINEER before bidding:
   1. Any errors.
   2. Any omissions
   3. Any Electrical Code problems
   4. Any Local Building Code problems.
   5. Any points of conflict with other trades.

B. The Electrical Contractor is required to attend a pre-bid conference and examine the premises completely before bidding. It is the Electrical Contractor's responsibility to be fully familiar with the existing conditions and local requirements and regulations. Difficulties that arise after the Contract has been awarded which could have been avoided by a more complete initial site visit are the responsibility of the Electrical Contractor to correct.

C. Review the existing site conditions and examine all shop drawings for the various items of equipment to determine exact routing and final terminations for al wiring and cables.

D. The Contractor, through the System Supplier, is responsible for the complete electrical and instrumentation Work:

1. Install extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical, power, and Process Control and Instrumentation System.

3.2 PREPARATION

A. The construction and installation of all electrical equipment and materials must comply with all applicable provisions of the:
   1. OSHA-Safety and Health Standards
   2. State building standards
   3. Applicable local codes and regulations

B. Furnish, place, and maintain guards, night-lights, protective screens, warning signs, etc. as required to prevent accidents or injuries to all personnel.

3.3 INSTALLATION

A. Equipment locations shown on Electrical Drawings may change due to variations in equipment size or minor changes made by others during construction:
   1. Verify all dimensions indicated on the Drawings:
      a. Actual field conditions govern all final installed locations, distances, and levels.
   2. Review all information shown on the Contract Drawings, including architectural, structural, mechanical, instrumentation, and the accepted electrical and mechanical shop drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.

B. Cutting and patching:
   1. Perform all cutting, patching, channeling, core drilling, and fitting required for the Electrical Work, except as otherwise directed:
      a. Actual field conditions govern all final installed locations, distances, and levels.
         1) Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made.
            a) Verify that area is clear and free of conduits, cables, piping, ductwork, post-tensioning cables etc.
            b) Use tone-locate system or X-ray to ensure that area is clear of obstructions.
         2) Review the complete Drawing set to ensure that there are not conflicts or coordination problems before cutting, channeling, or core drilling any surface.
   2. Perform all patching to the same quality and appearance as the original Work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material, typically:

a.	3M	CP25	Caulk
b.	3M	303	Putty
c.	T&B	S-100	Caulk
d.	T&B	FS-500 Putty	

e. T&B FST-60l Putty

3. Seal around conduit penetrations of below grade walls with a waterproof, non-shrink, nonmetallic grout:
   a. Use the Installation Details provided in the Contract Drawings as a guide for acceptable sealing methods.

C. Install all conduit and equipment in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear:
   1. Install all conduits and equipment in accordance with Working space requirements as outlined in Article 110, Requirements for Electrical Installation of the National Electrical Code.

D. Earthwork and Concrete:
   1. Install all trenching, shoring, concrete, backfilling, grading and resurfacing associated with the electrical work.
   2. Notify the Engineer before encasing or backfilling any electrical work, and arrange for inspection.

E. Roof Penetrations:
   1. Make all roof penetrations, and seal around all conduits. Use pitch pockets and flashings.
   2. Roofing Contractor to make actual seals around roof penetrations.

F. Terminations:
   1. Terminate all conductors required to interconnect power, controls, instruments, panels and other equipment otherwise specifically identified.

G. Miscellaneous Installation Requirements:
   1. In case of interference between electrical equipment shown on the Drawings and the other equipment, notify the Engineer in writing of the proposed change:
      a. Obtain Engineer's acceptance of the proposed changes before they are made.
   2. Location of manholes and pullboxes shown on Drawings are approximate. Coordinate exact location of manholes and pullboxes with mechanical and civil Work.
   3. Provide additional manholes or pullboxes to those shown where they are required to make a Workable installation.
   4. Circuits of different service voltage:
      a. Install in separate raceways, hand holes, pullboxes, and junction boxes.
      b. In manholes, install all cables operating at less than 50 VDC PVC coated flexible metallic conduit.
      c. The voltage and service levels are:
         1) Medium voltage: 12.47 KV
         2) Low voltage: 120 V, 208 V, 480 V
         3) Control: less than 50 VDC

H. Labeling:
   1. Provide all nameplates and labels as required in specification Section 26 05 53.

I. Equipment Tie-Downs:

1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing requirements, which apply to the site. See seismic design criteria, Section 01 81 10.
2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., must be permanently mounted and tied down to structures in accordance with requirements, which apply to the site.

3.4 FIELD QUALITY CONTROL

A. Inspection:
1. Conduct inspection of electrical, instrumentation and control system installation in accordance with provisions outlined in Section 01 41 26 of the General Requirements.
2. Allow Owner, Engineer, or Owner's Representative access to site for inspection of materials, equipment, or installation at any time.
3. Provide any technical data or other assistance necessary to support inspection activities.
4. Electrical inspections include, but not limited to, the following:
    a. Inspect equipment and materials for physical damage.
    b. Inspect installation of compliance with plans and specifications
    c. Inspect installation for obstructions and adequate clearances around equipment.
    d. Inspect equipment installation for proper leveling, alignment, anchorage and assembly.
    e. Inspect equipment nameplate data to verify compliance with design requirements.
    f. Inspect raceway installation quality Workmanship and adequate support.
    g. Inspect cable terminations.
    h. Schedule Structural Engineer to inspect all mounting of electrical devices and all penetrations and connections to structures.
5. Inspection activities conducted during construction do not satisfy inspection requirements outlined in each section of the Division 26 specifications.

B. Testing:
1. When the electrical Work is substantially completed, notify the Engineer that the project is ready for Field Acceptance Testing.
2. Perform the acceptance test in conformance with each section of the Division 26 specifications.
3. Record results of the required tests along with the date of test:
    a. Use conduit schedule identification numbers to indicate portion of circuit tested.

C. Workmanship:
1. Use only competent and skilled personnel experiences in their trade, Working under continuous competent supervision, to perform all Work, including installation, connection, calibration, testing, and adjustment.
    a. Perform all Work, including aesthetic as well as electrical and mechanical aspects, to standards consistent with the best practices of the trade.
2. All Work is subject to review by the Engineer or Owner at any time.
3. Provide all Work to the complete satisfaction of the Engineer or Owner.

4. Repair or replace any Work, which, in the sole opinion of the Engineer, does not conform to these Specifications, or trade practices.
5. Make all changes of any installed items to meet the intent of the Drawings and Specifications.
6. Install all materials and equipment in accordance with the Manufacturer's printed installation instructions.
    a. Where Contractor asks to deviate from the Manufacturer's recommendations, such changes shall be reviewed by the Engineer and Manufacturer before installation.

3.5 CLEANING

A. General Requirements:
1. Maintain all surfaces to be painted in a clean and smooth condition.
2. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.
3. Remove all debris, rubbish, and scraps, etc. each night.
4. Leave all areas swept clean each night.
5. Wipe clean all exposed threads of conduit of the KOPR-SHIELD compound after installation.

B. Vacuum clean all electrical enclosures of any debris before any wire or cable is installed.

C. Clean and re-lamp all new and luminaries that were used in the area affected by the construction, and return all used lamps to Owner.

D. As specified in other Sections of the Specifications.

E. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
1. Neatly coil and label spare wiring lengths.
2. Shorten re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.

END OF SECTION

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SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. 600 V Class wire and cable.
2. Instrumentation Class wire and cable.
3. Network cable.
4. 600 V Class Tray cable.

B. Related Sections - Contract Documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the Contractor and its subcontractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES:

A. American Society for Testing and Materials (ASTM):
1. B3 – Standard Specification for Soft or Annealed Copper Wire.
2. B8 – Specification for Concentric-Lay Copper Conductors, Hard, Medium-Hard, or Soft.

B. Insulated Cable Engineers Association (ICEA):
1. IPCEA X-61-402 for thermoplastic insulated wire and cable for the transmission and distribution of electrical energy.
2. IPCEA S-61-402 for rubber insulated wire and cable for the transmission and distribution of electrical energy.

C. National Electrical Code (NEC):
1. Article 250 – Grounding.
2. Article 310 – Conductors for General Wiring.
3. Article 760 – Fire Alarm Systems.

D. National Fire Protection Association (NFPA):
1. Article 72 – National Fire Alarm Code.
2. Article 101 – Life Safety Code.
3. Article 262 – Standard Method of Test for Flame Travel and Smoke or Wires and Cables for Use in Air-Handling Spaces.

E. Federal Specification J-C 30A.

F. Underwriters Laboratories (UL):
1. UL 1277 – Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
2. UL 1063 – Machine-Tool Wires and Cables.
3. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords.
4. UL 2196 – Tests for Fire Resistive Cables.

5. UL 1424 – Cables for Power-Limited Fire-Alarm Circuits.
6. UL 1569 – Metal-Clad Cables.
7. UL 225 – Metal-Clad Cables and Cable-Sealing Fittings for Use in Hazardous (Classified) Locations.

G. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
1. TAI/EIA/TSB95 – Additional Transmission Performance Guidelines for 4-pair 100 W Category 5 Cabling.
2. TIA/EIA-568-A Additional Transmission Performance Specifications for 4-pair 100 W Enhanced Category 5 Cabling.
3. TSB72 - Centralized Optical Fiber Cabling Guidelines, October 1995.

1.3 DEFINITIONS

A. Definitions of terms are specified in Division 26, Section 26 00 00 "Electrical General Provisions."

B. Definitions of terms and other electrical considerations as set forth in the:
1. NEC: National Electrical Code.
2. IEEE: Institute of Electrical and Electronic Engineers.
3. ICEA: Insulated Cable Engineering Association.
4. NFPA: National Fire Protection Association.
5. ASTM: American Society of Testing Materials.

1.4 SYSTEM DESCRIPTION

A. Furnish and install the complete wire can cable system.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00, and Sections 26 00 00.

B. Product Data:
1. Manufacturer of Wire and Cable.
2. Insulation:
   a. Type.
   b. Voltage class.
3. American Wire Gauge size.
4. Conductor material.
5. Pulling compounds.

C. Shop Drawings:
1. Show splice locations.

D. Calculations:
1. Submit cable pulling calculations for all conductor sizes for pulling lengths longer than 1,000 feet.

E. Test Reports:
   1. Submit test reports for megohm tests.

1.6 QUALITY ASSURANCE

A. As specified in Section 26 00 00 and as noted below.

B. Furnish and install all wire and cable in conformance with the applicable standards.

C. All wires and cables shall be UL listed and labeled.

1.7 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00 and as noted below.

B. Provide new wires and cables manufactured within 1 year of the date of delivery to the site.

C. Delivery conductors to the site in their original unbroken packages or on their original cable reels.

D. Store conductors out of the weather and where not subject to physical or chemical damage.

1.8 WARRANTY

A. As specified in Section 26 00 00 and as noted below.

B. Provide a complete material and installation warranty for all wires and cables, for a period of 2 years from substantial completion.
   1. During the warranty period, replace any wire or cable found to be defective along with all other wires and cables in the raceway containing the defective wire or cable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following or Engineer approved equal:
   1. 600 V Class wire and cable:
      a. General Cable.
      b. Okonite Company.
      c. Rome Cable Corporation.
      d. Southwire Company.
   2. Instrumentation Class wire and cable:
      a. Alpha Wire Company.
      b. Belden.
      c. General Cable BICC Brand.
      d. Okonite Company.
      e. Rockbestos Surprenant Cable Corporation.
      f. Rome Cable Corporation.
   3. Network Cables:
      a. Belden.

b. General Cables.
c. Lucent.

2.2 MATERIALS

A. Conductors:
1. Copper per ASTM B3.
2. Minimum 97% conductivity.

2.3 MANUFACTURED UNITS

A. General:
1. Permanently mark each wire and cable with the following at 24-inch intervals.
a. American Wire Gauge (AWG) size.
b. Voltage rating.
c. Insulation type.
d. UL symbol.
e. Month and year of manufacture.
f. Manufacturer's name.
2. Identify and mark wire and cable as specified in Section 26 05 53:
a. Use integral color insulation for Number 2 AWG and smaller wire.
b. Wrap colored tape around cable larger than Number 2 AWG.

B. 600 V Class wire and cable:
1. Provide American Wire Gauge (AWG) or kcmil sizes as indicated on the drawings or in the conduit schedules:
a. When not indicated on the drawings, size wire as follows:
1) In accordance with the National Electrical Code:
a) Use 75°C ampacity ratings.
b) Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.
2) Provide Number 12 AWG minimum for power conductors.
3) Provide Number 14 AWG minimum for control conductors.
2. Provide Class B standing per ASTM B8:
a. Provide Class C stranding where extra flexibility is required.
3. Insulation:
a. THWN/THWN-2.
b. 75°C/90°C rating in wet or dry locations, respectively.
4. Multi-conductor Cables:
a. Number and size of conductors, as indicated on the drawings or in the conduit schedules.
b. Individual conductors with THWN/THWN-2 insulation.
c. Overall PVC jacket.
d. Tray Cable rated.
e. Color coding for control wire per ICEA Method 1, E-2.
f. Ground conductor: Insulated, green, and sized per NEC 250-122.

C. Instrumentation class cable:

1. Type TC.
2. Suitable for use in wet locations.
3. Voltage Rating: 600 V.
4. Temperature Rating: 90° C wet or dry location.
5. Conductors:
    a. Insulation:
        1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.
    b. Number 16 AWG stranded and tinned.
    c. Color Code:
        1) Pair: Black and white.
        2) Triad: Black, white and red.
        3) Multiple pairs or triads: Color-coded and numbered.
6. Drain Wire:
    a. 18 AWG.
    b. Stranded, tinned.
7. Jacket:
    a. Flame retardant, moisture and sunlight resistant PVC.
    b. Rip-cord laid longitudinally under jacket to facilitate removal.
8. Shielding:
    a. Individual pair-triad:
        1) Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
    b. Multiple Pair or Triad Shielding:
        1) Group Shield: Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100 percent coverage.
        2) Completely isolate group shields from each other.
        3) Cable Shield: 2.35 miles double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
    c. All shielding to be in contact with the drain wire.

D. Network cables:
1. Category 6:
    a. Conductors:
        1) 23 AWG solid bare annealed copper.
    b. Insulation:
        1) Polyolefin.
        2) 4 twisted pairs.
    c. Color code:
        1) Blue-Blue/White.
        2) Orange-Orange/White.
        3) Green-Green/White.
        4) Brown-Brown/White.
    d. Outer jacket:
        1) PVC with ripcord.
    e. Electrical characteristics:
        1) Frequency range: 1-600 MHz.
        2) Attenuation: 51.4 dB.
        3) Power sum NEXT: 32.6 dB.

4) Attenuation to Crosstalk ratio: 0.0 dB.
5) Equal Level Far-End Crosstalk (ELFEXT): 15.2 dB.
6) Power-sum ELFEXT: 15.2 dB.
7) Return loss: 17.6 dB.
8) Propagation delay: 548 nanoseconds.
9) Delay skew: 50 nanoseconds.

2.4 ACCESSORIES

A. Wire Ties:
   1. One of the following or equal:
      a. T&B "Ty-Rap" cable ties.
      b. Panduit cable ties.

2.5 SOURCE QUALITY CONTROL

A. Assembly and testing of cable shall comply with the applicable requirements of ICEA publication No. S-68-516.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Color Coding:
   1. Color coding shall be consistent throughout the facility.
   2. The following color code shall be followed for all 240/120 V and 208/120 V systems:
      a. Phase A – Black.
      b. Phase B – Red.
      c. Phase C – Blue.
      d. Single-Phase System – Black for one hot leg, red for the other.
      e. Neutral – White.
      f. Equipment Ground – Green.
   3. The following color code shall be followed for all 480/277 V systems:
      a. Phase A – Brown.
      b. Phase B – Orange.
      c. Phase C – Yellow.
      d. Neutral – Gray or White.
      e. Equipment Ground – Green.
   4. The following color code shall be followed for all 120 VAC control wiring:
      a. Power – Red.
      b. Neutral – White.
   5. The following color code shall be followed for all general purpose DC control circuits:
      a. Negative – Tan.
      b. Positive – Pink.
   6. Switch legs shall be violet. Three-way switch runners shall be pink.
   7. Wires in intrinsically safe circuits shall be light blue.
   8. Wire colors shall be implemented in the following methods:
      a. Wires manufactured of the designed color.

B. Install conductors only after the conduit installation is complete, all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry.
   1. Install wires only in approved raceways.
   2. Do not install wire:
      a. In incomplete conduit runs..
      b. Until after the concrete work and plastering is completed.

C. Properly coat wires and cables with pulling compound before pulling into conduits and prevent mechanical damage to conductors during installation:
   1. For all Number 4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
      a. Ideal products.
      b. Polywater products.
      c. 3M Products.
      d. Greenlee products.
      e. Or equal as recommended by cable manufacturer.
      f. Do not use oil, grease, or similar substances.

D. Cable pulling:
   1. For cables Number 1 AWG and smaller, install cables by hand.
   2. For cables larger than Number 1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
   3. Provide documentation that maximum installed cable tension is no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the Engineer may, at his discretion, require replacement of the cable.
   4. Where approved by the Engineer, make splices where cable pulling tension or sidewall pressure exceeds manufacturer recommendation for the specified cable size:
      a. Make splices in manholes or pull boxes only.
      b. Leave sufficient slack to make proper connections.

E. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer's recommendations.

F. Install and terminate all wire in accordance with manufacturer's recommendations.

G. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire tires:
   1. Do not lace wires in gutter or panel channel.
   2. Install all wire ties with a flush cutting wire tie installation tool:
      a. Use a tool with an adjustable tension setting.
   3. Do not leave sharp edges on wire ties.

H. Terminate solid conductors at equipment terminal screws with conductor tightly wound around the screw so that it does not protrude beyond the screw head:
   1. Wrap the conductor clockwise so that the wire loop is closed as the loop is tightened.
   2. Do not use crimp lugs on solid wire.

I. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:

1. Use ring type lugs if box lugs are not available on the equipment.

J. Provide continuous circuits from origin to termination whenever possible, except for Number 10 AWG and smaller conductors in lighting and receptacle circuits.

K. Splices:
1. Except for Number 10 AWG and smaller conductors in lighting and receptacle circuits.
2. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths, make said splices in labeled junction boxes for power conductor or termination cabinets for control and instrument conductors.
3. Power and control conductors routed in common raceways may be spliced in common junction boxes.
4. Install NEMA 4X junction and terminal boxes in wet and outdoor locations. Clearly label junction and terminal boxes containing splices with the word "SPLICE".
5. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.
6. Install splices with compression type butt splices and insulate using a heat-shrink sleeve:
    a. In wet areas, provide heat-shrink sleeves that are listed for submersible applications.
    b. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas shall be made watertight using heat-shrink sleeves that are listed for submersible.

L. Terminations (600 V or Less):
1. Terminate control and instrument conductors on terminal boards with set-screw pressure connectors, with spade or ring lug connectors.

M. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.

N. Do not use common neutrals for any lighting circuits or receptacle circuits:
1. Use a separate neutral for each phase circuit.

O. Instrumentation Class Cable:
1. Install instrumentation class cables in separate raceway systems from power cables:
    a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
    b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the drawings.
3. Ground cable shields at only one location, not at field instruments.

P. Multi-Conductor Cable:
1. Where cable is not routed in conduit with a separate ground conductor, use one conductor in the cable as a ground conductor:
    a. Use an internal ground conductor, if it is no smaller than as indicated on the drawings and meets NEC requirements for equipment ground conductor size.

b. Where two parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with one of the full-sized conductors serving as ground.

Q. LAN Cable Testing:
1. Testing scope: Test all installed LAN cables.
2. Test plan and witnessing: Obtain Engineer's approval for the test procedures as part of the submittal process. Arrange for the Engineer to witness all testing. Submit a request for witness 15 days (minimum) before the proposed test date.
3. Pre-testing:
    a. Test individual cables before installation.
        1) Before physical placement of the cable, the installer shall test each cable while on the spool with a LAN certification test device.
        2) Before the cable is installed, the installer shall check that the cable conforms to the manufacturer's attenuation specification and that no damage has been done to the cable during shipping or handling.
        3) The test shall be fully documented, and the results submitted to the Engineer, including a hard copy of all the traces, before placement of the cable.
        4) The Engineer shall be notified if a cable fails to meet specification and the cable shall not be installed unless otherwise directed by the Engineer.
4. Test Equipment:
    a. LAN certification equipment used for the testing shall be capable of testing Category 6 cable installation to TIA proposed Level III accuracy. Tests performed shall include:
        1) Near End Cross Talk
        2) Attenuation
        3) Equal Level Far End Cross Talk
        4) Return Loss
        5) Ambient Noise
        6) Effective Cable length
        7) Propagation Delay
        8) Continuity/Loop Resistance
    b. LAN certification test equipment shall be able to store and produce plots of the test results.
    c. Manufacturers – One of the following:
        1) Agilent Technologies, WireScope 350.
        2) Or approved equal.

R. Signal cable:
1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by a minimum of 12 inches.

S. Submersible cable in wet wells:
1. Provide Kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.

T. Wiring Allowances:

1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductor and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the drawings.
2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes, and duct banks within 20 linear feet of locations indicated on the drawings.

3.2 FIELD QUALITY CONTROL

A. Testing: As specified in Section 26 08 00 “Field Electrical Acceptance Tests.”

B. Grounding: As specified in Section 26 05 26 “Grounding and Bonding.”

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. ASTM International.

B. Code of Federal Regulations.

C. Institute of Electrical and Electronics Engineers, Inc.

D. InterNational Electrical Testing Association, NETA.

E. NFPA 70, National Electrical Code.

F. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment**.**

B. Related Sections include the following:
   1. Division 26 Section 26 00 00 “Electrical General Provisions”.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 26 00 00 and 01 33 20.

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

C. Other Informational Submittals: Plans showing dimensioned as-built locations of test wells.

D. Qualification Data:
   1. Submit a written resume for the individual who will perform the grounding tests detailing experience and qualifications.
   2. Submit detailed information concerning test instruments, and tester’s qualifications to perform the specified tests.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Perform work to meet the requirements of legally constituted authorities having jurisdiction. Comply with the latest editions, amendments, practices, and rulings of the following documents and organizations, except where these specifications and the drawings are more stringent:
   1. American National Standards Institute.
   2. National Electrical Code, Article 250.
   3. Local and State Codes.
   4. IEEE 81.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V, unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Grounding Electrode Conductor: Conductor shall be sized in accordance with the National Electrical Code article 250.66, except where these specifications or the drawings are more stringent.
   4. Bonding Conductors and Bonding Jumpers: Shall be sized in accordance with the National Electrical Code article 250, except where these specifications or the drawings are more stringent.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory, acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Compression Connectors:
   1. Made of high copper alloy and manufactured specifically for the particular grounding application.
   2. Suitable for direct burial in earth and concrete.
   3. Identifying compression die number inscription to be impressed on compression fitting.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 8 feet in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum or as indicated on the drawings.
   1. Bury at least 36 inches below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

B. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than six (6) inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   4. Single-phase motor and appliance branch circuits.
   5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.
7. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three (3) rods spaced at least one-rod length from each other, and located at least the same distance from other grounding electrodes. Connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from the equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

G. Ground Ring: Install as shown on Drawings.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Install as shown on Drawings.

3.5 FIELD QUALITY CONTROL

A. Qualified individual shall perform the following tests and inspections and prepare test reports:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance not less than two (2) full days after last trace of precipitation, without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity Greater Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 and 3 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. American National Standards Institute.

B. ASTM International.

C. Institute of Electrical and Electronic Engineers.

D. National Electrical Manufacturers Association.

E. NFPA 70, National Electrical Code.

F. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section Includes:
   1. Outlet boxes and covers.
   2. Conduit bodies.

B. Related Sections include the following:
   1. Division 26, Section 26 00 00 "Electrical General Provisions".
   2. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.4 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. Institute of Electrical and Electronic Engineers.
   2. National Fire Protection Association.
      a. NFPA 70, National Electrical Code.

1.5 SYSTEM DESCRIPTION

A. Provide outlet boxes for all devices such as switches, receptacles, telephones, computer terminals, security systems etc. Materials shall be suitable for environmental conditions at the location of the box.
   1. Dry.

2. Wet.
3. Water -tight.
4. Corrosive.

B. Locate outlet boxes as indicated on the drawings. Adjust locations so as not to conflict with structural requirements or other trades.

C. All spare and/or empty conduits must terminate in an outlet box.

D. Provide conduit bodies as shown on the plans or as needed to complete the conduit installation.

E. Provide conduit bodies as needed to facilitate wire pulling, or whenever the total amount of bends in a conduit run exceeds 270°, as specified in Section 26 05 34 "Conduits."

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with:
1. Division 01, Sections 01 33 00 "Submittal Procedures."
2. Division 26, Section 26 00 00 "Electrical General Provisions."

B. Product Data:
1. Furnish complete manufacturer's catalog sheets for each product to be used on this project.
2. Furnish complete manufacturer's recommended special tools to be used for installation if required.

C. As-built Drawings:
1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements
1. Outlet boxes must comply with all applicable standards of the:
a. National Electrical Code, NFPA 70.
b. National Electrical Manufacturers Association.
c. Underwriters Laboratories.
d. Joint Industry Conference.

C. Codes and Standards
   1. Cast metal boxes.
      a. UL Standard 498 and 514.
      b. Federal Specification No. W-C-586B.
   2. Malleable iron boxes.
      a. ASTM A47-77, Grade 32510

PART 2 - PRODUCTS

2.1 CONDUIT BODIES, BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Metal Boxes:
      a. Cooper Crouse-Hinds; Division of Cooper Industries, Inc.
      b. EGS/Appleton Electric.
      c. Hoffman.
      d. Thomas & Betts Corporation.
   2. Plastic and/or fiberglass boxes:
      a. Hoffman.
      b. Carlon.
   3. Plastic coated steel boxes:
      a. Robroy Industries, Inc.; Enclosure Division.
      b. OCAL – Blue, Thomas & Betts Corporation.
   4. Cast device boxes:
      a. Cooper Crouse-Hinds; Division of Cooper Industries, Inc.
      b. EGS/Appleton Electric.

B. Pressed Steel Boxes
   1. 1-piece galvanized pressed steel.
   2. Knockout type boxes.
   3. Minimum size 4" square by 2-1/8" deep.
   4. In dry heated areas requiring NEMA 1 enclosures, unless otherwise indicated or required.
   5. Solid type gang boxes:
      a. For more than 2 devices.
      b. For barriered outlets.

C. Concrete Boxes
   1. For outlets in concrete construction.
   2. Pressed steel construction, concrete tight.
   3. Knockout size ranges from 1/2" to 1".
   4. Depth as needed.
   5. Types:
      a. 4" octagon.
      b. 4" octagon ceiling boxes with hanging bars.
      c. Gangable masonry boxes:
         1) 3-1/2" deep, 3-3/4" high, length as required.

a) 2-1/2" deep boxes may be used where wall thickness precludes the use of the deeper boxes.

2) With partitions as needed.

D. Threaded-Hub Boxes

1. Use deep threaded-hub malleable iron or aluminum boxes:
   a. Where legally required.
   b. Where exposed to the weather.
   c. In unheated areas.
   d. Where subject to mechanical injury.
      1) Here defined as exposed boxes less than 10 (ten) feet above the floor in areas accessible to anyone other than authorized operating or maintenance personnel.
   e. To act as a pull box for conductors in a conduit system.
   f. Accommodate wiring devices.
2. Cast conduit fittings may be used instead of boxes, except where boxes contain devices.
3. Construction:
   a. Each box shall contain an internal green ground screw.
   b. Each box shall be furnished with a suitable gasketed cover.
   c. Use integral cast mounting lugs when surface mounted.
   d. Conduit size ranges from 1/2" to 1".
   e. Tapered threaded hubs with integral bushing.
4. Aluminum boxes shall be high-strength, copper-free 4/10 of 1% max. alloy use with aluminum rigid conduit.

E. Plastic Coated Threaded-Hub Boxes

1. Use deep threaded-hub plastic coated malleable iron boxes in corrosive areas and NEMA 4X installations, or when the conduit system is type PCS.
   a. Where legally required.
   b. Where exposed to the weather.
   c. In unheated areas.
   d. Where subject to mechanical injury.
      1) Here defined as exposed boxes less than 10 (ten) feet above the floor in areas accessible to anyone other than authorized operating or maintenance personnel.
   e. To act as a pull box for conductors in a conduit system.
   f. Accommodate wiring devices.
   g. Tapered threaded hubs with integral bushing.
2. Cast conduit fittings may be used instead of boxes, except where boxes contain devices.
3. Construction:
   a. Each box shall contain an internal green ground screw.
   b. Each box shall be furnished with a suitable gasketed cover.
   c. With integral cast mounting lugs when surface mounted.
   d. Conduit size ranges from 1/2" to 1".
   e. Double-coated, with a nominal 0.002" (2 mil) urethane on both the interior and exterior prior to application of PVC coating.
   f. With a minimum 0.040" (40 mil) PVC coating bonded to exterior.

g. With pressure sealing sleeve to protect the connection with conduit.

F. Conduit Bodies
1. Material consistent with conduit type:
   a. Cast iron bodies and covers with type GRC.
   b. Cast aluminum bodies and covers with type RAC.
   c. PVC bodies with PVC conduit.
   d. PVC coated cast iron bodies and covers with type PCS.
   e. Cast iron or aluminum bodies with pressed steel or aluminum covers with EMT conduit.
2. Mogul design conforming to NEC requirements for bending space required by 1" and larger conduit, with conductors #4 AWG and larger, or where required for wire bending space.
3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.
4. PVC coated cast iron conduit bodies and covers:
   a. Bodies prior to coating shall meet requirements for cast iron conduit bodies.
   b. 0.040-inch exterior PVC coating and 0.002-inch interior urethane coating, as required for type PCS conduit and fittings.
   c. Utilize the PVC coating as an integral part of the gasket design.
   d. Stainless steel cover screw heads shall be encapsulated with plastic to assure corrosion protection.
   e. As manufactured by:
      1) Robroy REDH2OT, form 8 and mogul.
      2) OCAL Blue, form 8 and mogul.
5. PVC conduit bodies and covers as manufactured by Carlon.
6. Cast iron and cast aluminum bodies and covers as manufactured by:
   a. Appleton FM8 and mogul.
   b. Crouse-Hinds form 8 and mogul.

G. PVC Molded Junction Boxes
1. Boxes such as FSE, FSC, FSS, FSCC, etc. will be allowed, and compression type splices may only be made in these enclosures:
   a. Integral mounting feet for surface mounting.
   b. Molded plastic hubs for solvent welded conduit terminations.
   c. Conduit range 1/2" to 1".
   d. With gasketed covers and stainless steel attachment screws.
   e. As manufactured by:
      1) Carlon.
      2) P W Pipe.
2. PVC molded conduit bodies such as T, LL, LR, LB, C, E, X, etc. will be allowed; however, no splices may be made in these conduit bodies.
   a. Molded plastic hubs for solvent welded conduit terminations.
   b. Conduit range 1/2" to 2".
      1) Type LB up to 4".
3. With gasketed covers and stainless steel attachment screws.
4. As manufactured by:
   a. Carlon.
   b. P W Pipe.

H. Fiberglass Boxes
1. NEMA 4X, watertight, dust tight, corrosion-resistant, use only with PVC conduit.
2. Constructed of molded fiberglass reinforced polyester.
3. Integral neoprene gasket on cover attached with an oil- resistant adhesive.
4. Enclosures to have internal pads for mounting optional panels and terminal kits.
5. Covers:
   a. Screw cover enclosures.
      1) Covers held in place with captive, stainless steel or monel screws.
      2) Covers attached to body with internal zinc-plated steel hinges.
   b. Quick release latch covers.
      1) Corrosion resistant fiberglass hinges.
      2) Spring-loaded fiberglass latches with a monel or stainless steel bail attached with monel or stainless steel screws.
      3) With a 316 stainless steel padlock hasp.
6. External mounting feet.
7. Meeting the following minimum standards and tests:

Physical Property	Value	ASTM Method
Flexural Strength	12,000 psi	D-790
Heat Distortion	400°F	D-648
Water Absorption (24 hours)	0.5%	D-570
Tensile Strength	5000 psi	D-651
Specific Gravity	1.8	D-792
Flammability	94V-0	UL-94
Dielectric Strength	400 V.P.M.	D-149
Arc Resistance	180 Sec	D-495

8. All boxes to be supported with a minimum of 0.25” air space between the enclosure and supporting surface.
9. As manufactured by:
   a. Hoffman Engineering, TYPE JFG.
   b. Stahlin, TYPE CL.

I. Formed Steel Enclosures Usage Designed to house electrical controls, terminals, and any other devices.
1. Steel:
   a. NEMA 12.
   b. Fabricated from 14-gauge steel.
   c. All seams continuously welded ground smooth.
   d. Door shall have a rolled lip around three (3) sides.
      1) Attached to enclosure by means of a continuous stainless steel hinge and pin.
   e. Neoprene door gasket to provide a watertight seal:
      1) Attached with an adhesive.
      2) Retained by a retaining strip.
   f. All external removable hardware shall be fabricated from heavy gauge steel and shall be zinc plated, which shall clamp the door to the enclosure body.
   g. With a hasp and staple for padlocking.
   h. With a removable print pocket.

i. Internal panels:
   1) With plated steel shoulder studs for mounting an internal panel.
   2) Mounting panels shall be steel.
j. Large enclosures shall have door and body stiffeners for extra rigidity.
k. With no holes or knockouts.
l. Finish shall be:
   1) ANSI-61, gray electrostatically-applied polyester powder inside and out over phosphatized surfaces.
   2) White electrostatically-applied polyester powder mounting plate.
m. Heavy gauge steel external mounting brackets when surface mounted.
n. Floor stand kit when shown:
   1) Fabricated from 12-gauge steel.
   2) Bottom plate 11-gauge.
   3) Heights:
      a) 6".
      b) 12".
      c) 18".
      d) 24".
   4) When a floor stand kit is used, the box shall not have any external mounting brackets.
o. As manufactured by:
   1) Hoffman.
   2) Thomas & Betts.
   3) Stahlin.
   4) Rittal.

2. Stainless Steel:
   a. NEMA 4, NEMA 4X.
   b. Fabricated from 14-gauge type 304 stainless steel.
   c. All seams continuously welded.
   d. Door shall have a rolled lip around three (3) sides:
      1) Attached to enclosure by means of a continuous stainless steel hinge and pin.
   e. Neoprene door gasket to provide a watertight seal:
      1) Attached with an adhesive.
      2) Retained by a retaining strip.
   f. All external removable hardware shall be fabricated from heavy gauge stainless steel which shall clamp the door to the enclosure body.
   g. With a hasp and staple for padlocking.
   h. With a removable print pocket.
   i. Internal panels.
      1) With stainless steel shoulder studs for mounting an internal panel.
      2) Mounting panels shall be stainless steel.
   j. Large enclosures shall have door and body stiffeners for extra rigidity.
   k. With no holes or knockouts.
   l. Finish:
      1) Brushed.
   m. Stainless steel external mounting brackets when surface mounted.
   n. Floor stand kit when shown:
      1) Fabricated from 12-gauge stainless steel.

2) Bottom plate 11-gauge.
3) Heights:
a) 6".
b) 12".
c) 18".
d) 24".
4) When a floor stand kit is used, the box shall not have any external mounting brackets.

o. As manufactured by:
1) Hoffman.
2) Thomas & Betts.
3) Stahlin.
4) Rittal.

J. Cast Iron Junction Boxes.
1. NEMA 4.
2. Recessed cover boxes.
3. Suitable for use outdoors where subject to rain, dripping, or splashing water.
4. Designed for flush mounting in walls or floors.
a. Can be surface mounted using mounting lugs.
5. Construction:
a. Cast iron box.
b. Covers.
1) Checkered plate covers suitable for foot traffic.
2) When used in areas subject to vehicular traffic H-20 loading.
c. Hot dip galvanized.
d. Neoprene gasket.
e. Stainless steel screw covers.
6. As manufactured by:
a. Floor boxes shall be OZ Gedney, Type YR, or approved equal.
b. Surface boxes shall be OZ Gedney, Type YL or YF, or approved equal.

K. Boxes Serving Fixtures or Devices.
1. Use as pull boxes wherever possible.

L. In Finished Areas.
1. Provide specific pull or junction boxes only as indicated or directed.

M. Floor type outlet boxes shall be watertight cast iron, semi-adjustable.
1. Hubbell Type B25 with S2530 cover plate.
2. Telephone outlets shall be fitted with six (6) inch bushed nipples.
3. Floor outlets in open areas for service to desks shall be similar except that the Contractor shall provide pedestal housing.
a. Hubbell SC-3098, with plate SS-309-D for power.
b. Hubbell SC-3098, with plate SS-309-T for telephone.

N. Outlet boxes shall be used as junction boxes wherever possible.

O. Where separate pull boxes are required, they shall have screw covers.

P. Outdoor boxes shall be galvanized and provided with gasketed covers and threaded hubs.

Q. Indoor boxes shall be painted, as identified and in accordance with the painting schedule.

R. For boxes not indicated:
1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system, used or as directed.
2. Outlet, switch, and junction boxes for flush-mounting in general purpose locations shall be one-piece, galvanized, pressed steel.
3. Ceiling boxes for flush mounting in concrete shall be deep, galvanized, pressed steel.
4. Outlet, switch, and junction boxes where surface mounted in exposed locations shall be cast ferrous boxes with mounting lugs, zinc or cadmium plating, and enamel finish.
5. Surface mounted boxes in concealed locations may be pressed steel.
6. Outlet, control station, and junction boxes, including covers, for installation in corrosive locations shall be fiberglass reinforced polyester, stainless steel, or plastic coated steel to match the conduit system, and shall be furnished with mounting lugs.
7. All cast boxes and pressed steel boxes for flush-mounting in concrete shall be fitted with cast, malleable box covers and gaskets.
8. Boxes for installation in plastered areas shall be stainless steel over plaster rings.

S. Recessed Boxes
1. Support recessed boxes in suspended ceilings or stud partitions with galvanized steel box hangers of types made specifically for the purpose or attach directly to wood members or blocking.
2. Secure hangers or boxes to wood with 1" long cadmium-plated, Type A pan head screws. Fully or partially hammer-driven screws are not acceptable.

2.2 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.
1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having a structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC" or "TELEPHONE" as required for each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass, or a combination of the two.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. Armorcast Products Company.
b. Carson Industries LLC.

c. CDR Systems Corporation.
d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. Armorcast Products Company.
b. Carson Industries LLC.
c. Christy Concrete Products.
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete, reinforced concrete, cast iron, hot-dip galvanized-steel diamond plate.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. Carson Industries LLC.
b. Christy Concrete Products.
c. Nordic Fiberglass, Inc.

2.3 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional Engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 APPLICATON

A. Apply conduit bodies and boxes as required by NFPA 70, National Electrical Code.

B. NEMA classification for boxes in specific areas are as specified in Section 26 00 00.

3.2 INSTALLATION

A. Where Engineer's documents do not dictate location or control, consult with the trades concerned so that outlets may be symmetrically placed in the finished module.

B. Center outlets horizontally in vertical wall panels and vertically in masonry courses.

C. Use plastic boxes in corrosive areas where the conduit system specified is PVC.

D. In general, boxes shall conform to same materials as conduit system specified.

E. All boxes and or devices mounted on walls of areas classified as wet or corrosive shall be supported, so as to maintain a minimum of 0.25" free air space between the back of the enclosure and the wall.
   1. Use machined spacers to maintain air space. Built-up washers are not acceptable.
   2. Use stainless steel, steel that is completely electro-galvanized, or nylon materials for spacers.

F. Use cast malleable iron boxes when box must support other devices.

G. Use plastic coated malleable iron boxes when used with PVC jacketed rigid steel conduit.

3.3 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth, coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors, and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

END OF SECTION

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SECTION 26 05 34
CONDUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI C80.1 – Rigid Steel Conduit – Zinc Coated.
   2. ANSI C80.3 – Electrical Metallic Tubing – Zinc Coated.

B. ASTM International.

C. International Organization for Standardization.

D. National Electrical Contractors Association.

E. National Electrical Manufacturers Association:
   1. NEMA RN-1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Steel Conduit.
   2. NEMA TC2 – Electrical Plastic Tubing and Conduit.
   3. NEMA TC3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
   4. NEMA TC13 – Electrical Nonmetallic Tubing.

F. National Fire Protection Association:
   1. NFPA 70, National Electrical Code:
      a. Table 300.5 – Minimum Cover Requirements (0 to 600 volts, Nominal)
      b. Table 300.50 – Minimum Cover Requirements (over 600 volts, Nominal)
      c. Article 344 – Rigid Metal Conduit (RMC).
      d. Article 348 – Flexible Metal Conduit (FMC).
      e. Article 350 – Liquidtight Flexible Metal Conduit (LFMC)
      f. Article 352 – Rigid Polyvinyl Chloride Conduit (PVC).
      g. Article 356 - Liquidtight Flexible Nonmetallic Conduit (LFNC).
      h. Article 358 – Electrical Metallic Tubing (EMT)
      i. Article 360 – Flexible Metallic Tubing (FMT).
      j. Article 362 – Flexible Non-metallic Tubing (ENT).
      k. Article 500 – Hazardous (Classified) Locations.

G. Society of Cable Telecommunication Engineers.

H. Underwriters Laboratories Inc:
   1. UL 1 – Standard for Safety for Flexible Metal Conduit.
   2. UL 6 – Standard for Safety for Rigid Metal Conduit.
   3. UL 360 – Standard for Safety for Liquid-Tight Flexible Steel Conduit.

4. UL 651 – Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit.
5. UL 1660 – Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
6. UL 1653 – Standard for Safety for Electrical Nonmetallic Tubing.
7. UL 94VO – Standard for Vertical Flame Test.

1.3 SUMMARY

A. Section Includes:
   1. Conduits:
      a. Metallic Conduits:
         1) Galvanized Rigid Steel Conduit (GRC).
         2) Polyvinyl Chloride Coated Rigid Steel Conduit (PCS).
         3) Flexible Metal Conduit (FMC).
         4) Liquidtight Flexible Metal Conduit (LFMC).
      b. Non-metallic Conduits.
         1) Rigid Polyvinyl Chloride Conduit (PVC).
         2) Electrical Non-metallic Tubing (ENT).
         3) Liquidtight Flexible non-metallic (LFNC).
   2. Conduit fittings and accessories.
   3. Conduit installation.

B. Related Sections include the following:
   1. Section 26 00 00 “Electrical General Provisions”.
   2. Section 26 05 33 “Raceway and Boxes for Electrical Systems”.

1.4 DEFINITIONS

A. Definitions of terms are specified in Section 26 00 00 and noted herein.

B. Abbreviations:
   1. EMT: Electrical metallic tubing.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. FMC: Flexible metal conduit.
   4. GRC: Galvanized rigid steel conduit.
   5. LFMC: Liquidtight flexible metal conduit.
   6. NBR: Acrylonitrile-butadiene rubber.
   7. PCS: PVC coated rigid Steel Conduit.
   8. PVC: Polyvinyl chloride rigid nonmetallic conduit.

C. Conduit Bodies:
   1. A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of two or more sections of the system. Includes, but not limited to: shapes – C, E, LB, T, X, etc.

D. Conduit Fitting:
   1. An accessory that serves primarily a mechanical purpose. Includes, but not limited to: bushings, locknuts, hubs, couplings, reducers, etc.

1.5 SYSTEM DESCRIPTION

A. Furnish and install conduits, conduit bodies, fittings, junction boxes and all necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.

B. The Electrical Plans are Diagrammatic in Nature:
   1. Changes in conduit locations that are consistent with the design intent but are dimensionally different, or routing to bypass obstructions which differ from what is indicated on the Drawings are not considered a deviation.
   2. Relocation of electrical equipment that affects the conduit routing or changes in routing to bypass obstructions is not considered a change or deviation.
   3. The Engineer shall be the sole source in determining whether the change is constituted as a deviation.
   4. Any deviation requires Engineer's approval.

C. The Contractor shall bear the sole responsibility of any deviations in generation location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer.
   1. Any changes resulting in additional conduits, or extra work from such deviations performed by the Contractor.
   2. Such deviations made by the Contractor shall be reflected on the Contractor supplied "As-built Drawings".
   3. Owner shall have the right to deduct the amount of applicable reimbursement, equivalent to the cost of the engineering effort required to show those unauthorized changes on Record Drawings.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00 and 26 00 00.

B. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
   1. Furnish complete manufacturer's catalog sheets for each product to be used on this project.
   2. Furnish complete manufacturer's recommended special tools to be used for installation if required.

C. As-built Drawings:
   1. Structural members in the paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Source quality-control test reports.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, HANDLING

A. Do not expose type PVC, FRD, NFC and ENT to direct sunlight.

B. Do not store conduit in direct contact with the ground.

1.9 PROJECT/SITE CONDITIONS

A. As specified in Section 26 00 00.

1.10 SEQUENCING

A. Before installing any conduit or locating any device box.
   1. Examine the complete set of Contract Drawings and Specifications, and all applicable shop Drawings.
   2. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   6. Manhattan/CDT/Cole-Flex.
   7. Maverick Tube Corporation.
   8. OCAL, Inc.
   9. O-Z Gedney; a unit of General Signal.
   10. Perma Kote.
   11. Robroy Industries.
   12. Wheatland Tube Company.

B. Galvanized Rigid Steel Conduit and Couplings (GRC):
   1. Shall comply with the following standards:
      a. ANSI C80.1 Standard for Rigid Steel Conduit – Zinc Coated.
      b. UL-6 Safety Standard for Rigid Metal Conduit.
   2. All threads: NPT standard conduit threads with a ¾-inch taper per foot:
      a. Running conduit threads are not acceptable.
   3. Hot-dip galvanized inside and out, including threads, with chromate final coating..
      a. Electro-galvanizing is not acceptable.

C. PVC-Coated Rigid Steel Conduit (PCS):
   1. The steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material and shall conform to the requirements for type GRC.
   2. Coated conduit conforms to NEMA Standard RN-1, the galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
   3. Factory bonded PVC jacket of 0.040-inch minimum thickness.
      a. The conduit system to make use of pre-jacketed couplings, elbows etc.
      b. PVC coating on conduit and associated fittings shall have no sages, blisters, lumps, or other surface defects and shall be free of holes and holidays.
   4. The PVC adhesive bond on conduit and fittings shall be greater than the tensile strength of the PVC plastic coating. Confirm bond by certified test results.
   5. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal thickness of 0.002 inch. Conduit having areas with thin or no coating shall be unacceptable.
   6. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degrees Celsius).
   7. The conduit threads shall be hot-dip galvanized or shall be galvanized after fabrication and coating of the conduit using a method that ensures complete coverage and heats the zinc and steel to a temperature that ensures the zinc alloys with the steel over the entire surface. All threads shall be coated with urethane.
   8. The exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
   9. Nominal thickness of the exterior PVC coating shall be 0.040 inches thick except where part configuration or application of the piece dictated otherwise.
   10. PCS Couplings:
      a. The conduit coupling, before plastic coating, shall be new, unused material and shall conform to appropriate UL standards.
      b. The PVC Coating on the outside of conduit couplings shall be 0.040 inches thick and have a series of longitudinal ribs to protect the coating from tool damage during installation.
      c. A PVC sleeve extending 1 pipe diameter or 2 inches, whichever is less, shall be formed at each female conduit opening of the couplings.
   11. The exterior PVC coating and the interior urethane coatings shall be factory supplied by the same manufacturer.

D. Electrical Metallic Tubing (EMT): ANSI C80.3.
   1. Minimum size ¾-inch.

E. Liquid Tight Flexible Metal Conduit (LFMC):
   1. Conforms to the following standards:
      a. UL 360.
   2. Available in the following configurations:
      a. General Purpose:
         1) Temperature range -20 degrees Celsius to +80 degrees Celsius.
      b. Oil Resistant:
         1) Temperature range -20 degrees Celsius to +60 degrees Celsius.
      c. Computer Room:
         1) Temperature range -20 degrees Celsius to +80 degrees Celsius.

d. Temperature rated.

3. Sunlight resistant, weatherproof, and watertight.
4. Manufactured from single strip steel, hot dip galvanized on all four sides before conduit fabrication.
5. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
6. With an overall polyvinyl chloride jacket.
7. With integral copper ground wire, built in the core, in conduit trade sizes ½-inch through 1-1/4-inch.
8. Minimum size ½-inch.

F. Flexible Metal Conduit (FMC)

1. Materials:
   a. Single strip steel hot-dip galvanized on all four sides before conduit fabrication.
   b. Full wall:
      1) Reduced wall thickness not allowed.
2. Interlocking design formed from continuous metal strip for integrity and flexibility.
3. UL conduits through penetration fire wall rating:
   a. 3-hour rated for steel.
   b. 2-hour rated for aluminum.
4. UL rated for Cable Tray and Environmental Air-Handling Space requirements.
5. Minimum size ¾-inch.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Galvanized Rigid Steel Conduit Expansion Fitting for Exposed Locations:
   a. Suitable for use with conduit system being used.
2. Galvanized Rigid Steel Conduit Expansion Fittings at Structural Exposed Joints:
   a. Suitable for use with conduit system being used.
3. Conduit Sleeve:
   a. Suitable for use with conduit system being used.
4. Conduit Seals:
   a. Installed at locations as indicated on the Drawings, in the specifications and as required by NEC.
   b. Suitable for use with conduit system being used.
5. Conduit Thru-wall Seals:
   a. Installed at locations as indicated on the Drawings, in the specifications and as required by NEC.
   b. Suitable for use with conduit system being used.
6. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
7. Fittings for EMT: Set-screw or compression type.
8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corporation.
   4. CANTEX Inc.
   5. CertainTeed Corp.; Pipe & Plastics Group.
   6. Condux International, Inc.
   7. ElecSYS, Inc.
   8. Electri-Flex Co.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Manhattan/CDT/Cole-Flex.
   11. RACO; a Hubbell Company.
   12. Thomas & Betts Corporation.

B. Rigid Polyvinyl Chloride Conduit (PVC):
   1. Shall be NEMA TC 2, Type EPC-40-PVC**,** unless otherwise indicated.
   2. Rated for 90 degrees Celsius conductors or cable

C. Liquidtight Flexible Non-metallic Conduit (LFNC):
   1. Provide liquid-tight and corrosion resistant flexible-non-metallic conduit and fittings.
   2. Fabricated from a hard PVC spiral completely surrounded by flexible PVC:
      a. UL listed for sunlight resistance.
      b. Suitable for use at conduit temperatures of 80 degrees Celsius dry, 60 degrees Celsius wet and 60 degrees Celsius oil resistant.
   3. Temperature Range -20 degrees Celsius to +80 degrees Celsius.

D. Electrical Non-metallic Tubing (ENT):
   1. Corrugated thermoplastic construction.
   2. Trades sizes ½-inch through 2-inch.

E. Fittings: NEMA TC 3; match to conduit or tubing type and material.

2.3 ACCESSORIES

A. Connectors and Fittings:
   1. Manufactured with compatible materials to the corresponding conduit.

B. Insulated Throat Metallic Bushings:
   1. Construction:
      a. Malleable iron or zinc plated steel when used with steel conduit, with a positive metallic conduit end stop.
      b. Integrally molded non-combustible phenolic insulated surfaces rated 150 degrees Celsius.
      c. Use fully insulated bushings on non-metallic conduit system made of high impact 150 degrees Celsius rated non-combustible thermosetting phenolic.

C. Insulated Grounding Bushings:
   1. Construction:
      a. Malleable iron or steel, zinc plated, with a positive metallic end stop.
      b. Integrally molded non-combustible phenolic insulated surfaces rated 150 degrees Celsius.
      c. Tin plated copper grounding saddle for use with copper or aluminum conductions.

D. Electrical Unions (Erickson Couplings):
   1. Construction:
      a. Malleable iron hot dip galvanized for use with steel conduit.
      b. Aluminum for use with aluminum conduit.
      c. Concrete tight, 3-piece construction.
      d. Rated for Class 1 Division Group D I hazardous areas.

E. PVC Coated Rigid Steel Conduit (PCS) Fittings:
   1. All hollow conduit fittings, which serve as part of the PCS conduit system must be coated with an exterior PVC coating and interior urethane coating as described for the conduit.
   2. The conduit fitting, before plastic coating, shall be new, unused material and shall conform to appropriate UL standards.
   3. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female conduit opening on fittings except unions. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
   4. Flexible overlapping sleeves on all hubs and couplings shall provide a vapor and moisture tight seal at every connection.

F. Liquidtight Flexible Metal Conduit (LFMC) Fittings:
   1. Construction:
      a. Malleable iron hot dip galvanized.
      b. Furnished with locknut and sealing ring.
      c. Liquidtight, rain-tight, oil-tight.
      d. Insulated throat.
      e. Furnish as straight, 45 degree elbows and 90 degree elbows.
      f. Designed to prevent sleeving:
         1) Verify complete bonding of the raceway jacket to the plastic gasket seal.
      g. Equipped with grounding device to provide ground continuity irrespective of raceway core construction. Grounding device if inserted into raceway and directly in contact with conductors shall have rolled over edges for sizes under 5 inches.
      h. Where terminated into a threadless opening using a threaded hub fitting, a suitable moisture resistant/oil resistant synthetic rubber gasket shall be provided between the outside of the box or enclosure and the fitting shoulder. Gasket shall be adequately protected by and permanently bonded to a metallic retainer.

G. Corrosion Resistant and Outdoor Liquidtight Flexible Metal Conduit (LFMC) Fittings:

1. Construction:
    a. PVC coated liquid-tight fittings with a bonded 0.04 inch thick PVC coating on the metal connector to form a seal around the SLT conduits.
    b. Connectors shall have an insulated throat and an integral sealing ring.

H. Hubs for Threaded Attachment of Steel Conduit to Sheet Metal Enclosures:
1. Construction:
    a. Shall have an insulated throat.
    b. When used in corrosive areas shall be PVC coated.
    c. Bonding locknut.
    d. Recessed neoprene o-ring to assure watertight and dust tight connector.
    e. 1/2-inch through 1-1/4-inch steel zinc electroplated.
    f. 1-1/2-inch through 6-inch malleable iron zinc plated.
    g. Aluminum with aluminum conduit.
2. Usage:
    a. All conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.

I. Sealing Fittings:
1. Construction:
    a. When used in corrosive areas shall be PVC coated.
    b. Malleable ductile iron with steel conduit.
    c. Aluminum with aluminum conduit.
    d. Crouse-Hinds Type EYD where drains are required.
    e. Crouse-Hinds Type EYS where drains are not required.
    f. UL listed for use in Class 1, Division 1, Groups A, B, C, D; Class 1, Division 2, Groups A, B, C, C; Class 2, Divisions 1 and 2; Groups E, F, and G.

J. PVC Fittings:
1. Shall include the following:
    a. Couplings.
    b. Terminal Adapters.
    c. Female Adapters.
    d. Caps.
    e. Reducer Bushings.
    f. Duct Couplings.
    g. Eng Bells.
    h. Expansion Couplings.
    i. Duct Couplings 5 degree.
    j. C – Pull Fittings.
    k. E – Pull Fittings.
    l. LB – Pull Fittings.
    m. LL – Pull Fittings.
    n. LR – Pull Fittings.
    o. T – Pull Fittings.
    p. X – Pull Fittings.
2. Materials:
    a. All devices shall be made of PVC, using the same materials as used for Type PVC conduit.

b. All metal hardware shall be stainless steel.

K. Through Wall and Floor Seals:
1. Materials
a. Body.
b. Grommet – neoprene.
c. Pressure rings – PVC coated steel.
d. Disc material – PVC coated steel.
e. Aluminum when used with conduit type RAC.

L. Expansion/Deflection Couplings:
1. Use to compensate for movement in any directions between two conduit ends that they connect.
2. Shall allow movement of ¾-inch from the normal in all directions.
3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
4. Materials:
a. End couplings – Bronze.
b. Sleeve – Neoprene.
c. Bands – Stainless Steel.
d. Bonding Jumper – Tinned copper braid.

M. Expansion Couplings:
1. Shall allow for expansion and contraction of conduit:
a. Permitting 8-inch movement, 4 inches in either direction.
2. Materials:
a. Head – Malleable or ductile iron.
b. Sleeve – Steel.
c. Insulating Bushing – Phenolic.
d. Finish – Hot dip galvanized.

2.4 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type shall comply with area as specified in section 26 00 00 “Electrical General Provisions”, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type or as indicated.

E. Finish: Manufacturer's standard enamel finish.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Apply raceway products as required by NFPA 70 – National Electrical Code and as specified in section 26 00 00 "Electrical General Provisions"

B. Minimum Raceway Size: 3/4-inch trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

E. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Conduit Installation General:
   1. Every installer of PVC coated Aluminum (PCA) or Rigid Steel (PCS) conduits shall be certified by the manufacturer for installation of the conduit.
   2. Install conduit runs in accordance with schematic representation as indicated on the Drawings and as specified. Modify conduit runs to suit field conditions, as accepted by the Engineer.
   3. Install complete conduit systems between outlets, boxes, and circuit source before conductors are installed.
   4. Install conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings.
   5. For conduit not specifically identified, i.e., lighting and receptacle conduits in process areas, the lighting and receptacle conduit materials shall match those selected for the power and process control systems.
   6. Use conduit size and type as identified in the Drawings.
   7. Route conduit to avoid drains or other gravity lines. Where conflicts occur, relocate conduit as required, at no additional cost to the Owner.
   8. Adequate clearances from high-temperature surfaces shall be provided for all conduit runs. Provide clearances as follows:
      a. Clearances of 6 inches from surfaces 113 degrees Fahrenheit to 149 degrees Fahrenheit.

b. Clearances of 12 inches from surfaces greater than 149 degrees Fahrenheit.
c. Keep conduit at least 6 inches from the coverings on hot water and steam pipes, 18 inches from the coverings on flues and breechings and 12 inches from fuel lines and gas lines.
d. Where it is necessary to route conduit close to high-temperature surfaces, a high-reflectance thermal barrier should be installed between the conduit and the surface.

9. Support conduit runs on water-bearing walls a minimum of 1 inch away from wall on an accepted channel. Use hot-dip galvanized steel or stainless steel channel, consistent with type of conduit being installed. Do not run conduit within water-bearing walls unless otherwise indicated on the Drawings.
10. All conduit to be concealed except for straight run from floor penetration to equipment. Contractor to request permission of the Engineer before running any other exposed conduit.
11. Run conduit exposed to view parallel with or at right angles to structural members, walls, or lines of the building. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends. Make changes in direction with long radius bends of with conduit bodies. Turn conduits with neat symmetrical bends.
12. Route all exposed conduit to preserve headroom, access space and work space and to prevent tripping hazards and clearance problems. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and not block or interfere with ingress or egress, including equipment removal hatches.
13. Conduit may be run in concrete members or slabs with permission of the Engineer, provided the outside diameter does not exceed 1/3 of the thickness of the concrete. Locate such conduit in the center of the concrete or where the minimum concrete cover will be 1 conduit diameter. Space conduits at least 3 diameters apart on centers. As a general rule, conduit may not cross other conduit at pipe in concrete members or slabs.
14. When installing conduit through existing slabs or walls make provisions for locating any possible conflicting items where conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into existing conduit, piping, cables, post-tensioning cables etc.
15. Conduit runs between pull boxes or junction boxes:
    a. Total bends equaling not more than 270 degrees.
    b. Install NEC required pull boxes at locations acceptable for the Engineer.
    c. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
    d. Cap spare conduits and provide plastic pulling tape below threaded cap.
    e. Provide bonding bushing and bond wire.
16. Install conduit thruwall seals where indicated on the Drawings.
17. For existing and new 2 inch and larger conduit runs, snake conduits with conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of conduit. Remove and replace conduits through which mandrel will not pass. Clean and make certain that new and existing conduit runs are not crushed or creased.
18. Conduit Sizes shall be in accordance with the NEC or specified as follows unless otherwise indicated on the Drawings:
    a. Concealed conduit in partitions or accessible ceilings: Minimum ¾ inch.
    b. Exposed Conduit: Minimum ¾ inch.

c. Rigid Steel (RGC or PSC) encased in Concrete: Minimum 1 inch.
d. Rigid PVC Encased in Concrete
e. Liquidtite and Flex Conduit Minimum ½-inch.

19. The Contractor shall be responsible for providing all sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically shown on the Drawings.

C. Corrosive Areas:
1. Use conduit system as indicated on the Conduit Schedules.
a. Install PCS in corrosive areas where conduit may need to be self-supporting or where subject to mechanical damage.
b. Use liquid tight flexible conduits (SLT or NFC) and corrosion resistant connectors.
c. GRC where area and conduit are to be painted using an epoxy based paint.

D. Conduit Usage:
1. General Conditions:
a. Except as otherwise indicated, provide the type of conduit legally permitted or required for each location or condition.
b. Seal ends of all conduit with approved, manufactured conduit seals, caps or plugs immediately after installation. Keep ends sealed until immediately before pulling conductors.
c. Conduit sizes not indicated in the schedule or on the Drawings shall be in accordance with NEC requirements and shall be sized based on quantities of sizes of wire installed therein, including the insulated grounding conductor.
d. Conduit types not specified shall be consistent with other conduit systems in the area, the area classifications, and enclosure requirements.
e. Use insulated metallic bushings for all metallic conduit.
2. Underground and Embedded Conduits:
a. Install minimum 2-inch ductbank conduit, unless otherwise indicated on the Drawings.
b. Use types and systems as indicated on the Drawings.
1) PVC Schedule 40 in embedded locations and underground in ductbanks.
c. Use Type PCS or PVC wrapped GRC conduit and elbows for underground and embedded installations as follows:
1) Stub-up and risers to grade floor or equipment from non-metallic conduits.
2) Entering and exiting underground conduit runs a minimum 12 inches above and below grade or finished floor.
3) All 90-degree elbows with a bend radius of 12 inches or less.
d. Install underground conduits in conformance with Section 26 00 00 “Electrical General Provisions”, and as shown or required on the Drawings.
e. Make conduit size transitions at pullboxes and manholes for underground conduits.
f. Install spare conduits in underground duct banks towards top center of runs to allow for ease of installation of future cables as conduits enter underground manholes and pullboxes.
3. PVC Coated Rigid Steel Conduit (PCS):

a. Use specifically manufactured or machined threading dies to manufacturer's specifications to accommodate the PVC jacket.
b. Use only manufactured approved tools for clamping conduit.

4. Galvanized Rigid Steel Conduit (GRC):
   a. Use Type GRC in locations as identified in specification 26 00 00 "Electrical General Provisions" and as shown or required on the drawings.
   b. Conduit shall be cut square and reamed before threading.
5. Flexible Conduit:
   a. Use flexible conduit for short lengths for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment or where required for equipment servicing.
   b. Maximum length of flexible conduit 36 inches.
   c. Use Type LFMC in wet and damp locations, areas exposed to the weather, corrosive areas where NEMA 4X construction is required and conduit type is PCS, or as indicated on the Drawings or conduit schedule, provided the jacket temperature limitations will not be exceeded:
      1) Use UL sunlight resistant outdoors and in the presence of ultraviolet lights.
   d. Use type LFNC in all corrosive atmospheres where conduit type is PVC and where indicated on the plans or conduit schedule.
   e. Use explosion proof flexible conduit in Class I Division hazardous areas. In Class 1, Division 1 areas, flexible fittings must be approved and marked suitable for Class 1, Division 1, and must also be listed for compatibility with the Group type atmosphere when used.
   f. In Class I, Division 2 areas, use liquidtight metal conduit with approved fittings.
      1) Maximum length of liquidtight metal conduit is 18 inches.
6. Non-Metallic Conduit (PVC):
   a. Conduit terminations shall be vi threaded adapters into threaded hubs on the junction boxes or conduit bodes.
   b. Conduit terminations into boxes without threaded hubs shall utilize a threaded adapter and a flat neoprene washer on the outside of the box. Use a locknut on the inside of the box to tighten the adapter to the box:
      1) Flat washers as manufactured by Carlon, Type E943, DW, EW, FW, GW, HW, and JW.
   c. Install PVC conduit for exposed runs only when indicated on the Drawings. Route conduit so as to afford it the maximum physical protection. If necessary, cover conduit to afford additional protection when it cannot be shielded by the structure or machinery frames:
      1) Use schedule 80 where exposed runs may be subject to physical damage.
   d. Use UV resistant conduit where it can be exposed to ultraviolet light and in exposed outdoor areas.

E. Conduit Joints and Bends:
   1. General:
      a. Where conduits are underground, under slabs on grade, exposed to the weather or in wet locations, make joints liquid tight and gas-tight.

b. Keep bends and offsets in conduit runs to an absolute minimum. For the serving utilities, make large radius ends to meet their requirements.
c. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
d. Bend conduit to radius as legally required.
e. All bends shall be symmetrical.
f. All of the following conduit systems shall use large radius sweep elbows:
    1) Underground conduits.
    2) Conduits containing medium voltage cables.
    3) Conduits containing shielded cables.
    4) Conduits containing fiber optic cables.

2. Threaded Conduit:
a. Cut threads on GRC, IMC, and RAC with a standard conduit cutting die that provides a ¾-inch per foot taper and to a length such that all bare metal exposed by the threading operation will be completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that all joints will become secure and wrench tight just preceding the point where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.
b. Thoroughly ream conduit after threads have been cut to remove burrs. Seal joints with accepted conductive sealant compound and make watertight. Set up joints tight. Use bushings or conduit fittings at conduit terminations.
c. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing "Galvabar" or CRC "Zinc It."
d. Threaded conduit joints shall be coated with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation.
    1) Use KOPR-Shield as manufactured by T&B on threads of ferrous conduit.
    2) Use AP* ALUMA-Shield as manufactured by T&B on threads of aluminum conduit.
    3) Apply to the male threads and tighten joints securely.
    4) Clean excess sealant from exposed threads after assembly.
e. Securely tighten all threaded connections.
f. Any exposed threaded surface must be cleaned and coated with a galvanizing solution so that all exposed surfaces have a galvanized protective coating before painting.
g. Provide large radius factory-made bends for 1-1/4-inch trade size or larger or field-bend the conduit with power bending equipment specifically intended for the purpose and made so that the conduit is not damaged and the internal diameter is not effectively reduced.
h. Bends should be made with a radius of not less than the requirements found in the NEC:
    1) The radius must be greater than the minimum bending radius of the cable.
    2) A field bend shall be made with power bending equipment or manual benders specifically intended for the purpose and made so that the conduit is not damaged and the internal diameter is not effectively reduced.

3. Non-Metallic (PVC):
    a. Use approved solvent-weld cement specifically manufactured for the purpose. Spray type cement is not allowed.
4. Apply heat for bends so that conduit does not distort or discolor. Use a spring mandrel as required to assure full inside diameter at all bends.

F. Support raceways as specified below:
1. General:
    a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications.
    b. Support conduit at the intervals required by the NEC.
    c. Perforated strap and plumbers tape are not acceptable for conduit supports.
    d. Do not install one inch or larger conduits in or through structural members unless approved by the Engineer.
    e. Conduit fittings and supports are not shown on the Drawings. The Contractor shall provide all fittings and supports required to suit the conditions.
    f. Securely fasten exposed conduits with clamps or straps. Run exposed conduit on walls and ceilings only, parallel to planes of walls or ceilings. Do not run conduit diagonally.
2. Above Suspended Ceilings:
    a. Support conduit on or from the structure, conduit shall not be supported from hanging wires or suspended ceiling grid.
3. Concealed Conduit on Wood:
    a. Use 2-hole galvanized steel straps screwed or nailed to the wood or hammer-driven supports of the stamped galvanized type having serrated or sawtooth edges on the driven portion and designed specifically for the size and type of conduit being supported. Drive these latter supports so that the conduit is tightly and rigidly supported. Replace any dented or damaged conduit.
4. In Steel Stud Construction:
    a. Tie conduit at a maximum 4-foot intervals with No. 16 gauge double annealed galvanized wire so that conduit cannot move from vibration or other causes.
5. Conduit on Concrete or Masonry:
    a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
    b. Use preset inserts in concrete when possible.
    c. Use pipe spacers (clamp backs) in wet locations.
    d. On plaster or stucco, use 1-hole malleable iron straps with toggle bolts.
6. Conduit on Metal Decking:
    a. Use 1-hole malleable iron straps with 1-inch long cadmium-plated Type A panhead sheet metal screws. Fully or partially hammer-driven screws are not acceptable.
7. Suspended Conduit:
    a. Use malleable iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.
    b. For grouped conduits, construct racks with threaded rods and tiered angle-iron or Unistrut cross members. Clamp each conduit individually to a cross member. Where rods are more than 2 feet long, provide rigid sway bracing.
8. Supports at Structural Steel Members:

a. Use beam clamps.
b. Drilling or welding may be used only as indicated or with approval of the Engineer.

9. PVC Coated Rigid Steel Conduit (PCS) systems:
   a. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All "U" bolts shall be supplied with PVC encapsulated nuts that cover the exposed portions of the threads.
   b. Securely fasten exposed PCS conduits with Type 316 stainless steel clamps or straps or PVC coated clamps or straps manufactured and supplied by the PCS conduit supplier.

G. EMT shall only be permitted when concealed within finished walls, and ceilings, of offices and control rooms unless otherwise indicated.

H. Expansion or Expansion/Deflection Fittings:
1. General:
   a. Align expansion coupling with the conduit run to prevent binding.
   b. Follow manufacturer's instructions to set the piston opening.
   c. Install expansion fittings across concrete expansion joints and at other locations where necessary to compensate for thermal or mechanical expansion and contraction as indicated on the Drawings.
   d. Shall be of the same material as the conduit system.
2. For metallic conduit (PCS, GRC and RAC) use expansion or expansion/deflection couplings, as appropriate, where:
   a. Conduit may be affected by dissimilar movements of the supporting structures or medium or conduit crosses building or structural expansion joints.
   b. These fittings shall be constructed in such a manner that will provide the continuity of the ground path in each conduit or raceway.
   c. Install expansion fittings a minimum of every 200 feet in straight conduit runs.
3. For PVC use expansion or expansion/deflection couplings, as appropriate, where length change due to temperature variation exceeds 2 inches:
   a. Rigidly fix the outer barrel of the expansion coupling so it cannot move.
   b. Mount the conduit connected to the piston loosely enough to allow the conduit to move as the temperature changes.

I. Empty Conduits:
1. Provide a polyethylene rope rated 250 pounds tensile strength in each empty conduit more than 10 feet in length.
2. Provide conduit marker tags for each spare conduit.

J. Miscellaneous:
1. Provide flashings and counter flashings or pitch pockets for waterproofing of raceways, outlets, fittings, and other items that penetrate the roof.
2. Electrical unions shall be used at all points of union between ends of rigid conduit systems that cannot otherwise by coupled. Running threads and threadless couplings shall not be used.

3. Transition fittings to mate steel conduit to PVC conduit, and PVC access fittings, shall be furnished by or as recommended by the manufacturer or the PVC conduit.
4. Where a transition between PVC conduit and rigid conduit systems is required, such transition shall be accomplished by means of a PCS elbow or a minimum 3 foot length of PCS conduit.
5. Any conduit installed that the Engineer determines does not meet the best practices of the trade shall be replaced by the Contractor at no cost to the Owner.

K. Field Conditions and Related Requirements:
1. Underground water table may be near or above the location of new ductbanks.
2. Contractor shall include cost for necessary dewatering, and cleaning equipment to perform work in underground ductbanks, pull boxes and manholes, before installation.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom with 6" of select backfill below the conduits. Select backfill shall pass through a ¾" sieve frame and contain less than 30 percent rock solids by volume.
2. Install select backfill around conduits and 18 inches above conduits.
3. Duct shall be assembled using high impact nonmetallic spacers and saddles to provide conduits with vertical and horizontal separation. Plastic spacers shall be set every 5 feet.
4. The duct shall be laid on a grade line of at least 4 inches per 100 feet, sloping towards pullboxes or manholes. Duct shall be installed and pullbox and manhole depths adjusted so that the top of the duct is a minimum of 24 inches below grade or as shown on the drawings.
5. Couplings shall be staggered at least 6 inches vertically.
6. Each bore of the completed duct bank shall be cleaned by drawing through it a standard flexible mandrel one foot long and 1/4-inch smaller than the nominal size of the duct through which the mandrel will be drawn. After passing of the mandrel, draw a wire brush and swab through.
7. A raceway, in the duct envelope, which does not require conductors, shall have a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway.
8. Duct bank penetration through walls of manholes or pullboxes, and on building walls below grade shall be watertight.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor. All underground rigid steel conduit shall be PVC-coated or taped.
    a. Couple steel conduits to ducts with adapters designed for this purpose.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
10. Warning Tape: Bury warning tape approximately 18 inches above direct-buried conduits. Align tape along the centerline of conduit bank.

B. Concrete-Encased Ducts: Support ducts on duct separators.

1. The type of concrete used is specified in section 26 00 00 "Electrical General Provisions.
2. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
3. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
4. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
5. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
6. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
7. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
8. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor. All underground rigid steel conduit shall be PVC-coated or taped.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

C. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.4 CONDUIT PENETRATIONS:

A. Conduit Penetrations on walls, concrete structures, pull boxes, and equipment cabinets shall be performed in accordance with the following:
   1. Seal all raceways entering structures at the first box or outlet with conduit sealant to prevent the entrance into the structure of gases, liquids, or rodents.
   2. Dry pack with nonshrink grout around raceways that penetrate concrete walls, floors, or ceilings aboveground, or use one of the methods indicated for underground penetrations.
   3. Where an underground conduit enters a structure through a concrete roof or a membrane waterproofed wall or floor, provide an acceptable, malleable iron, watertight, entrance sealing device. When there is no raceway concrete encasement, provide such device having a gland type sealing assembly at each end with pressure bushings which may be tightened at any time. When there is raceway concrete encasement indicated, provide such a device with a gland type sealing assembly on the accessible side. Securely anchor all such devices into the masonry construction with one or more integral flanges. Secure membrane waterproofing to such devices in a permanently watertight manner.
   4. Where an underground raceway without concrete encasement enters a structure through a nonwaterproofed wall or floor, install a sleeve made of Schedule 40 galvanized pipe. Fill the space between the conduit and sleeve with a suitable plastic expandable compound, or an oakum and lead joint, on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device may be used in lieu of the sleeve.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials are specified in section 26 00 00 "Electrical General Provisions".

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for identifying electrical, instrumentation, and process equipment and components.
   2. Material, manufacturing and installation requirements for identification devices.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCE

A. Refer to Division 26, Section 26 00 00 "Electrical General Provisions" for a list of references.

1.3 DEFINITIONS

A. Definitions of terms are specified in Section 26 00 00.

1.4 SYSTEM DESCRIPTION

A. Nameplates:
   1. Provide a nameplate for each piece of electrical equipment, process equipment, valve, pump, mixer, feeder, fan, air-handling unit, motor, switch, receptacle, controller, instrument transducer, instrument power supply, solenoid, motor control center, starter, panelboard, switchboard, individually mounted or plug-in type circuit protector or motor controller, disconnect switch, bus duct tap switch, time switch, relay and for any other control device or major item of electrical equipment, either located in the field or within panels.
   2. All nameplates shall be of identical style, color, and material throughout the facility.
   3. Device nameplates shall include:
      a. Designations as shown on the drawings and identified on the Process and Instrumentation Drawings.
      b. Device tag and loop number ID (i.e. EDV-60.0101.01).
      c. Circuit ID (i.e. LPA-111).
      d. Area served (i.e. Lighting Chemical Building).
      e. Black lettering on white background, laminated plastic.

B. Wire Numbers:
   1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
      a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.

b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
c. Internal panel wires on a common terminal shall have the same wire number.
d. Multiconductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. All multi-conductor and instrumentation cables shall be identified at pull points as described above:
    1) Label armored multiconductor cable using the conduit number as indicated on the drawings, following the requirements for conduit markers in Section 26 05 34 "Conduits."

2. Provide the following wiring numbering schemes throughout the project and used for field wires between Process Control Module (PCM's), Vendor Control Panels (VCP's), Motor Control Centers (MCC's), field starters, and field instruments:
    a. (ORIGIN LOC.)-(ORIGIN TERM.)/(DEST. LOC.)-(DEST. TERM.) OR
    b. (ORIGIN LOC.)-(ORIGIN TERM.)
    c. (DEST. LOC.)-(DEST. TERM.)
        1) ORIGIN LOC. = Designation for originating panel or device.
        2) ORIGIN TERM. = Terminal designation at originating panel or device.
        3) DEST. LOC. = Designation for destination panel or device.
        4) DEST. TERM. = Terminal designation at destination panel or device or PLC I/O address at destination panel.

3. Where:
    a. Identify equipment and field instruments as the origin.
    b. PCM's are always identified as the destination.
    c. Location is the panel designation for VCP, LCP, or PCM. For connections to MCC's, location is the specific starter tag and loop number. Location is the tag and loop number for motor starts, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
    d. Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multiconductor cables, all terminal numbers shall be shown, separated by commas.
    e. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (i.e. T1, T2, T3, etc.).
    f. Terminal designations at PCM's where the field conductor connects to a PLC input or output shall be the PLC Address (Note: the following PLC I/O numbering scheme is typical for Allen Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project).
        1) Discrete point: W:X:Y/Z
        2) Analog point: W:X:Y.Z
            a) W = I for input, Q for output, AI for analog input, AQ, for analog output.
            b) X = PLC number (1, 2, 3….).
            c) Y = Slot number (01, 02, 03….).
            d) Z = Terminal number (00, 01, 02…) for a discrete point or a word numbering for an analog point (1,2,3…).

4. Where:
   g. Terminal designations at PCM's where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (i.e. C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have and capital letter suffix starting with A: (i.e. 0010A).
5. Case 1: Vendor Control Panel (VCP) to Process Control Module (PCM):
   a. Field wire number/label: A-B/C-D.
      1) Vendor Control Panel number without hyphen (VCP60.0101.01).
      2) Terminal number within VCP (manufacturer's or vendor's standard terminal number).
      3) Process Control Module number without hyphen (PCM60.0101).
      4) Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010).
         a) Examples: VCP60.0101.01-10/PCM60.0101-1:1:01/01
            VCP60.0101.01-10/PCM60.0101-0:1:01/10/07
            VCP60.0101.01-10/PCM60.0101-C0100
6. Case 2: Field Instrument to Process Control Module (PCM):
   a. Field wire number/label: E-F/C-D.
      1) Process Control Module number without hyphen (PCM60.0101).
      2) Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010).
      3) Field mounted instrument tag and loop numbers without hyphen (EDV60.0101.01).
      4) Manufacturer's standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma.
         a) Examples: TIT60.0101.01-2,3/PCM60.0101-l:1:01.1
            TSH60.0101-1/PCM60.01001-l:2:01/00
7. Case 3: Motor Control Center (MCC) to Process Control Module (PCM):
   a. Field wire number/label: G-B/C-D.
      1) Terminal number within Motor Control Center (manufacturer's or vendor's standard terminal number).
      2) Process Control Module without hyphen (PCM60.0101).
      3) Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010).
      4) Actual Starter designation in the Motor Control Center without hyphen (MMS60.0101).
         a) Examples: MMS60.0101-10/PCM60.0101-I:01/01
            MMS60.0101-10/PCM60.0101-O:1:10/07
            MMS60.0101-10/PCM60.0101-C0100
8. Case 4: Motor Control Center (MCC) to Vendor Control Panel (VCP):
   a. Field wire number/label: G-B/A-B.
      1) Vendor Control Panel number without hyphen (BCP60.0101.01).
      2) Terminal number within motor control center, or vendor control panel.
      3) Manufacturer's or vendor's standard terminal number.

4) Actual Starter designation in the Motor Control Center without hyphen (MMS60.0101).
a) Examples: MMS60.0101-X2/VCP60.0101.01-10

9. Case 5: Motor leads to a Motor Control Center (MCC):
a. Field wire number/label: H-I/G-B.
1) Terminal number within motor control center (Manufacturer's standard terminal number).
2) Actual Starter designation in the Motor Control Center without hyphen (MMS60.0101).
3) Equipment tag and loop number without hyphen (PMP60.0101.01).
4) Motor manufacturer's standard motor lead identification (T1, T2, T3, etc.).
a) Examples: PMP-60.0101.01-T3/MMS60.0101.01-T3

10. Case 6: Remote or separately mounted starter or Variable Frequency Drive (VFD) to Process Control Module (PCM):
a. Terminal number within starter or Variable Frequency Drive (VFD) (manufacturer's standard terminal number).
b. Process Control Module number without hyphen (VCP60.0101.01).
c. Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC/I/O point (C0010).
d. Starter or Variable Frequency Drive tag and loop number without hyphen (MMS60.0101).
a) Examples: MMS60.0101-10/PCM60.0101-I:01/01
MMS60.0101-10/PCM60.0101-O:2:10/07
MMS60.0101-10/PCM60.0101-C0010

11. Case 7: Field Bus Trunk Segment:
a. Field cable number/label: C/K-L/M; C/K-L/H; C/K-L/J.
1) Process Control Module number without hyphen (PCM60.0101).
2) Field Bus Cable Type.
3) Field Bus Segment Number.
4) Field Bus Field Network Component, without hyphen (PTB1).
5) Equipment tag and loop number without hyphen (EMV61.1100.01).
6) Starter or Variable Frequency Drive tag and loop number without hyphen (VFD60.0101).
a) Examples: PCM60.0101/PA-1A/PTB1
PTB1/PA-1B/PTB2
PCM60.0101/DN-1A/VFD60.0112
PCM60.0101/DP-2A/EMV61.1100.01

10. Case 8: Field Bus Spur (Drop):
a. Field cable number/label: E/K-L/M.
1) E = Field mounted instrument tag and loop numbers without hyphen (FIT62.0110.02).
2) K = Field Bus Cable Type.
3) L = Field Bus Segment Number.
4) M = Field Bus Field Network Component without hyphen (PTB1), identify ports.
a) Examples: FIT62.0110.02/PA-1C/PTB1-1
FIT62.0110.02/PA-1D/PTB1-2

11. All spare conductors shall be terminated on terminal blocks and shall be identified as required for other field wires with an "S" prefix:
    Examples: A MMS60.0101-10/PCM60.0101.01-C011

C. Conduit Numbers:

1. Number the conduits as shown on the electrical standard detail drawing E-SD-6. See details E-5044 and E-5045.

1.5 SUBMITTALS

A. Furnish submittals in accordance with Sections 01 33 00 and 26 00 00.

B. Furnish complete product Data, Schedules, and Record Drawings submittals as specified below.

C. Nameplates:

1. Product Data:
   a. Color.
   b. Size:
      1) Outside dimensions.
      2) Lettering.
   c. Material.
   d. Mounting means.
2. Nameplate Schedule:
   a. Show exact wording for each nameplate.
   b. Include nameplate and letter sizes.

D. Wire Numbers:

1. Manufacturer's catalog data for wire labels and label printer.

E. Record Drawings:

1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

1.6 QUALITY ASSURANCE

A. Representatives of the Contractor, Owner, and Engineer shall convene before any major purchases of cable or conductors and before the installation or termination of any cables or conductors.

PART 2 – PRODUCTS

2.1 NOT USED

2.2 MATERIALS

A. Nameplates:
   1. Fabricated from white-center and black or red face laminated plastic engraving stock:
      a. 3/32-inch thick material.
      b. 2-ply.
      c. With chamfered edges.
      d. Engraved characters shall be of a block style, and of adequate size to be read easily from a distance of six (6) feet with no characters smaller than 1/8-inch in height.

B. Signs:
   1. Automatic Equipment and High-Voltage Signs.
      a. Shall be suitable for exterior use.
      b. Shall be in accordance with OSHA regulations.

C. Conductor and Cable Markers:
   1. Markers shall consist of machine printed, black characters on white tubing.
   2. Characters shall be no smaller than size 10 font.
   3. Characters shall be machine printed on tubing.

D. Conduit and Raceway Markers:
   1. UV resistant holder and letters.
   2. Black letters on yellow background.
   3. Minimum ½-inch high letters.

E. Medium Voltage Circuit Raceway Labels:

   1. Vinyl plastic.
   2. Minimum 1-inch high letters.

2.3 SOURCE QUALITY CONTROL

A. Nameplates:

   1. Provide all nameplates for control panel operator devices (i.e. pushbuttons, selector switches, pilot lights, etc.) using the same material and of the same color and appearance as the device nameplates, in order to achieve an aesthetically consistent and coordinated system.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Nameplates:

   1. Attach nameplates to equipment with stainless steel sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
   2. In corrosive or wet areas use epoxy-based cement to attach nameplates.

3. Nameplates shall be aligned and level or plumb to within 1/64 inch over the entire length:
    a. Misaligned or crooked nameplates shall be remounted, or new enclosures shall be provided at the discretion of the Engineer.

B. Signs:

1. Automatic Equipment and High Voltage Signs:
    a. Mount permanent warning signs at mechanical equipment that may be started automatically from remote locations. Fasten warning signs with round head stainless steel screws or bolts. Locate and mount warning signs in a suitable manner that is acceptable to the Engineer.
    b. Mount permanent and conspicuous warning signs on the front and back of equipment, doorways to equipment rooms, pull boxes, and manholes where the voltage exceeds 600 V.
    c. Place warning signs on equipment that has more than one source of power:
        1) Warning sign to identify every power source.
    d. Place warning signs on equipment that has a 120 VAC control voltage source used for interlocking.

C. Conductor and Cable Markers:

1. Apply all conductor and cable markers to termination.
2. Heat-shrinkable Tubing:
    a. Tubing shall be shrunk using a heat fun that produces low-temperature heated air.
    b. Tubing shall be tight on the wire after it has been heated.
    c. Characters shall face the open panel and shall read from left to right, or top to bottom.
    d. Marker shall start within 1/32 inch of the end of the stripped insulation point.

D. Conduit Markers:

1. Provide and install conduit markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system.
2. Conduits shall be marked at the following locations:
    a. Each end of conduits that are greater than 10 feet in length.
    b. Where the conduit penetrates a wall or structure.
    c. Where the conduit emerges from the ground, slab, etc.
    d. The middle of conduits that are ten feet or less in length.
3. Conduits shall be marked after the conduits have been fully painted.
4. Conduit markers shall be positioned so that they are easily read from the floor.
5. Secure all conduit markers with nylon cable ties:
    a. Conduit markers exposed to direct sunlight shall be secured with ultraviolet resistant cable ties.
6. Conduits shall be marked before construction review by Engineer for punch list purposes.
7. Intrinsically safe conduits shall be labeled in accordance with the requirements of the National Electrical Code (NEC).

E. Medium Voltage Raceway Labels:

1. Apply at 50-foot intervals stating the voltage level contained within the raceway.

3.2 FIELD QUALITY CONTROL

A. Replace any nameplates, signs, conductor markers, cable markers or raceway labels that in the sole opinion of the Engineer do not meet the Engineer's aesthetic requirements.

END OF SECTION

SECTION 26 05 73
POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 SUMMARY

A. This Section includes computer-based, fault-current, overcurrent protective device coordination, and arc flash studies. Protective devices shall be set based on results of the protective device coordination study.
   1. Series-rating of devices is not permitted.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For the Power System Study specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed.
   1. Input data, including completed computer program input data sheets.
   2. Fault Current Study and Equipment Evaluation Reports.
   3. Coordination-Study Report.
   4. Arc Flash Study Report.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Professional Engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of Engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for Arc Flash Study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Computer software shall be SKM Power Tools for Windows.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.
   4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
1. Switchgear and switchboard bus.
2. Motor-control center.
3. Distribution panelboard.
4. Branch circuit panelboard.
5. Transfer switches
6. Equipment control panels.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with applicable IEEE sections.
1. Transformers:
a. ANSI C57.12.10.
b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.
e. IEEE C57.96.
2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
    a. Device tag.
    b. Voltage and current ratio for curves.
    c. Three-phase and single-phase damage points for each transformer.
    d. No damage, melting, and clearing curves for fuses.
    e. Cable damage curves.
    f. Transformer inrush points.
    g. Maximum fault-current cutoff point.
    h. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH STUDY

A. Perform arc flash study using approved computer software program. Prepare a written report using results of fault-current study and in conjunction with protective device coordination study.

B. Arc flash study should be performed using IEEE1584 equations and NFPA 70E-2024 Standard.

C. Incident energy and arc flash hazard boundary shall be calculated at all significant locations in the electrical distribution system (all switchboards, panelboards, motor control centers, and 3-phase industrial control panels).

D. Calculations should be based on the worst case of all available sources.

E. Calculations should be based on actual overcurrent protective device clearing time, with a maximum arc fault clearing time of 2 seconds.

F. Calculations should be based on results of overcurrent protective device coordination study recommended settings.

G. Arc Flash Study Report: Prepare a written report indicating the following results of the arc flash study:
    1. Tabular Format for each bus:
        a. Arc fault current.
        b. Overcurrent protective device clearing time.
        c. Calculated incident energy at the working distance.
        d. Arc flash protection boundary.

H. Arc Flash Labels shall be provided for installation by the Contractor. Labels should meet the following Standards and requirements:
    1. UL 969 – Standard for Marking and Labeling Systems.
    2. ANSI Z535.4 – Product Safety Signs and Labels.
    3. Labels should include the following information:
        a. System Voltage.

b. Equipment Name and Upstream Protective Device.
c. Arc Flash Protection Boundary.
d. Working Distance.
e. Arc Flash Incident Energy.
f. Recommended PPE based on NFPA 70E-2024 Annex H.
g. Limited and Restricted approach Shock Hazard Boundaries.
h. Date study was performed.

4. Labels should be printed by thermal transfer type printer, with no field markings.

END OF SECTION

SECTION 26 05 83
WIRING CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. ASTM International.

B. Code of Federal Regulations.

C. International Electrical Testing Association, NETA.

D. National Electrical Manufactures Association.

E. NFPA 70, National Electrical Code.

F. Underwriters Laboratories Inc.

1.3 SUMMARY

A. Section Includes:
   1. Wiring connecting devices.
   2. Terminations.
   3. Splices.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the CONTRACTOR and its Sub-contractors to review all sections to ensure a complete and coordinated project.

1.4 DEFINITIONS

A. Definitions of terms are specified in Section 26 00 00.

1.5 SYSTEM DESCRIPTION

A. Provide a complete system of wiring connectors, terminators, fittings, etc. for a complete wiring system suitable for the cables and conductors used.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00 and 26 00 00.

B. Product Data:
   1. Catalog cut sheets.

C. Shop drawings:
   1. Drawings showing the installation of junction modules, splices and terminators.

D. Instruction and Operating Manuals:
   1. Include drawings and data for medium voltage cable connectors, splices and junction modules in the operating manuals.

1.7 QUALITY ASSURANCE

A. As specified in Section 26 00 00.

B. All materials shall be UL listed.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Control Connections:
   1. Use insulated ring type wire terminators for connections to all screw terminals:
      a. With chamfered/funneled terminal barrel entry.
      b. Deep internal serrations.
      c. Long barrel design to reduce electrical resistance and increased insulator- barrel surface area to ensure that the insulator remains in contact with the barrel.
      d. Electroplated-tin copper conductor.
      e. Manufactured by the following or equal:
         1) Thomas and Betts, Stakon.
   2. For process equipment connections work from manufacturer's drawings.

B. Joints, Splices, Taps, and Connections:
   1. For 600-volt conductors use solderless connectors.
   2. Use only plated copper alloy connectors or lugs:
      a. Aluminum connectors or lugs are not acceptable for copper conductors.
   3. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.
   4. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps.
      a. Manufactured by the following or equal:
         1) Buchanan 2006S or 2011S with 2007 or 2014 insulating caps.
   5. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
      a. Manufactured by one of the following or equal:
         1) Burndy.
         2) Thomas and Betts.
   6. Where waterproof splices are required:

a. Suitable for indoor, outdoor, weather exposed, direct buried or submersed applications.
b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kV.
d. Two-part mold body with tongue and groove seams and built in spacer webbing.
e. Manufactured by the following or equal:
1) 3M – Scotchcast 72-N

7. Optical Fiber terminations:
a. All multimode optical fiber cable installed shall be terminated with a split-ferrule alignment sleeve and a precision ceramic tip. All multimode optical fiber connectors shall meet the following technical specifications:
1) Connector Type: ST
2) Fiber Outside Diameter: 125 microns Nominal
3) Loss Repeat: < 0.2 dB per 100 reconnects
4) Axial Load Minimum: 35 Pounds
5) Temperature Stability: +0.1 dB Maximum from -40°C to 75°C
b. All single mode optical fiber cable installed shall be terminated utilizing a split-ferrule alignment sleeve and a precision ceramic tip. All single mode connectors shall meet the following technical specifications:
1) Connector Type: SC
2) Fiber Outside Diameter 125 Microns
3) Loss Repeat: < 0.2 dB per 1000 reconnects
4) Axial Load, min. 30 pounds
5) Temperature Stability: -40°C to 85°C
c. Contractor shall provide multimode optical fiber patch cords. The multimode optical fiber patch cords shall be Lucent Technologies ML2SC-SC-XX, and shall meet the following technical specifications:
1) Number of fibers: 2
2) Approximate loss, mean, variance 0.1, 0.1
3) Minimum bandwidth: 160 MHz-km @ 850 nm
d. Contractor shall provide single mode optical fiber patch cords. The single mode optical fiber patch cords shall be Lucent Technologies MS2SC-SC-XX, and shall meet the following technical specifications:
1) Number of fibers 2
2) Approximate Loss, mean, variance 0.1dB, 0.7dB

C. Insulating Tape:
1. General purpose insulating tape:
a. Minimum 7 mil vinyl tape.
b. Suitable for application in an ambient of -18°C
c. (0°F).
d. Operating range up to 105°C (220°F).
e. Flame retardant, hot- and cold- weather resistant, UV resistant.
f. For use as a primary insulation for wire cable splices up to 600 VAC.
g. Meeting and complying with:
1) ASTM D-3005 Type I
2) UL 510

3) CSA C22.2

h. Manufactured by the following or equal:
1) 3M – Scotch Number Super 33+.

2. General-purpose color-coding tape:
a. Minimum 7 mil vinyl tape.
b. Suitable for application on PVC and polyethylene jacketed cables.
c. For use indoors and outdoors in weather protected enclosures.
d. Available with the following colors;
1) Red.
2) Yellow.
3) Blue.
4) Brown.
5) Gray.
6) White.
7) Green.
8) Orange.
9) Violet.
e. For use as phase identification, marking, insulating, and harnessing.
f. Meeting and complying with:
1) UL 510.
2) CSA C22.2
g. Manufactured by the following or equal:
1) 3M – Scotch Number 35.

3. Fire and Electric Arc Proofing tape:
a. Minimum 30-mil, flexible, elastomer tape that expands in fire to form an insulating firewall between flame and cable.
b. Bind in place with glass cloth electrical tape.
c. Manufactured by the following or equal:
1) 3M – Scotch Number 77.

4. Glass cloth electrical tape:
a. 7.4-mil thermosetting silicone adhesive that performs at Class H temperatures 180°C (356°F).
b. Use for the following applications:
1) To secure no-PSA insulations such as glass in high-temperature areas.
2) Splice wire rated at 180°C (356°F).
3) For binding Fire and Electric Arc Proofing Tape.
c. Meeting and complying with:
1) MIL-I-1966C.
2) UL Recognized Component listing for 200°C (392°F) (Guide OANZ2, File E17385).
3) CSA Accepted Component 180°C (356°F) File LR93411.
d. Manufactured by the following or equal.
1) 3M – Scotch Number 69.

5. Self-fusing Silicone Rubber Tape:
a. 12-mil, high-temperature, track resistant, insulating tape.
b. Composed of fully cured inorganic silicone rubber.
c. Use as a protective overwrap for terminating medium voltage cables.
d. Manufactured by the following or equal:
1) 3M – Scotch Number 70.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Load connections:
   1. Connect loads to the circuits as indicated. Color-code all branch circuits as per Section 26 05 53 "Electrical Identification."

B. Zero to 600-volt systems:
   1. Make all connections with the proper tool and die as specified by the device manufacturer.
   2. Use only tooling and dies manufactured by the device manufacturer.
   3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
   4. Number all power and control wires before termination.

C. Motor connections (600 Volts and below):
   1. Terminate wires with compression type ring lugs at motors.
   2. Connection at both the motor leads and the machine wires are to have ring type compression lugs.
   3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
      a. In damp and wet locations use a complete kit containing mastic that shall seal out moisture and contamination.
      b. Shrink cap with low heat as recommended by manufacturer.
   4. Wire markers shall be readable after boot installation.
   5. Manufactured by one of the following or equal:
      a. Raychem MCK.

END OF SECTION

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SECTION 26 08 00
FIELD ELECTRICAL ACCEPTANCE TESTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for testing the electrical system.
   2. Adjusting and calibration.
   3. Acceptance Tests.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the Contractor and its subcontractors to review all sections to ensure a complete and coordinated project.

C. Copyright information:
   1. Some portions of this Specification are copyrighted by the International Electrical Testing Association Incorporated, (NETA). See NETA publication ATS-2021 for details.

1.2 REFERENCES:

A. International Electrical Testing Association Incorporated:

B. Manufacturer's testing recommendations and instruction manuals

C. Specifications sections for the electrical equipment being tested.

D. Submitted seismic calculations and installation details.

1.3 DEFINITIONS

A. Definitions of terms are specified in Section 26 00 00 and noted herein.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. See specific specification sections for additional field quality control requirements.

B. Switchgear and Switchboard:
   1. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with the Drawings and Specifications.

b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding and required clearances.
d. Inspect equipment for cleanliness.
e. Verify that circuit breaker/fuse sizes and types correspond to the approved submittals.
f. Verify that current and voltage transformer ratios correspond to the Drawings.
g. Inspect bolted connections by the following methods.
    1) Calibrated torque wrench.
        a) Refer to manufacturer's instructions of r proper foot-pound levels or NETA ATS-2021.
h. Mechanical and Electrical interlocks:
    1) Attempt closure on locked-open devices.
    2) Attempt to open locked-closed devices.
    3) Make/attempt key-exchanges in all positions.
i. Lubrication requirements.
    1) Verify appropriate lubrication on moving current-carrying parts.
    2) Verify appropriate lubrication on moving and sliding surfaces.
j. Inspect insulators for evidence of physical damage or contaminated surfaces.
k. Verify correct barrier and shutter installation and operation.
l. Exercise all active components.
m. Inspect all indicating devices for correct operation.
n. Verify that filters are in place and/or vents are clear.
o. Perform visual and mechanical inspection of instrument transformers as specified below.
p. Inspect control power transformers.
    1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    2) Verify that primary and secondary fuse ratings match the submittal drawings.
    3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

C. Dry Type Transformers:
1. Visual and Mechanical Inspection.
    a. Compare equipment nameplate data with the Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding and required clearances.
    d. Inspect equipment for cleanliness.
    e. Verify that resilient mounts are free and that any shipping brackets have been removed.
    f. Inspect bolted connections by the following methods.
        1) Calibrated torque wrench.
            a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS-2021.
    g. Verify that as-lift tap connections are as specified.

D. Cables, 600 volts and less:

1. Visual and Mechanical inspection:
    a. Compare cable data with the Drawings and Specifications.
    b. Inspect exposed sections of cables for physical damage and correct connection in accordance with the Drawings.
    c. Inspect bolted electrical connections for high resistance by the following methods:
        1) Calibrated torque wrench.
    d. Inspect compression-applied connectors for correct cable match and indentation.
    e. Inspect for correct identification and arrangements.
    f. Inspect jacket insulation and condition.

E. Low Voltage Molded Case and Insulated Case Circuit Breakers:
1. Visual and Mechanical Inspection:
    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage and alignment.
    d. Circuit breaker shall be checked for proper mounting, conductor size and feeder designation.
    e. Operate circuit breaker to ensure smooth operation.
    f. Check tightness of connection with torque wrench in accordance with manufacturer's recommendations.
    g. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
2. Electrical tests breakers in excess of 200 Amp trip ratings:
    a. Perform resistance measurements through bolted connections with a low resistance ohmmeter.
    b. Time-current characteristic tests shall be performed by passing 300 percent rated current through each pole separately. Trip time shall be determined:
        1) Determine long-time pickup.
        2) Determine short-time pickup.
    c. Instantaneous pickup current shall be determined by run-or pulse method:
        1) Clearing times should be within 4 cycles or less.
    d. Insulation resistance shall be determined pole to pole, across pole and pole to ground.
        1) Circuit breaker shall be closed.
        2) Test voltage shall be 1000 volts dc applied for one minute.
    e. Perform adjustments for final setting in accordance with the Short Circuit and Coordination Study.
3. Test values:
    a. Contact resistance shall be compared to adjacent poles and similar breakers:
        1) Deviations of more than 50 percent shall be investigated.
    b. Insulation resistance shall not be less than 100 megohms.
    c. All trip times shall fall within manufacturer's published time current curves:
        1) Circuit breakers exceeding maximum time shall be replaced.
    d. Instantaneous pickup current levels should be within 20 percent of manufacturer's published values.

F. Protective Relays:
1. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with Drawings and Specifications.
b. Inspect relays for physical damage, Remove shipping restraint material.
c. Verify the unit is clean.
d. Tighten case connections. Inspect cover for correct gasket seal. Clean cover glass. Inspect shorting hardware, connections paddles, and/or knife switches. Remove any foreign material from the case. Verify target reset.
e. Inspect relay for foreign material, particularly in disk slots of the damping and electromagnets. Verify disk clearance. Verify contact clearance and spring bias. Inspect spiral spring convolutions. Inspect disk and contacts for freedom of movement and correct travel. Verify tightness of mounting hardware and connections. Burnish contacts. Inspect bearings and/or pivots.
f. Set relays in accordance with the Short Circuit and Coordination Study.

2. Electrical Tests:
   a. Perform insulation-resistance test on each circuit-to-frame:
      1) Determine allowable procedures for this test from manufacturer's published data.
   b. Inspect indicators:
      1) Verify operation of all light-emitting diode indicators.
      2) Set contrast for liquid-crystal display readouts.
      3) Determine pick-up and drop-out of electromechanical targets.
   c. Perform the following tests on the nominal settings specified by Engineer:
      1) Pickup parameters on each operating element.
      2) Timing test shall be performed at 3 points on time dial curve.
      3) Pickup target and seal in units.
      4) Special test as required to check operation of restraint, directional and other elements per manufacturer's instruction manual.
   d. Perform phase angle and magnitude contributions tests on all differential and directional type relays after energization to vectorially prove proper polarity and connection.

G. Grounding Systems:
1. Visual and mechanical inspection:
   a. Inspect ground system for compliance with Drawings and Specifications.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage.
2. Electrical tests:
   a. Perform fall of potential test per IEEE Standard No. 81, Section 8.2.5 on the main grounding electrode or system.
   b. Perform ground continuity test between main ground system and all major electrical equipment frames, the system neutral and any derived neutral points:
      1) The test shall be made by passing a minimum of 10 amperes D.C. current between ground reference system and the ground point to be tested.
      2) Voltage drop shall be measured and resistance calculated by voltage drop method.
3. Test values:
   a. The main ground electrode system resistance to ground should be no greater than 5 ohms for commercial or industrial systems and 1 ohm or less for

generating or transmission station ground unless otherwise specified by the Engineer.

b. Investigate point-to-point resistance values that exceed 0.5 ohm.

H. Rotating Machinery:

1. Visual and mechanical inspection:
   a. Compare equipment nameplate information with the Drawings and Specifications.
   b. Inspect physical and mechanical condition.
   c. Inspect for proper anchorage, alignment, and grounding.
   d. Inspect air baffles, filter media, cooling fans, slip rings, brushes and brush rigging.
   e. Inspected bolted electrical connections for high resistance by one of the following:
      1) Use of low resistance ohmmeter.
      2) Calibrated torque wrench.
   f. Verify correct application of appropriate lubrication and lubrication systems.
   g. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.
   h. Verify that resistance temperature detector (RTD) circuits conform to the Drawings.
   i. Verify that metering or relaying devices utilizing RTD's have the correct rating.
   j. Special tests as suggested by manufacturer, such as gap spacing and pedestal alignment shall be made where applicable.
2. Electrical tests:
3. Perform resistance measurements through bolted connections with a low resistance ohmmeter.
4. Perform insulation resistance test in accordance with ANSI/EEE43. Test voltage shall be as specified by the manufacturer:
   a. On motors 200 HP and smaller, test duration shall be one minute. Calculate dielectric absorption ratio using resistance measurements at 20 seconds and 60 seconds.
   b. On motors larger than 200 HP, test duration shall be 10 minutes. Calculate polarization index using resistance measurements at one minute and 10 minutes.
   c. Perform dc overpotential tests on motors rated at 1000 horsepower and greater and 4000 volts and greater in accordance with ANIS/EEEE95.
   d. Perform stator resistance test phase-to-phase.
   e. Perform insulation power-factor or dissipation-factor tests.
   f. Perform surge comparison tests.
   g. Perform resistance tests on RTD's.
   h. Verify operation of motor space heater.
   i. Perform a rotation test to ensure correct shaft direction.
   j. Measure no load and full load running current and compare to nameplate.
   k. Observe proper operation and sequence of any reduced voltage starters.
   l. Perform vibration base line test on motors larger than 200 horsepower. Amplitude to be plotted vs. frequency.
   m. Perform vibration amplitude test on motors 200 HP and smaller.

n. Check all protective devices in accordance with other sections of these specifications.
o. After start-up of each motor, the current on each phase shall be measured:
1) At no load.
2) At defined load:
a) Record the voltage of each phase to round during this test.
3) Inrush current.
p. Measurements shall be recorded on copies on Form 16 B, contained in this Section.

5. Test Values:
a. Insulation resistance should be not less than 10 megohms.
b. Dielectric absorption ratio or polarization index readings less than the manufacturer's recommended values (not less than three for polarization index or 1.4 for dielectric absorption ratio) shall be investigated.
c. Motor measured full load current shall not exceed nameplate value.
d. Vibration amplitudes shall not exceed values furnished by manufacturer.

I. Motor Control:
1. Visual and Mechanical Inspection:
a. Compare equipment nameplate data with Drawings and Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Verify contactors:
1) Verify mechanical operation.
2) Inspect contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.
f. Inspect bolted electrical connections for high resistance using one of the following methods:
1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 100.12.

g. Lubrication requirements:
1) Verify appropriate lubrication on moving current-carrying parts.
2) Verify appropriate lubrication on moving and sliding surfaces.

J. Motor Control, Motor Control Centers, Low Voltage:
1. Test the motor control center bus in accordance with the requirements set forth.
2. Test the motor control center circuit breakers in accordance with the requirements set forth.
3. Test the motor control centers drives in accordance with the requirements set forth.

K. Adjustable speed drive systems:
1. Visual and mechanical inspection:
a. Compare equipment nameplate data with Drawings and Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.

e. Ensure vent path openings are free from debris and that heat transfer surfaces are clean.
f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
g. Motor running protection:
1) Verify drive overcurrent setpoints are correct for their application.
2) If drive is used to operate multiple motors, verify individual overload element ratings are correct for their application.
3) Apply minimum and maximum speed setpoints. Verify setpoints are within limitations of the load coupled to the motor.
h. Inspect bolted electrical connections for high resistance using one of the following methods.
1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

2. Surge Arresters, Low-Voltage Surge Protection Devises:
a. Visual and Mechanical inspection:
1) Compare equipment nameplate data with Drawings and Specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, grounding, and clearances.
4) Verify the arresters are clean.
5) Inspect bolted electrical connections for high resistance using one of the following methods:
a) Use of low-resistance ohmmeter.
b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
7) Verify that stroke counter is correctly mounted and electrically connected, if applicable.
8) Record stroke counter reading.

L. Emergency systems, engine generator:
1. Visual and Mechanical inspection:
a. Compare equipment nameplate data with Drawings and Specification.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
2. Electrical and Mechanical Tests:
a. Test generator in accordance with manufacturer's published data.
b. Test protective relay devices in accordance with manufacturer's published data.
c. Perform phase-rotation test to determine compatibility with load requirements.
d. Functionally test engine shutdown for low pressure, overtemperature, overspeed, and other protection features as applicable.
e. Perform vibration test for each main bearing cap.

f. Conduct performance test in accordance with ANSI/NFPA 110.
g. Verify correct functioning of governor and regulator.

3. Test Values
   a. Phasing shall meet the requirements of the connected load.
   b. Vibration levels shall be in accordance with manufacturer's published data.
   c. Performance tests shall conform to manufacturer's published data and ANSI/NFPA 100.

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SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. General: The Contractor shall provide electric motors, accessories, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section apply to electric motors 250 hp and less.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Bearing Manufacturers Association (ABMA):
   1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 43 – Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   2. IEEE 112 – Standard Test procedure for Polyphase Induction Motors and Generators.
   3. IEEE 114 – Standard Test procedure for Single-Phase Induction Motors.
   4. IEEE 303 – Recommended Practice for Auxiliary Devices for Motors in Class 1, Groups A, B, C, and D, Division 2 Locations.
   5. IEEE 841 – Standard for Petroleum and Chemical Industry – Severe Duty totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – up to and including 500hp.
   6. IEEE 1349 – Guide for the Application of Electric Motors in Class I, Division 2 Hazardous (Classified) Locations.

C. National Electrical Manufacturers' Association (NEMA):
   1. MG-1 – Motors and Generators.
   2. MG-1 – Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators.

D. Underwriters Laboratories Inc. (UL):
   1. UL 674 – Electric Motors and Generators for use in Division 1 Hazardous (Classified) Locations.

1.3 CONTRACTOR SUBMITTALS

A. Complete motor data shall be submitted with the driven machinery shop drawings. Motor data shall include:
   1. Machine name and specification number of driven machine.
   2. Motor manufacturer.
   3. Motor type or model and dimension drawing. Include motor weight.
   4. Nominal horsepower.
   5. NEMA design.

6. Enclosure.
7. Frame size.
8. Winding insulation class and temperature rise class.
9. Voltage, phase and frequency ratings.
10. Service factor.
11. Full load current at rated horsepower for application voltage.
12. Full load speed.
13. Guaranteed minimum full load efficiency. Also provide nominal efficiencies at 1/2 and 3/4 load.
14. Type of thermal protection or overtemperature protection, if included.
15. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable.
16. Bearing data. Include recommended lubricants for relubricatable type bearings.
17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery.
18. Power factor at 1/2, 3/4 and full load.
19. Recommended size for power factor correction capacitors to improve power factor to 0.95 (lagging) when operated at full load.

B. If water cooling is required for motor thrust bearings, the shop drawing submittals shall indicate this requirement.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of providing full motor load, under the conditions defined in Section 26 00 00.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and handling of motors shall be in accordance with manufacturer's recommendations. Preferred storage is indoors in clean, dry space with uniform temperature to prevent condensation. Protect motors from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 QUALITY ASSURANCE

A. All motors shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:
1. Emerson, US Motors.
2. General Electric.
3. Reliance.
4. Toshiba.
5. Baldor.

2.2 GENERAL REQUIREMENTS

A. Electric motors driving identical machines shall be identical.

B. Maximum motor loading shall in all cases be equal to nameplate horsepower rating or less, exclusive of service factor and as verified with the approved submittal data of the driven machinery.

1. Minimum Motor Horsepower: All motors shall be sized to carry continuously all loads which may be imposed through their full range of operation. The motor horsepower shall be not less than the estimated minimum specified for each driven machine. If the estimated minimum horsepower specified is not adequate to satisfy the foregoing restrictions or any other requirements of these Specifications, the motor with the required horsepower shall be supplied at no additional cost to the Owner. In addition, any changes caused by increase in motor horsepower shall be made by the Contractor at no additional cost to the Owner; such changes may involve circuit breakers, magnetic starters, motor feeder conductors, conduit sizes, etc.
2. Exempt Motors: Motors which are for valve operators, submersible pumps, or motors which are an integral part of Standard Manufactured Equipment, i.e., non-NEMA mounting, common shaft with driven element, part of domestic or commercial use apparatus may be excepted from these Specifications to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

2.3 DESIGN REQUIREMENTS

A. General: All electric motors shall comply with ANSI/NEMA MG 1 - Motor and Generator.

B. NEMA Design: Electric motors shall be NEMA Design B, (except as indicated in Equipment Specifications for motors controlled for variable speed operation and other special motors,) constant speed squirrel-cage induction motors having normal starting torque with low starting current. In no case shall starting torque or breakdown torque be less than the value in ANSI/NEMA MG 1. Motors shall be suitable for the starting method indicated on the Electrical Drawings.

C. Motor Voltage Ratings: Motors shall have voltage ratings in accordance with the following, unless otherwise indicated:

1. Voltage:
   a. All motors ½ hp and larger shall be 460V, 3 phase unless otherwise indicated on the Drawings.
   b. dual voltage motors rated 230/460V, 3 phase are acceptable provided all leads are brought to the conduit box.
2. Motors driving identical machines shall be identical.
3. All motors 1 hp and larger shall be “Premium Efficiency” motors as defined in NEMA MG-1.
4. Horsepower as indicated on the Drawings:
   a. Horsepower ratings shown on the drawings are based on Vendor’s estimates. Provide motors sized for the load of the actual equipment furnished.
5. Service Factor:
   a. Provide motors rated at 1.15 Service Factor.

b. Provide motors capable of operating continuously at 1.15 Service Factor at project altitude.
    1) Without exceeding Class B temperature rise limits where motors are provided with Class F insulation.
    2) Without exceeding Class F temperature rise limits where motors are provided with Class H insulation.

6. Torque:
    a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
    b. When started using reduced voltage starters:
        1) Provide motors that develop sufficient torque for acceleration to full speed.
    c. NEMA Design B except where driven load characteristics require other than normal starting torque.
        1) In No case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
7. Enclosures:
    a. As indicated in the individual equipment Specifications or as specified in this section.
    b. Totally Enclosed Fan Cooled::
        1) Cast iron conduit box.
        2) Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller, and automatic breather and drain devices for frames 324T and larger.
    c. Explosion-Proof:
        1) Tapped drain holes with corrosion resistant plugs for frames 286T and smaller and automatic breather and drain devices for frames 324T and larger.
    d. Lifting Devices: All motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
8. Manufactured with cast iron frames in accordance with NEMA MG-1.
9. Nameplates:
    a. Provide all motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
        1) NEMA Standard motor data.
        2) Bearing description and lubrication instructions.
10. Hardware:
    a. Type 316 stainless steel.
11. Conduit Boxes:
    a. Cast iron or stamped steel.
    b. Split from top to bottom.
    c. Provide gaskets at the following interfaces:
        1) Frames and conduit boxes.
        2) Conduit boxes and box covers.
    d. Rotatable through 360 degrees in 90 degree increments.
    e. Exceeding the dimensions defined in NEMA MG-1.
    f. Provide grounding lugs inside conduit boxes for motor frame grounding.
12. Motor Bearings:
    a. Antifriction.

b. Regreasable and initially filled with grease.
c. Pumps Motor ion excess of 100 HP shall have oil lubricated bearings.
d. Bearings and lubrication suitable for ambient temperature and temperature rise.
e. Suitable for intended application and have ABMA L-10 rating life of 60,000 hours or more.
f. Fit bearings with easily accessible grease/oil supply, flush, drain, and relief fittings using extension tubes where necessary.
g. Where specified in the equipment specifications, provide split-sleeve type hydrohdynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.

13. Insulation Systems:
    a. Motors Installed in Ambient Temperatures of 40 degrees Celsius or less:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 40 degrees Celsius and at the altitude where the motor will be installed.
    b. Motors Installed in Ambient Temperatures of 40 degrees Celsius and 65 degrees Celsius:
        1) Provide Class H insulation.
        2) Design temperature rise consistent with Class F insulation.
        3) Rated to operate at an ambient temperature of 65 degrees Celsius and at the altitude where the motor will be installed.
14. Motor Leads:
    a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
15. Noise:
    a. Maximum operating noise level of 85dB measured as per IEEE 85.

D. Submersible Motors:
1. Enclosures:
    a. Totally Enclosed Non-Ventilated (TENV) watertight casing.
    b. Smooth outer surface. Cooling fins may clog with solids and are not acceptable.
    c. Inner and outer shaft seals separated by an oil chamber.
2. Cooling:
    a. Suitable continuous operation in totally, partially, or nonsubmerged condition without overheating.
    b. Convection cooling only.
    c. Water jackets and oil cooling are not acceptable.
3. Electrical Cables:
    a. Wire unit without splices. Coordinate with Contractor to ensure cables of adequate length.
    b. Epoxy encapsulated able entry into terminal box.
4. Insulation:
    a. Sealed moisture resistant windings.
5. Motor Protection:
    a. Provide temperature detection in motor windings.
    b. Provide moisture detection in motor housing.

c. Provide associated electronics and relaying in a separate enclosure to be mounted remotely.

E. Vertical Motors:
1. Enclosures:
a. Weather protected Type II (WPII) where installed outdoors.
b. Weather protected Type I (WPII) where installed indoors.
2. Thrust Bearings:
a. Selected for combined rotor and driven equipment loads.
b. Coordinate with driven equipment supplier for maximum vertical thrust of driven equipment.

F. Variable Frequency Drive Motors
1. Compatible with the variable frequency drives specified.
2. Inverter duty rated and labeled.
3. Meet the requirements of NEMA MG-1 Part 31.
4. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
5. Capable of running continuously at 1/10th of full speed, with no harmful effects or overheating.
6. Service factor of 1.0 when driven by VFD.

G. Motors Installed in Corrosive Environments:
1. Nameplate indicating conformance to IEEE 841.
2. Stator double dipped in varnish and baked.
3. Stator and rotor coated with corrosion resistant epoxy.
4. Frame, brackets, fan guard and conduit box coated with minimum of two coats of epoxy paint.
5. Withstand salt spray tests as per ASTM B-117.
6. Suitable for hose down areas.

H. Single Phase Motors:
1. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified or as indicated on the Drawings.
2. Totally enclosed, fan cooled motors manufactured in accordance with NEMA MG-1.
3. Ball Bearings: Sealed.
4. ½ Horsepower or Less Fan Motors:
a. Split-phase or shaded pole type when standard for the equipment.
b. Open type when suitably protected from moisture, dripping water, and lint accumulation.
5. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the Engineer.
6. Integral overload protection.

2.4 ACCESSORIES

A. Space Heaters:
1. Provide all 3 phase motors with belted or cartridge space heaters mounted within the motor enclosure as indicated on the Drawings and Equipment Specifications

2. Space heater rating shall be 120 volts, single-phase, unless otherwise shown.
3. Power leads for heaters wired into conduit box.
4. Installed within motor enclosure adjacent to core iron.

B. Winding Temperature Detectors:
1. Provide temperature switches with normally closed contacts or resistance temperature detectors, 2 per each phase, as indicated on the Drawings and Equipment Specifications.

C. Bearing Temperature Detectors:
1. Where required by the driven equipment specification or as indicated on the Drawings.
2. RTD type and wiring matches the winding RTDs.

D. Vibration Detectors:
1. Where required by the driven equipment specification.
2. In accordance with the driven equipment specification.

E. See Drawings for accessories included in pump motor starter wiring diagrams. Contractor responsible to coordinate all accessories specifically required by pump motor supplier for incorporation in motor starter control cabinet whether shown on Drawings or not.

2.5 SOURCE QUALITY CONTROL

A. Factory Testing
1. Perform factory tests in accordance with:
   a. IEEE 112 for three phase motors.
   b. IEEE 114 single phase motors.
2. Furnish copies of test reports.
3. Include testing of:
   a. No load current.
   b. Locked rotor current.
   c. Winding resistance.
   d. High potential.
4. Tests required on motors 250 hp and larger:
   a. Manufacturer's routine test (use polarization index voltage = 5000V for insulation resistance tests).
   b. Efficiency and power factor versus load test performed at rated speed and 50 percent, 75 percent, 90 percent, and 100 percent of rated load. The curves from the motor tests shall be submitted for information.
   c. The maximum allowable residual unbalance in each correction plane (journal) shall be calculated using the following equation:
      1) U = 4 W/N
      2) Where:
      3) U = residual correction plane unbalance, in ounces-inches
      4) W = static correction plane journal loading, in pounds
      5) N = maximum specified operating speed, in revolutions per minute

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motors in accordance with manufacturer's instructions.

B. Electrical work involving connections, controls, switches, disconnects, etc., shall be performed as provided in the applicable sections of Division 26.

3.2 FIELD QUALITY CONTROL

A. Before start-up perform insulation resistance test on each motor furnished or installed on this project.
   1. Windings energized to 1000 volts D.C. for one minute.
   2. Resistance measured at the end of the test, recorded, and submitted to the Engineer for review.
   3. Inform the Engineer of any unusual or unacceptable test results.

3.3 VISUAL AND MECHANICAL INSPECTION FOR MOTORS AND THEIR ROTATING MACHINERY:

A. Compare equipment nameplate information with the Drawings and Specifications.

B. Inspect physical and mechanical condition.

C. Inspect for proper anchorage, alignment, and grounding.

D. Inspect air baffles, filter media, cooling fans, slip rings, brushes and brush rigging.

E. Inspected bolted electrical connections for high resistance by one of the following:
   1. Use of low resistance ohmmeter.
   2. Calibrated torque wrench.
   3. Thermographic survey.

F. Verify correct application of appropriate lubrication and lubrication systems.

G. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.

H. Special tests as suggested by manufacturer, such as gap spacing and pedestal alignment shall be made where applicable.

3.4 ELECTRICAL TESTS:

A. Perform resistance measurements through bolted connections with a low resistance ohmmeter.

B. Perform insulation resistance test in accordance with ANSI/IEEE43. Test voltage shall be as specified by the manufacturer:
   1. On motors 200 HP and smaller, test duration shall be one minute. Calculate dielectric absorption ratio using resistance measurements at 20 seconds and 60 seconds.

2. On motors larger than 200 HP, test duration shall be 10 minutes. Calculate polarization index using resistance measurements at one minute and 10 minutes.
   a. Perform stator resistance test phase-to-phase.
   b. Perform insulation power-factor or dissipation-factor tests.
   c. Perform surge comparison tests.
   d. Verify operation of motor space heater.
   e. Perform a rotation test to ensure correct shaft direction.
   f. Measure no load and full load running current and compare to nameplate.
   g. Observe proper operation and sequence of any reduced voltage starters.
   h. Perform vibration base line test. Amplitude to be plotted vs. frequency.
   i. Check all protective devices in accordance with other sections of these specifications.
   j. After start-up of each motor, the current on each phase shall be measured:
      1) At no load.
      2) At defined load:
      3) Record the voltage of each phase to round during this test.
      4) Inrush current.

C. Measurements shall be recorded and submitted to the Engineer.

3.5 TEST VALUES:

A. Insulation resistance should be not less than 10 megohms.

B. Dielectric absorption ratio or polarization index readings less than the manufacturer's recommended values (not less than three for polarization index or 1.4 for dielectric absorption ratio) shall be investigated.

C. Motor measured full load current shall not exceed nameplate value.

D. Vibration amplitudes shall not exceed values furnished by manufacturer.

END OF SECTION

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MOTOR DATA SHEET

MOTOR NUMBER: _____ MOTOR/EUIPMENT NAME _____

SPECIFICATION NUMBER OF DRIVEN MACHINE _____

MOTOR NAMEPLATE DATA

MANUFACTURER _____ MODEL/SERIES _____ MODEL NO. _____

FRAME		ENCLOSURE		NEMA DESIGN	
HP		SERVICE FACTOR		RPM	
INSULATION CLASS		VOLTS		FULL LOAD AMPS	
AMBIENT TEMP		PHASE		NO LOAD AMPS	
DESIGN TEMP RISE		HERTZ		LOCK ROTOR AMPS	
				INRUSH CODE LETTER	

	100 PERCENT LOAD	75 PERCENT LOAD	50 PERCENT LOAD
GUARANTEED MIN EFFICIENCIES			
GUARANTEED MIN POWER FACTOR			

MAX SIZE OF POWER FACTOR CORRECTION CAPACITOR _____ KVAR

ACCESSORIES

MOTOR WINDING HEATER _____ VOLTS _____ WATTS

WINDING THERMAL PROTECTION _____

WINDING TEMP SWITCHES (YES/NO) _____

RTD TYPE _____ QUALITY PER PHASE _____ # OF WIRES _____

NOMINAL RESISTANCE _____ NOMINAL TEMP _____ COEFFICIENT _____

RECOMMENDED ALARM _____ DEGREES C _____ RECOMMENDED TRIP _____ DEGREES C

SPECIAL APPLICATIONS

INVERTER DUTY* (YES/NO) _____ PART WINDING (YES/NO) _____ WYE-DELTA (YES/NO) _____

2 SPEED, 1 WINDING (YES/NO) _____ 2 SPEED, 2 WINDING (YES/NO) _____

AREA CLASSIFICATIONS

CLASS _____ DIVISION _____ GROUP _____ TEMP CODE _____

* Conforms to NEMA MG-1 Part 31.

SECTION 26 21 00
UTILITY COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Requirements for coordination with the utility companies to provide service.
   2. Contractor's responsibilities for connecting to utilities and providing utility service to the facilities.
   3. Descriptions of utility services required.

1.2 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

1.3 SYSTEM DESCRIPTION

A. Electrical Service
   1. The facility will be served primary power at distribution voltage levels from an underground feeder and metering enclosure owned and furnished by the Electric Utility.
   2. The Contractor shall make all necessary arrangements with the electric utility to provide electric service.
   3. The Contractor shall provide all work and materials and bear all costs for providing temporary construction power and the permanent electrical service, including but not limited to:
      a. All work and materials not provided by the Utility.
      b. All permits and fees required by the Utility.
   4. The Contractor shall provide electrical ducts, raceways, conductors and connections shown on the plans, and all other work and materials required for a complete electrical service, including but not limited to the following:
      a. Electrical service conduits and conductors from the point of utility termination to the service entrance equipment.
      b. Metering conduits from the instrument transformers to the meter.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Certification
   1. Submit certification that the intended installation has been coordinated with the utility companies. Certification shall include a narrative description of the utility's

requirements and points of connection and names and telephone numbers for contacts at the utilities.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements
   1. NEC.
   2. Local codes.
   3. Local utility standards.

1.6 SEQUENCING AND SCHEDULING

A. Prior to submitting any bid, the Electrical Contractor is responsible for contacting the utilities to determine the work and materials that will be required from the Contractor, and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the Contractor's bid.
   1. No additional charges will be allowed by the Contractor, due to failure to include such charges in its bid.

B. Prior to start of site work, make arrangements for temporary communication and electrical service as required.

C. Prior to commencing work, coordinate complete electric service entrance requirements with local electric utility to assure that the installation will be complete in accordance with these specifications.
   1. Ensure power transformer size, electrical characteristics and location are consistent with the design and service voltage provided by the electrical utility coordinated with other trades.
   2. Arrange for electric meter (by Utility) and provide meter bases in accordance with utility requirements.
   3. Furnish and coordinate installation of metering C.T.'s and P.T.'s furnished by Utility.
   4. Pay any charges required by the electric utility for connection and turn-on.

D. Prior to commencing site work, coordinate underground conduit installations with other work to eliminate conflicts and avoid interferences with other underground piping systems.

E. Coordinate necessary outages with local utility and Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be furnished in accordance with the applicable requirements of the utilities and these specifications.

2.2 EQUIPMENT

A. Equipment shall be furnished in accordance with the applicable requirements of the utilities and these specifications.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 26 22 00
DRY TYPE TRANSFORMERS (FURNISHED BY OWNER)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Enclosed dry type transformers.
      a. Stand-alone units.
      b. Units located in motor control centers.
      c. Units located in packaged power supplies.
   2. Rated 1 to 1,000 KVA.
   3. Primary voltage 600 V and below.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

C. The contractor shall be responsible for installation of the dry-type transformer from arrival on-site from supplier to completion of project. Installation to include:
   1. Installation of transformer from delivery by supplier to manufacturer-provided wall-mounting bracket, which shall also be furnished by owner but shall be installed by the contractor in accordance with manufacturer's requirements.
   2. Anchorage of transformer to mounting bracket per manufacturer’s requirements.
   3. All conduit, wire, and terminations required for connection to transformer.

1.2 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. American National Standards Institute.
   4. National Fire Protection Association.

1.3 DELIVERY STORAGE AND HANDLING

A. Transformer shall be protected from the elements during storage and must be stored indoors in dry heated areas. Factory wrapping shall be maintained, or additional heavy plastic cover shall be provided to protect the transformer from dirt, water, construction debris and traffic.

B. Transformer shall be handled to avoid damage to components, enclosure or finish. All damage shall be repaired prior to installation.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Floor, wall, platform, MCC, packaged power supply, or roof mounted, as indicated.

B. Locate where not in direct contact with building structure.

C. Install on Korfund Series F or H double-deflection mounts, selected for maximum isolation.

D. Make any necessary connections to the enclosure with liquidtight flexible conduit having neoprene gaskets and insulated ground bushings.

E. Ground the enclosure:
   1. To an equipment ground conductor in the conduit.
   2. To the facility ground ring.

F. Install floor-mounted transformers on 3-1/2" housekeeping pads.

2.2 FIELD QUALITY CONTROL

A. Perform acceptance tests in accordance with Section 26 08 00, “Field Electrical Acceptance Tests.”

2.3 ADJUSTING

A. In the presence of the Engineer, provide all meters and manpower to set the transformer taps as directed by the Engineer.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS (FURNISHED BY OWNER)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 SUMMARY

A. Section Includes:
   1. Switchboard ready to use, completely engineered and assembled, furnished by Owner, and installed by Contractor. Contractor responsible to review requirements of this Specification and shop drawings once available from Owner.
   2. The contractor shall be responsible for installation of the switchboard from arrival on-site from supplier to completion of project. Installation to include:
      a. Housekeeping pad.
      b. Transition of switchboard from shipping trailer to housekeeping pad, including crane if required.
      c. Anchorage of switchboard to equipment pad per manufacturer and seismic requirements.
      d. All conduit and wiring external to the switchboard and terminations of external connections.

1.3 QUALITY ASSURANCE

A. Installer Qualifications:
   1. An employer of workers qualified as defined in NEMA PB 2.1
   2. Trained in electrical safety as required by NFPA 70E.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside switchboards and install temporary electric heaters to prevent condensation.

B. Handle and prepare switchboards for installation according to applicable standards.

1.5 PROJECT CONDITIONS

A. Installation Pathway:
   1. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and

temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.6 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - EXECUTION

2.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to applicable standards.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

2.2 INSTALLATION

A. Install switchboards and accessories according to manufacturer's recommendations.

B. Equipment Mounting: Install switchboards on concrete bases.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with seismic mounting and anchoring requirements.

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Comply with NECA 1.

2.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 05 53.

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 05 53.

C. Device Nameplates: Label each disconnecting device, overcurrent protective device, meter, and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53.

2.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform Tests and Inspections:
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   2. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
   3. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

2.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated in the Overcurrent Protective Device Coordination Study.

2.6 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

2.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 26 24 16
PANELBOARDS (FURNISHED BY OWNER)

PART 1 - GENERAL

1.1 SUMMARY

A. Related Sections:
   1. Division 26, Section 26 00 00 "Electrical General Provision."

B. Section Includes: Panelboards serving facility feeder circuits or other utilization equipment at the following voltage levels:
   1. 208Y/120 V, 3-phase, 4 wire.
   2. 480Y/277 V, 3-phase, 4 wire.

C. The contractor shall be responsible for installation of the panelboards from arrival on-site from supplier to completion of project. Installation to include:
   1. Installation of panelboards from delivery by supplier to wall.
   2. Mounting of panelboards to wall per manufacturer requirements.
   3. All conduit and wiring external to the panelboards and terminations of external connections.

1.2 DELIVERY STORAGE AND HANDLING

A. Panelboards shall be protected from the elements during storage and must be stored indoors in dry heated areas. Factory wrapping shall be maintained, or additional heavy plastic cover shall be provided to protect the panelboards from dirt, water, construction debris and traffic.

B. Panelboards shall be handled to avoid damage to components, enclosure or finish. All damage shall be repaired prior to installation.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1.

B. Install filler plates for unused spaces in panelboards.

C. Provide typed circuit directory for each branch circuit panelboard, and revise directory to reflect circuiting changes to balance phase loads.

D. Install engraved plastic nameplates in accordance with Section 26 00 00 and 26 05 53.

E. Install spare conduits out of each recessed panelboard to an accessible location above ceiling.

F. Ground and bond panelboard enclosure according to Section 26 00 00 and 26 05 26, and connect equipment ground bars of panels in accordance with NFPA 70.

2.2 FIELD QUALITY CONTROL

A. Refer to Division 01, Section 01 40 10 “Quality Assurance/Quality Control.”

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

D. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

E. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

2.3 ADJUSTING

A. Measure steady state load currents at each panelboard feeder.

B. Rearrange circuits in panelboard to balance phase loads to within 20 percent of each other.

C. Maintain proper phasing for multi-wire branch circuits.

2.4 SCHEDULES

A. Circuiting with the panelboard shall match the panel schedules as indicated on the drawings.

B. Provide type-written schedule in each panelboard.

END OF SECTION

SECTION 26 24 19
LOW-VOLTAGE MOTOR CONTROL CENTERS (FURNISHED BY OWNER)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Low Voltage Intelligent Motor Control Center (MCC), ready to use, completely engineered and assembled furnished by Owner, installed by Contractor. Contractor responsible to review requirements of this Specification and MCC shop Drawings once available from Owner.
   2. Contractor shall be responsible for installation of MCC from arrival on-site from supplier to completion of project. Installation to include:
      a. Housekeeping pad.
      b. Transition of MCC from shipping trailer to housekeeping pad, including crane if required.
      c. Anchorage of MCC to equipment pad per manufacturer and seismic requirements.
      d. All conduit and wiring external to the MCC and terminations of external connections.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Drawings, Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all drawings and sections to ensure a complete and coordinated project.

1.2 REFERENCES

A. National Electrical Manufacturer's Association (NEMA):
   1. ICS-2-322 - AC General Purpose Motor Control Centers.

B. Underwriters Laboratories (UL):
   1. UL 845 - Motor Control Centers.

C. NFPA-70 National Electrical Code (NEC).

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

B. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
   1. AFIE: Arc Flash Incident Energy

2. CDR: Closed Door Racking
3. ELM: Earth Leakage Module
4. EPMS: Electrical Power Management System
5. FAT: Factory Acceptance Testing
6. GFM: Ground Fault Module
7. iMCC: Intelligent Motor Control Center
8. IMPR: Intelligent Motor Protection Relay
9. MCC: Motor Control Center
10. MCCB: Molded Case Circuit Breaker
11. MOV: Metal Oxide Varistors
12. OIT: Operator Interface Terminal
13. PIV: Peak Inverse Voltage
14. RSTP: Rapid Spanning Tree Protocol
15. RVSS: Reduced Voltage Solid State motor controller
16. SCR: Silicon-Controlled Rectifier
17. SNMP: Simple Network Management Protocol
18. VFD, AFD: Variable Frequency Drive

1.4 DELIVERY STORAGE AND HANDLING

A. Motor control centers shall be protected from the elements during storage and must be stored indoors in dry heated areas. Factory wrapping shall be maintained, or additional heavy plastic cover shall be provided to protect the motor control center from dirt, water, construction debris and traffic.

B. Motor control centers shall be handled to avoid damage to components, enclosure or finish. . All damage shall be repaired prior to installation.

1.5 SEQUENCING

A. Refer to Section 26 00 00.

1.6 SCHEDULING

A. Refer to Section 26 00 00.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants and other accessories necessary to completely install the motor control center for the line, load and control connections.

B. Assemble and install the motor control center in the locations and with the layouts shown on the Contract Drawings and in complete conformance with the manufacturer's recommended procedures.

C. Install motor control centers on a 3-1/2 inch raised concrete housekeeping pad with imbedded leveling channels as shown on the Contract Drawings.

D. Anchor vertical sections to leveling channels by welding or bolting motor control center base channels to the leveling channels imbedded in the housekeeping pad.

E. Furnish all components, drills, tools etc necessary to complete the installation.

F. Replace any hardware lost or damaged during installation or handling to provide a complete installation.

G. Completely fill the space between the housekeeping pad and the bottom of the motor control center with a silicone rubber sealant.

H. Provide openings in the top or bottom of the motor control center for conduit only. No additional openings are allowed.
   1. Mis-cut holes will require the entire vertical bay or removable panel be replaced. No hole closers or patches will be allowed.

I. Bundle circuits together and terminate in each unit.
   1. Tie with wire ties. Refer to Section 26 05 19.
   2. Label all wires at each end with wire numbers as shown on the approved elementary schematics.
   3. All connections to and from the motor control center shall be made via terminal blocks.

J. Furnish all mounting brackets, stands, etc that may be required to physically mount the motor control center.

K. Tolerances
   1. Install the motor control center so that it is plumb and level to within ± 1/16 inch across its entire dimension.

2.2 FIELD QUALITY CONTROL

A. Test
   1. Field testing and checking of motor control center installation shall be performed by the manufacturer's field representative or by an independent testing agency.
   2. Perform acceptance tests in accordance with Section 26 08 00.

2.3 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer or testing firm.

2.4 CLEANING

A. Clean and vacuum all enclosures to remove all metal filings, surplus insulation, visible dirt, dust and other matter prior to starting the system or energizing the equipment.

B. Do not use compressors or air blowers for cleaning.

2.5 DEMONSTRATION

A. Demonstrate the operation to the Engineer's and Owner's satisfaction.

2.6 PROTECTION

A. Protect all equipment from damage or degradation after testing is complete until such time as the Project is substantially completed and accepted by the Engineer and Owner.

END OF SECTION

SECTION 26 27 25
TOGGLE SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers.

B. National Electrical Contractors Association.

C. National Electrical Manufacturers Association.

D. NFPA 70, National Electrical Code.

E. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section includes the following:
   1. General purpose toggle switches.
   2. Special Purpose Switch (press actuated switch) for corrosive and wet areas.
   3. Rocker type switches.
   4. Single-pole, double throw, three-position switches.
   5. Dimmer switches.

B. Related Sections include the following:
   1. Division 26 Section 26 27 26 “Receptacles.”
   2. Division 26 Section 26 27 27 “Plates.”
   3. Division 26 Section 26 00 00 “Electrical General Provisions.”

1.4 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

C. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

1.5 SYSTEM DESCRIPTION

A. Toggle switches shall be specification grade, back and/or side wired, quiet action, totally enclosed, rated 20 amperes at 120-277 VAC or as indicated on the plans, and meeting the latest applicable Federal Specifications.

B. Toggle switches used for programmable panelboards shall be as recommended by the panelboard manufacturer.

C. Provide switches with the operator style and contact arrangement as shown on the plans and as required for proper operation.

D. General purpose toggle switches shall be black everywhere except in finished rooms, where they shall be white. Special purpose switches shall have a color as shown.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00 and 26 00 00.

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

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements.
   1. Shall meet all applicable UL and CSA standards.

B. Standards.
   1. Federal Specification W-S-896E.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Eaton (Cooper) Wiring Devices.
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
   5. General Electric Co.

2.2 MANUFACTURED UNITS

A. Comply with NEMA WD 1 and UL 20.

B. Heavy Duty Switches, 120/277 V, 20 A, back wired, catalog numbers are for black switches:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Eaton (Cooper); AH1221BK (single pole), AH1222BK (two pole), AH1223BK (three way), AH1224BK (four way).
      b. Hubbell; 1221BK (single pole), 1222BK (two pole), 1223BK (three way), 1224BK (four way).
      c. Leviton; 1221-2E (single pole), 1222-2E (two pole), 1223-2E (three way), 1224-2E (four way).
      d. Pass & Seymour; PS20AC1BK (single pole), PS20AC2BK (two pole), PS20AC3BK (three way), PS20AC4BK (four way).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Verify compliance of wiring device with dry area, wet area, corrosive area, or other area conditions which may be listed in other sections of the specifications or on the drawings.

3.2 INSTALLATION

A. Over 300 Volts
   1. Where switches used in systems of more than 300 volts between conductors, are to be ganged in outlet boxes, provide switches having no exposed live parts or use barriers between the individual switches.

B. Mount all toggle switches four (4) feet above finished floor unless otherwise noted.

C. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

D. Conductors:
   1. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

2. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
3. Existing Conductors:
    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

E. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
6. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on the device.
8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

F. Dimmers:
1. Install dimmers within terms of their listing.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

END OF SECTION

SECTION 26 27 26
RECEPTACLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. ASME International

B. Institute of Electrical and Electronics Engineers Inc.

C. International Electrical Testing Association.

D. National Electrical Manufacturers Association.

E. NFPA 70, National Electrical Code.

F. NFPA 110, Emergency and Standby Power Systems.

G. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section includes the following:
   1. Receptacles and receptacles with integral GFCI.
   2. Isolated-ground receptacles.
   3. Data and communications jacks.
   4. 480 V, three-phase receptacles.

B. Related Sections include the following:
   1. Division 26 Section 26 27 25 “Toggle Switches.”
   2. Division 26 Section 26 27 27 “Plates.”
   3. Division 26 Section “Electrical General Provisions.”

1.4 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

1.5 SYSTEM DESCRIPTION

A. General purpose duplex receptacle shall be black everywhere except in finished rooms, where they shall be white.

B. General purpose receptacles shall be rated 20 A at 125 VAC, NEMA configuration 5-20R, except as otherwise required by the plans or specifications.

C. Receptacles in the following areas shall be of the ground fault interrupter type:
   1. Outdoors.
   2. Vaults.
   3. Pipe galleries.
   4. Toilet and restrooms.
   5. Reservoirs.
   6. Below grade rooms and areas.
   7. Other areas as required by the National Electrical Code.

D. In the office areas of the plant, all receptacles shall be of the rectangular designer type.

E. On 20 A circuits with a single duplex receptacle, outside, in corrosive areas, or as indicated on the plans, provide receptacles rated 20 A at 125 VAC, NEMA configuration 5-20R.

F. Where a 125 V, 30 A receptacle is shown on the plans, use NEMA configuration 5-30R.

G. Where a 250 V, 20, 30 or 50 A receptacle is shown on the plans, use NEMA configuration 6-20R, 6-30R or 6-50R, respectively.

H. Three-phase receptacles shall be of the 3-pole, 4-wire type with a separate grounding contact.

I. 480 V receptacles shall be of the weatherproof type with spring door.

J. Furnish one matching plug for each three-phase power receptacle.

K. All receptacles powered from a UPS panelboard or identified as IG (Isolated Ground) shall:
   1. Be orange in color.
   2. The isolated ground conductor must be a dedicated conductor that runs from the IG terminal of the receptacle directly to the panelboard.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00 and 26 00 00.

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

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements.
   1. Shall meet all applicable UL and CSA standards.

B. Standards.
   1. Federal Specification W-C-596.

C. Comply with NFPA 70.

1.8 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configuration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Eaton (Cooper) Wiring Devices.
   2. Crouse-Hinds.
   3. General Electric.
   4. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   5. Interlink.
   6. Leviton Mfg. Company Inc. (Leviton).
   7. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
   8. Russellstoll.
   9. Woodhead.

2.2 MANUFACTURED UNITS

A. Convenience Duplex Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Receptacles shall have back wire and side wire option; back wire option shall have a screw tightened pressure plate to hold the wire (catalog numbers are for black receptacles).
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Eaton (Cooper); 5352G.
      b. Hubbell; CR5352BK.
      c. Leviton; 5352E.
      d. Pass & Seymour; 5362BK.

B. Convenience Receptacles, 250 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 6-20R, and UL 498. Receptacles shall have back wire and side wire option; back wire option shall have a screw tightened pressure plate to hold the wire (catalog numbers are for black receptacles).

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL5462BK.
   b. Leviton; CR20-E.
   c. Pass & Seymour; 5862BK.

C. 30A and 50A, 125V and 250V, single phase, single receptacles: Comply with NEMA WD 1, NEMA WD 6, and UL 498 (catalog numbers are for black receptacles).
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL9308 (30A, 125V, configuration 5-30R), HBL9330 (30A, 250V, configuration 6-30R), HBL9367 (50A, 250V, configuration 6-50R).
   b. Leviton; 5371 (30A, 125V, configuration 5-30R), 5372 (30A, 250V, configuration 6-30R), 5374 (50A, 250V, configuration 6-50R).
   c. Pass & Seymour; 3802 (30A, 125V, configuration 5-30R), 3801 (30A, 250V, configuration 6-30R), 3804 (50A, 250V, configuration 6-50R).

D. GFCI RECEPTACLES
1. General Description: Straight blade, feed-through type: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A.
   a. Duplex GFCI Convenience Receptacles, 125 V, 20 A, back and side wired (catalog numbers are for black receptacles) Products: Subject to compliance with requirements, provide one of the following:
      1) Eaton (Cooper); SGF20BK.
      2) Hubbell; GF20BKLA.
      3) Pass & Seymour; 2097BK.
   b. Duplex GFCI Convenience Receptacles for use in offices and other finished areas, 125 V, 20 A, back and side wired (catalog numbers are for white receptacles) Products Subject to compliance with requirements, provide one of the following:
      1) Eaton-Cooper; SGF20W.
      2) Hubbell; GF20WLA
      3) Pass & Seymour; 2097W.

E. 480-volt, three-phase, four-wire, 30 A receptacles:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Crouse-Hinds ARE3423.
   b. Hubbell Hubbellock® HBL21420.
   c. T&B Russellstoll™ DF3404FRAB.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount all weatherproof outlets horizontally.

B. Mount vertical receptacles with equipment ground opening down.

C. Mount horizontal receptacles with neutral opening up.

D. Three-phase receptacles shall be consistent with respect to phase connection of receptacle terminals. Errors in phasing shall be corrected at the bus, and not at the receptacle.

E. Mount all receptacles at the following heights unless otherwise noted:
   1. Office and finished areas twelve (12) inches above finished floor.
   2. Process and production areas four (4) feet above finished floor.

F. Coordination with Other Trades:
   1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

G. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

H. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
   5. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   6. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   7. Tighten unused terminal screws on the device.
   8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

I. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

J. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Receptacle Identification shall comply with Division 26 Section "Plates", and conductor Identification shall comply with Division 26 Section "Electrical Identification."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2Ω are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 26 27 27
PLATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. National Electrical Manufacturers Association.

B. NFPA 70, National Electrical Code.

C. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section includes the following:
   1. Indoor and outdoor plates for toggle switches.
   2. Indoor and outdoor plates for receptacles.
   3. Covers for floor boxes.
   4. NEMA 4 or NEMA 4X plates.

B. Related Sections include the following:
   1. Division 26 Section 26 27 25 “Toggle Switches.”
   2. Division 26 Section 26 27 26 “Receptacles.”
   3. Division 26 Section 26 00 00 “Electrical General Provisions.”

1.4 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00 and 26 00 00.

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

C. Engraving Schedule:
   1. Description of materials and process used for premarking wall plates.
   2. Furnish complete engraving schedule for engraved nameplates.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use square or rectangular metal plates for all applications unless otherwise indicated. Metal plates shall be steel hot-dip galvanized, cast aluminum, sherardized, or stainless steel.

B. Use stainless steel type 302 plates, 0.040" thick, in all plant and process areas.

C. Use cast iron or cast aluminum plates for cast device boxes, material to match that of the box.

D. Plates for receptacles installed outdoors or in wet or damp areas shall have gasketed stainless steel or cast aluminum flip covers. Plates shall be U.L. approved for weatherproof locations with plug inserted.
   1. For standard duplex receptacles:
      a. Crouse Hinds WLRD1.
      b. Pass & Seymour approved equal.
   2. For GFCI (ground fault) receptacles:
      a. Pass & Seymour approved equal .

E. Plates for switches installed outdoors or in wet or damp areas shall have gasketed stainless steel or cast aluminum flip covers.
   1. At outdoor locations shall be rain tight, gasketed:
      a. Crouse-Hinds DS185 cast aluminum.
      b. Pass & Seymour WP2 stainless steel.

F. Plates for special purpose switches in corrosive and wet areas requiring NEMA 4 or NEMA 4X enclosures shall be gray neoprene and weatherproof.

G. Plates for receptacles installed indoors in dry areas shall be:
   1. Stainless steel.
      a. Standard Duplex Receptacles Arraignments:
         1) Pass & Seymour Type SS8.
         2) Pass & Seymour Type SS82.
         3) Pass & Seymour Type SS83.
         4) Pass & Seymour Type SS84.
         5) Pass & Seymour Type SS85.
         6) Pass & Seymour Type SS86.

H. Decorator Receptacle Arraignments, for use with GFCI receptacle:
   1. Pass & Seymour Type SS26.

I. Plates for switches installed indoors in dry areas shall be:
   1. Stainless steel.
      a. Standard Toggle Switch Arraignments:
         1) Pass & Seymour Type SS1.
         2) Pass & Seymour Type SS2.
         3) Pass & Seymour Type SS3.
         4) Pass & Seymour Type SS4.
         5) Pass & Seymour Type SS5.
         6) Pass & Seymour Type SS6.
      b. Decorator Switch Arraignments:
         1) Pass & Seymour Type SS26.

J. Plates for receptacles and switches:
   1. Plastic and shall match color of receptacle or switch.
   2. Are only acceptable in offices and finished areas.

K. Covers for floor boxes shall be the checker plate type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ensure all plates make a firm seal with wall for recessed mounted devices.
   1. Outside edges of plates must conform with building lines.

B. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

C. Provide plates for all outlet boxes and fittings of all systems except at outlets where fixture canopies are used.

3.2 IDENTIFICATION

A. Comply with Division 26 Section 26 05 53 "Electrical Identification."
   1. Plates for switches and receptacles shall be engraved where possible.
      a. Engraved plates shall be in lieu of separate nameplates.
      b. Plates shall be engraved with the following information:
         1) Area served.
         2) Circuit fed from.
      c. Engraving shall be treated to improve visibility and, except for stainless steel plates, to prevent corrosion.
      d. Characters shall be block letter pantograph, engraved with a minimum character height of 1/8."

END OF SECTION

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SECTION 26 28 15
SAFETY SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Enclosed safety switches; fusible and nonfusible.

B. Related Sections:
   1. Division 26 Section 26 00 00 "Electrical General Provisions."
   2. Division 26 Section 26 05 53 "Electrical Identification."
   3. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

B. System Description:
   1. Furnish and install heavy-duty type safety switches as indicated on the plans and in the specifications.
   2. Provide safety switches with the number of poles, voltage, current, and horsepower ratings as required by the load.
   3. Furnish and install a local horsepower rated safety switch for each and every motor as identified on the drawings.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00 and 26 00 00.

B. Product Data:
   1. Catalog Cut Sheets
   2. Complete data sheets indicating:
      a. Manufacturer.
      b. Type of enclosure.
      c. Voltage rating.
      d. Current rating.
      e. Horsepower rating.

f. Fused or Non-fused.
g. Cross-referenced to device table in drawings.
h. Complete dimensional and weight information.

C. Operating Manuals:
1. Furnish complete operating and maintenance instructions presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this section.
a. Complete electrical ratings.
b. Complete renewal parts list.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
1. All safety switches shall be heavy-duty type and shall comply with the following standards.
a. NEMA KS1-1990 for Type HD.
b. UL 98 30 A and below.
c. UL 489 greater than 30 A.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. Subject to compliance with requirements, provide product by one of the following:
a. Eaton.
a. Square D; a brand of Schneider Electric.
b. Siemens.
c. ABB/GE.

2.2 EQUIPMENT

A. Switch Interiors
1. With the switch door open, the switchblades shall be fully visible in the "OFF" position.
2. All current carrying parts shall be completely plated on all surfaces.
3. Arc shields shall be removable to allow access to the movable and stationary contacts.
4. Line and load connections lugs:
a. Front accessible.
b. Front removable.
c. UL listed for 60 or 75 °C copper conductors.

B. Switch Mechanism
1. Shall be of the quick make, quick break designs, so that the parting contacts cannot be prohibited or restrained from moving by the operating handle once the contacts have started to move in either the "open" or "closed" direction.
2. Operating handle must be an integral part of the enclosure frame and in no way part of the door or cover.

3. Provisions shall be made for padlocking the switch in either the "ON" or "OFF" position.
    a. "OFF" position as a standard feature with a minimum of three locks.
    b. "ON" position by drilling out a center punched marking in the handle guide for one lock.
4. Dual cover interlock to prevent opening of the switch door in the "ON" position and to prevent closing the switch mechanism with the door open.
5. Handle position shall clearly indicate whether the switch is "ON" or "OFF."

C. Ratings
1. All switches shall be UL horsepower rated for AC and/or DC with the rating not less than the load served.
2. Fused switches.
    a. Shall have a UL approved method of field conversion from standard Class H fuse spacing to Class J fuse spacing.
        1) Ratings 100 A thru 600 A at 240 V.
        2) Ratings 30 A thru 600 A at 600 V.
    b. Shall accept Class R fuses and shall have a UL listed rejection feature present to reject all fuses except Class R when Class R fuses are shown on the plans.
    c. Minimum UL listed short circuit ratings:
        1) 200,000 A RMS symmetrical when used with Class R or Class J fuses.
        2) 10,000 A RMS symmetrical when used with Class H fuses.
        3) 200,000 A RMS symmetrical when used with Class L fuses in the 800 and 1200 A size.
    d. Fuse clips shall be spring reinforced and plated.

D. Enclosures
1. At minimum, enclosures must meet the requirements for the area designation as defined and listed:
    a. In Section 26 00 00 “Electrical General Provisions.”
    b. On the contract drawings.
    c. In case of a conflict, in which case the more stringent enclosure standard shall be used.
2. NEMA 1 enclosures:
    a. General purpose enclosures with hinged doors.
    b. Sheet steel.
    c. Manufacturer’s standard gray baked enamel finish, electrostatically deposited.
3. NEMA 3R enclosures:
    a. Doors shall be securable in the open position.
    b. Provisions for bolt on hubs or Meyer hubs.
    c. Constructed of galvanized steel.
    d. Manufacturer’s standard gray baked enamel finish UV resistant, electrostatically deposited.
4. NEMA 12 enclosure:
    a. Furnish without knockouts.
    b. Hinged covers fully gasketed to assure a dust-tight enclosure.
    c. Constructed of galvanized steel.

d. Manufacturer's standard gray baked enamel finish, electrostatically deposited.

5. NEMA 4, 4X and 5 enclosures:
   a. Furnished without knockouts.
   b. Stainless steel enclosures and hardware.
   c. Fully gasketed door(s), held closed under pressure by latches.
6. NEMA 7 and 9 enclosures:
   a. Shall be used in hazardous areas as indicated on drawings.
   b. Shall be rated for the Hazardous Classification indicated.

E. Neutral and Grounding Provisions
   1. Provisions shall be made for a field installed, insulated groundable neutral kit.
      a. The neutral kit shall be furnished where indicated on the contract drawings.
   2. Equipment ground kits shall be furnished for each switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive safety switches for compliance with installation tolerances and other conditions affecting installation.

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

3.2 INSTALLATION

A. Provide all mounting brackets, stands, and hardware as necessary to completely support the switches at the locations indicated on the drawings.
   1. Finish and provide materials for all brackets, stands and hardware, which shall match the switch installed thereon.

B. When possible, mount switches rigidly to exposed building structure or equipment structural members.

C. When mounting NEMA 4, 4X, 5 enclosures maintain a minimum of 0.25 inch air space between the enclosure and the supporting surface.

D. Use Meyers hubs or bolt-on hubs for all conduit penetrations on NEMA 3R, 4, 4X, and 5 enclosures.

E. Connect equipment grounding conductors only to the approved equipment ground kit.

F. Furnish and install a nameplate for each safety switch.
   1. In conformance with Division 26 Section 26 05 53 "Electrical Identification".
   2. Shall identify voltage, circuit, fuse size, and equipment served on the nameplate.

G. When mounting switches on Unistrut type channel lagged to walls, channel must be run vertically behind the switch.

H. Switches must be mounted plumb and level to within ±1/32" over their longest dimension.

3.3 CLEANING

A. All switches must be vacuumed clean after installation and prior to installation of any wire.

END OF SECTION

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SECTION 26 28 16
LOW-VOLTAGE CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Requirements for circuit breakers.
      a. Molded case circuit breakers.
      b. Molded case switches.
      c. Motor circuit protectors.

B. Related Sections:
   1. Division 26 Section 26 00 00 “Electrical General Provisions.”
   2. Division 26 Section 26 05 53 “Electrical Identification.”
   3. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the contractor and its sub-contractors to review all sections to ensure a complete and coordinated project.

1.3 REFERENCES

A. Molded Case Circuit Breakers
   1. UL:
      a. UL 489 - Branch Circuit and Service Circuit Breakers.
      b. UL 1087 - Molded Case Switches.
   2. NEMA:
      a. AB-1 - Standards Publication Molded Case Circuit Breakers.
   3. Federal Specifications:
      a. WC -375A - Circuit Breaker, Molded Case, Branch Circuit and Service.

1.4 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. NFPA: National Fire Protection Association.

1.5 SYSTEM DESCRIPTION

A. Furnish molded case, insulated case, power type, or motor circuit protector circuit breakers as indicated on the drawings, and connect to form a completed system.

B. Circuit breakers must be of the current and voltage ratings indicated and be capable of interrupting the available fault current.

C. Where circuit breakers are used as disconnects for miscellaneous over-current protection, provide automatic, enclosed units, with the indicated ratings that comply with requirements (including manufacturer) for circuit breakers as specified.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00 and 26 00 00.

B. Product Data:
   1. Catalog Cut Sheets
   2. Complete data sheets indicating:
      a. Manufacturer.
      b. Type of enclosure.
      c. Voltage rating.
      d. Current rating.
      e. Amperage rating.
      f. Complete dimensional and weight information.

C. Operating Manuals
   1. Furnish complete operating and maintenance instructions presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this section.
      a. Complete electrical ratings.
      b. Complete renewal parts list.

1.7 WARRANTY

A. All circuit breakers shall be 100% warranted for a period of not less than two years from the date of final acceptance by the ENGINEER.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Eaton.
   2. Square D; a brand of Schneider Electric.
   3. Siemens.
   4. ABB/GE.

2.2 EQUIPMENT

A. General Breakers
   1. All breakers shall have temperature insensitive trips.

B. Molded Case Circuit Breakers

1. Molded case circuit breakers for distribution panelboards and motor control centers.
    a. Basic circuit breaker must be trip free with a quick-make, quick-break mechanism.
    b. Trip indicating handle position.
    c. Frame sizes:
        1) 150 A.
        2) 400 A.
        3) 600 A.
        4) 800 A.
        5) 1,200 A.
    d. Trip mechanism as indicated on drawings:
        1) Thermal magnetic.
        2) Thermal high magnetic.
        3) Solid state.
            a) Adjustable long-time pickup - ampere setting to determine the value of current that the breaker will carry indefinitely.
            b) Adjustable long-time delay - varies the time it will take the breakers to trip under sustained overload.
            c) Adjustable short time pickup - controls the level of high current the breaker will carry for short periods of time.
            d) Adjustable short time delay - controls the length of time the breaker will carry a high current without tripping.
            e) Adjustable instantaneous pickup - controls level at which immediate tripping of breaker occurs.
                i. Instantaneous trip function may be eliminated on main breakers, refer to drawings.
            f) Adjustable ground fault pickup - controls the level at which the breaker will trip under a ground fault condition (where shown on the drawings).
            g) Adjustable ground fault delay - controls the time that a ground fault can exist without tripping the breaker (where ground fault feature is shown on the drawings).
            h) Long-time pickup indicator - provides a visual indication that the breaker is experiencing an overload condition.
            i) Fault indicator - shall be either mechanical or powered from a separate battery and charger, and shall be an integral component of the switchboard.
                i. Indicator for overload fault trip.
                ii. Indicator for short circuit fault trip.
                iii. Indicator for ground fault trip.
2. Provide non-automatic trip breakers (molded case switches) only where specifically indicated on the contract drawings or in the specifications.

C. Enclosures
1. Furnish enclosures consistent with the area classification and NEMA designation as indicated on the plans and specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive safety switches for compliance with installation tolerances and other conditions affecting performance of the work.

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

3.2 INSTALLATION

A. Arrange all breakers to correspond exactly with the schedules.

B. In damp or wet areas, mount the enclosures on Unistrut type mounting channels that run vertically, so that water and moisture may flow freely behind enclosure.

3.3 FIELD QUALITY CONTROL

A. Low-Voltage Molded Case and Insulated Case Circuit Breakers
   1. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with drawings and specifications.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage and alignment.
      d. Circuit breaker shall be checked for proper mounting, conductor size and feeder designation.
      e. Operate circuit breaker to ensure smooth operation.
      f. Check tightness of connection with torque wrench in accordance with manufacturer's recommendations.
      g. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
   2. Electrical tests for breakers in excess of 200 A trip ratings:
      a. Perform resistance measurements through bolted connections with a low resistance ohmmeter.
      b. Time-current characteristic tests shall be performed by passing 300% rated current through each pole separately.
         1) Determine long-time pickup.
         2) Determine short-time pickup.
      c. Instantaneous pickup current shall be determined by run-up or pulse method:
         1) Clearing times should be within 4 cycles or less.
      d. Insulation resistance shall be determined pole to pole, across pole, and pole to ground.
         1) Circuit breaker shall be closed.
         2) DC testing shall be performed, using 1000 V applied for one minute.
      e. Perform adjustments for final setting in accordance with the Short Circuit and Coordination Study.
   3. Test values:
      a. Contact resistance shall be compared to adjacent poles and similar breakers.
         1) Deviations of more than 50% shall be investigated.
      b. Insulation resistance shall not be less than 100 MΩ.
      c. All trip times shall fall within manufacturer's published time current curves:

1) Circuit breakers exceeding maximum time shall be replaced.

d. Instantaneous pickup current levels should be within 20% of manufacturer's published values.

END OF SECTION

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SECTION 26 29 23
VARIABLE FREQUENCY DRIVES (FURNISHED BY OWNER)

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. Variable frequency drives in motor control center (MCC) furnished by Owner. MCC installed by contractor. See Division 26 Section "Low Voltage Motor Control Centers".

1.2 RELATED DOCUMENTS

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

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers.
   1. IEEE C62.41: Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   2. IEEE 519: Recommended Practices and Requirements for Harmonic Control in Electric Power Systems. 1992. (ANSI)

B. InterNational Electrical Testing Association
   1. NETA ATS-2017: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

C. National Electrical Manufacturers Association
   1. NEMA 250-97: Enclosures for Electrical Equipment (1000 Volts Maximum)
   2. NEMA AB 1-99: Molded Case Circuit Breakers and Molded Case Switches
   3. NEMA ICS 2-93: Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
   4. NEMA KS 1-96: Enclosures and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
   5. NEMA MG 1-98: Motors and Generators (Including Revisions 1 and 2)

D. National Fire Protection Association
   1. NFPA 70: National Electrical Code

E. Underwriters Laboratories Inc
   1. UL-50 Standards for Enclosures for Electrical Equipment.

1.4 SUMMARY

A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections include the following:
   1. Division 26 Section "Low Voltage Motor Control Centers".

2. Division 26 Section “Electrical General Provisions”.

1.5 DEFINITIONS

A. IGBT: Insulated gate bipolar transistor.

B. LAN: Local area network.

C. PID: Control action, proportional plus integral plus derivative.

D. PWM: Pulse-width modulated.

E. VFD: Variable frequency drive.

PART 2 - EXECUTION

2.1 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
1. Test insulation resistance for each enclosed drive element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
1. Inspect drives, wiring, components, connections, and equipment installation.
2. Assist in field testing of equipment including pre-testing and adjusting of solid-state drives.
3. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

2.2 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

2.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency drives.

END OF SECTION

SECTION 26 32 00
PACKAGED ENGINE GENERATOR (FURNISHED BY OWNER)

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. Packaged engine generator furnished by Owner, installed by Contractor. Contractor responsible to review requirements of this Specification and generator shop Drawings once available from Owner.

B. Contractor responsible for installation of generator from arrival on-site from supplier to completion of project. Installation to include:
   1. Generator pad.
   2. Transition of generator from shipping trailer to generator pad, including crane required.
   3. Anchorage of generator to equipment pad per manufacturer and seismic requirements.
   4. All conduit, wire, and terminations required between the generator and transfer switch.

1.2 RELATED DOCUMENTS

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

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers.

B. National Electrical Contractors Association.

C. American Society for Testing and Materials (ASTM):
   1. A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   2. A106 – Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   3. A181 – Specification for Carbon Steel Forgings for General Purpose Piping.
   4. A240 – Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
   5. A536 – Specification for Ductile Iron Castings.
   6. D2310 Standard Classification for Machine-Made Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

D. International Fire Code Institute (IFCI):
   1. Uniform Fire Code (UFC).

E. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum)
   2. NEMA MG-1 – Motor and Generators.

F. National Fire Protection Association (NFPA):
   1. NFPA 30 – Flammable and Combustible Liquids Code.
   2. NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines.
   3. NFPA 70 – National Electrical Code.
   4. NFPA 99 – General Overall Requirements.
   5. NFPA 110 – Emergency and Standby Power Systems.

G. Underwriters Laboratories (UL):
   1. UL 142 – Standards for Steel Aboveground Tanks for Flammable and Combustible Liquids.
   2. UL 508 – Industrial Control Equipment.
   3. UL 2200 – Standards for Stationary Engine Generator Assemblies.

1.4 SUMMARY

A. This Section includes packaged engine-generator sets for standby power supply; provided by the Owner, installed by the Contractor.

B. Related Sections include the following:
   1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets. Transfer switch shall be furnished by generator manufacturer.
   2. Division 26 Section “Electrical General Provisions”.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for package engine generator. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - EXECUTION

2.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

2.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine-generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with vibration isolators having a minimum deflection in accordance with manufacturer recommendations on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is referenced in Division 26 Section “Electrical General Provisions”.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

E. Fuel: Contractor shall fill the fuel tank and perform the load test. Upon completion of the load test, contractor shall completely fill the fuel tank. Fuel shall be Grade DF-2 fuel oil.

2.3 CONNECTIONS

A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance. All connections shall be made in accordance with the shop drawings, Manufacturer’s recommendations, and all applicable codes.

B. Ground equipment as noted on drawings and according to Division 26 Section "Grounding and Bonding."

C. Connect wiring as noted on drawings and according to Division 26 Section "Conductors and Cables."

2.4 IDENTIFICATION

A. Identify system components as noted on drawings and according to Division 26 Section "Electrical Identification."

2.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Contractor to engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. The tests are listed in the following paragraphs of this article. Report results in writing.
   1. Engine technician must be completely knowledgeable in the operation, maintenance, and start-up of the mechanical system.
   2. Electrical technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.

B. Tests and Inspections:
   1. Perform tests recommended by manufacturer and those tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
   2. Before start-up, inspect the entire installation and all connections, both mechanical and electrical, and ensure that they are proper and consistent with all Drawings and Specifications.
      1. Inspect for physical damage.

2. Compare nameplate rating and connection with specifications and single line diagram.
3. Inspect for proper anchorage and grounding. Engine cooling and fuel system integrity shall be verified.

3. The factory-certified technicians, during the start-up and adjustment period, shall make sure all items furnished are in proper operating condition.
4. Certify that fuel, lubricating oil, and antifreeze conform to the Manufacturer's recommendations under the environmental conditions present.
5. Check accessories that normally function while the equipment is in standby mode for proper operation, before cranking the engine.
   a. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
      1. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
      2. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
      3. Verify acceptance of charge for each element of the battery after discharge.
      4. Verify that measurements are within manufacturer's specifications.
   b. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
   c. Engine heaters.
6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
7. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
8. Exhaust Emissions Test: Comply with applicable government test criteria.
9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
10. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Load Test: Full-load test the generating system at the site in the presence of the ENGINEER, with the Manufacturer's representative providing the necessary resistive load banks.

1. Loading shall be:
    a. 25% rated for 30 minutes.
    b. 50% rated for 30 minutes.
    c. 75% rated for 30 minutes
    d. 100% rated for 3 hours.
2. Permanently installed load banks supplied as part of the project may be utilized to provide part of the specified load.
3. Record voltage, frequency, load current, oil pressure and coolant temperature during test. Voltage regulation, frequency stability and maximum temperature rise shall be calculated.
4. Measure radiator performance at full load including airflow, air inlet temperature and air outlet temperature.
5. Correct defects that become evident during testing.
6. Measure flows, pressures and temperatures of fuel, coolant, exhaust gas, and radiator air at inlets and outlets to system components.
7. Provide copies of the test reports to the Engineer. In accordance with submittal requirements referenced in section one.
8. Include the cost for the fuel to perform all load testing and/or re-testing. Fill fuel tank when testing is complete.

G. Phase rotation shall be verified to determine compatibility with load requirements.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
1. Engine shutdown features shall be function tested:
    a. Low oil pressure.
    b. Over-temperature.
    c. Over-speed.
    d. Other features as applicable.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
1. Report must state that the installation is complete and satisfactory.
2. List the items requiring additional attention.

2.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel regarding the operation and maintenance of the packaged engine generators. Including any and all special systems installed by them, or installed under their supervision.
1. Minimum of 8 hours in two 4 hour sessions each.
2. Supply written handouts during the training period, and these handouts should be suitable for future reference after the training period is completed.

END OF SECTION

SECTION 26 36 00
TRANSFER SWITCHES (FURNISHED BY OWNER)

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. Transfer switch furnished by Owner, installed by Contractor. Contractor responsible to review requirements of this Specification and transfer switch shop Drawings once available from Owner.

B. Contractor responsible for installation of switch from arrival on-site from supplier to completion of project. Installation to include:
   1. Equipment pad.
   2. Installation of transfer switch from delivery by supplier to equipment pad, including crane as required.
   3. Anchorage of transfer switch to equipment pad per manufacturer and seismic requirements.
   4. All conduit, wire, and terminations required between the generator and transfer switch.

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches.

B. Related Sections include the following:
   1. Division 26 Section "Packaged Engine Generator" for the generator specifications that the switch will be used with.
   2. Division 26 Section "Electrical General Provisions".

1.4 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.
   1. Concrete Bases: Install transfer switches on 3-1/2 inch raised concrete housekeeping pad, with chamfered edges, unless otherwise indicated, as shown on the Contract

Drawings. Comply with requirements for concrete referenced in Division 26 Section "Electrical General Provisions".

B. Identify components according to Division 26 Section "Electrical Identification."

2.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

C. Connect wiring according to Division 26 Section "Wire Connections."

2.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Contractor to engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
      a. Set field-adjustable intervals and delays, relays, [and engine exerciser clock].
   2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
      a. Check for electrical continuity of circuits and for short circuits.
      b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
      c. Verify that manual transfer warnings are properly placed.
      d. Perform manual transfer operation.
   5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
      a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
      b. Verify time-delay settings.
      c. Verify pickup and dropout voltages by data readout or inspection of control settings.
      d. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
      e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Remove and replace malfunctioning units and retest as specified above.

2.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment. Provide minimum 2-hour onsite training. Coordinate training with Owner, and provide programming of transfer switch during training.

B. Coordinate this training with that for generator equipment.

END OF SECTION

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SECTION 26 50 00
LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the general requirements for luminaries and light poles.

B. Related Sections - Contract documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
1. National Electrical Code.
2. Institute of Electrical and Electronic Engineers.
3. National Fire Protection Association.
4. Illuminating Engineering Society.

1.3 SYSTEM DESCRIPTION

A. The Contractor shall furnish and install luminaries and accessories for all lighting systems, complete and operable, all in accordance with the requirements of the contract documents.

B. Individual luminaire types are identified in the plans and on the luminaire schedule.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Division 26, Section 26 00 00 “Electrical General Provisions.”

B. Product Data

1. Catalog literature for each luminaire specified, cross-referenced to the luminaire type found on the luminaire schedule in the plans.

    a. Each such submittal shall clearly describe:
        1) Materials.
        2) Type of diffuser.
        3) Hardware.
        4) Gasketing.
        5) Reflector.
        6) Chassis.
        7) Finish.
        8) Ballast.

2. Complete literature for each luminaire substitutions.

   a. Submittals for luminaries shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire.
      1) Photometric data shall include coefficients of utilization, average brightness, candle power distribution curves, and lumen output chart.
   b. Substitutions for specified luminaires shall be based upon quality of construction, light distribution, appearance and maintenance.

3. Support method shall be submitted for interior fixtures weighing over 50 pounds.

4. Ballast catalog data indicating lamp wattage, input watts, sound rating, power factor, and type of ballast. Data for outdoor ballast shall include low temperature starting characteristics.

5. Photocell data submittal shall indicate switching capacity, the means of adjusting the lighting pickup level, and enclosure.

6. Pole-mounted luminaries, including complete data on the pole material, finish, handholes, anchoring, and fixture attachment.

7. Pole height, dimensions, bolt hole circle layout, light supporting rating, and wind withstand rating based on effective area of luminaries, and hardware.

C. Calculations

1. Provide mounting details for indoor lights with calculations showing that the installation meets the seismic requirements of the site.

2. Calculations and design must be made by and stamped by a registered professional engineer, registered in the state where the project is being constructed. In light of the fact that this design is being provided by a professional engineer, the submittal will be reviewed for form and content but not reviewed for technical completeness, methods, or calculations.

D. Record Drawings

1. The luminaire schedule in the plans must be updated to reflect the acceptable substitutions, after the substitution has been reviewed and accepted by the Engineer.

1.5 QUALITY ASSURANCE

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

1. National Electric Code.

2. Underwriters Laboratories.
3. ANSI C82.1 - Specifications for Fluorescent Lamp Ballasts.
4. ANSI C84.4 - Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type).
5. Standards of the Certified Ballast Manufacturer's Association.
6. Illuminating Engineering Society (IES).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Luminaries shall be stored in their original cartons from the manufacturers until the time of installation.

B. Luminaire poles shall be stored on blocks above grade until the time of installation.

1.7 PROJECT/SITE CONDITIONS

A. Seismic and wind withstand ratings in accordance with Division 26, Section 26 00 00.

1.8 SEQUENCING AND SCHEDULING

A. Exterior lighting system operation shall be demonstrated during the hours of darkness.

B. Lighting demonstration shall occur within 2 weeks prior to project acceptance.

1.9 WARRANTY

A. The Contractor shall warrant all luminaries, ballasts, and lamps for a minimum period of one (1) year from substantial completion unless otherwise specified by the General Conditions.

1. Furnish, and replace any defective equipment during that period at no charge to the Owner.
2. Said warranty shall be independent of any manufacturer infant mortality or normal failure statistics.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Pre-approved manufacturers are indicated on the luminaire schedule, and in notes on the drawings.

1. This selection of manufacturer's is not intended to be overly restrictive, and the Contractor may make substitutions from the manufacturers listed in the luminaire schedule to offer a more advantageous luminaire package.
2. The lighting design and luminaire selection has been based upon the photometrics of the identified luminaries. It is the Contractor's responsibility to ensure and prove to the Engineer at time of submittal that any substitutions meet the quality and photometric requirements of the original design.
3. The Engineer shall make final determination if proposed substitutes are acceptable.

4. The Contractor shall furnish the identified luminaries at no additional cost to the Owner for any luminaire substitutions that in the sole opinion of the Engineer, are not acceptable.

2.2 EQUIPMENT

A. Luminaries – General

1. All luminaries shall be pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
2. In general, the luminaries furnished shall be as per the luminaire schedule. The specifications apply to those luminaries not described, or as an addition or supplement to the luminaire schedule.

B. Exterior Luminaries

1. Exterior luminaries, in combination with their mounting pole and bracket, shall be capable of withstanding winds of levels consistent with the levels identified in Section 26 00 00, without damage.
2. Exterior luminaries shall have corrosion-resistant hardware and hinged doors or a lens retainer.
3. Luminaries specified to be furnished with integral photo-electrical control shall be of the luminaire manufacturer's standard design.

C. Interior Luminaries

1. Interior fluorescent luminaries without diffusers shall be furnished with end plates.
2. Where diffusers are required, they shall be of high molecular strength acrylic.
   a. Minimum thickness of the acrylic shall be 0.125 inches for all diffusers, except those on 4-foot square fixtures which shall be 0.187 inches thick.

D. Lamps

1. Lamps shall be first-line:
   a. General Electric.
   b. Westinghouse.
   c. Sylvania.
   d. Phillips.
2. Fluorescent lamps shall be:
   a. As indicated on the luminaire schedule.
3. Incandescent lamps shall be frosted unless a specified lighting control system requires clear globe lamps.
4. High-pressure sodium lamps shall be of the dual filament design, suitable for use in standby duty.
   a. General Electric - LU400/SBY.
5. Unless otherwise indicated in the Contract Documents, lamps shall be suitable for operation in any burning position.

E. Photo-Electric Cells

1. Photoelectric cells for control of multiple fixtures shall be a self-contained, weatherproof type and shall be provided with time-delay features.

F. Ballasts
   1. Ballasts for fluorescent luminaries in office areas shall have a Class "A" sound rating:
      a. Such ballasts shall be of the low-loss type.
      b. All ballasts shall be high-power factor, Class P.
      c. Primary ballast voltage shall be suitable for use in the branch circuits indicated in the contract documents.
      d. Ballast shall be of the electronic design with plug and receptacle type connectors.
   2. In general, all ballasts must be:
      a. High efficiency.
      b. High-power factor.
      c. High output.
      d. Suitable for operation at -20° F for all luminaries not located in office areas.

2.3 COMPONENTS

A. Poles in general:

   1. As indicated in the luminaire schedule.
   2. Anchor bolts:
      a. Hot dip galvanized, and formed from hot rolled carbon steel bar stock, with an "L" bend on one end.
      b. Complete with leveling shims.
   3. Anchor base:
      a. Fabricated from structural quality hot rolled carbon steel plate, with a minimum yield strength of 36,000 psi.
      b. Base plate to telescope the pole shaft.
      c. Welded top and bottom along the entire perimeter.
      d. With slotted bolt holes on the bolt circles, as submitted.
   4. Handhole:
      a. Reinforced handhole located approximately eighteen (18) inches above the base.
      b. Complete with steel cover and attachment screws.
      c. With an integral ground connection nut, ½" x 13 UNC welded to the pole for connection to the grounding system.
   5. Pole mounted convenience outlet:
      a. Furnish a 120 V, GFCI-protected receptacle integrally mounted in the pole shaft at twenty-four (24) inches above the base. Complete with corrosion resistant and weatherproof cover.
      b. In accordance with Division 26, Section 26 27 26 “Receptacles.”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Special Techniques
   1. Luminaries shall be installed plumb and square with building and wall intersections.

a. Pendant-mounted luminaries which are mounted from sloping ceilings shall be suspended by ball hangers, unless otherwise indicated on the drawings.
b. Luminaries installed in machinery rooms shall be located after machines have been installed.

2. In all cases, luminaire locations shall be coordinated with work of other trades to prevent obstruction of light from the fixtures.
3. Luminaries shall be installed in accordance with the architectural reflected ceiling drawings.
4. Unless otherwise indicated, luminaries shall be centered on ceiling tiles.
5. Luminaries weighing more than 25 pounds shall be supported independently of the outlet box.
6. Recessed luminaries shall be installed light-tight to the ceiling and shall be provided with auxiliary safety supports attached directly to the building structure.
   a. Said safety supports shall consist of #12 AWG, soft drawn galvanized wire.
7. Luminaries installed in suspended grid ceilings shall be supported independently of the grid.
8. All luminaries installed in suspended grid ceilings shall be held in place with seismic restraint clips.

B. Lighting Poles

1. Poles shall be set on anchor bolts and secured with double nuts on each bolt.
2. After luminaire has been leveled and plumbed, the pole base shall be dry-packed.
3. Poles that are specified as hinged shall have one pole lowering winch furnished for all of the poles.

3.2 ADJUSTING

A. All outdoor luminaries shall be aimed after installation during dark evening hours as directed by the Engineer.

3.3 CLEANING

A. Lenses, diffusers, and reflectors shall be cleaned just prior to the time specified for the system demonstrations.

B. Luminaire trim, poles, and support brackets where finish has been damaged, shall be refinished.

C. All luminaries used during construction for construction lighting shall be cleaned, the lamps shall be replaced, and the used lamps returned to the Owner.

3.4 DEMONSTRATION

A. Exterior lighting system operation shall be observed to indicate that fixtures are properly focused, photo-cell operation is correct, and that switching functions as intended in accordance with paragraph 1.09 of this Section.

B. Similar requirements shall apply to interior lighting.

C. Through demonstration, the Contractor shall also verify that panel schedules properly indicate the lighting outlets connected to each circuit.

D. Lighting demonstration shall occur in accordance with paragraph 1.09 of this Section.

3.5 SCHEDULES

A. Refer to the Luminaire Schedules as found in the plans.

END OF SECTION

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SECTION 26 50 10
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes lightning protection for the following buildings:

1. Lift Station Building

B. Roof types:

1. Standing seam steel metal roof.

1.3 SUBMITTALS

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

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.
2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification Data: For qualified Designer, Installer and manufacturer. Include data on listing or certification by UL.

D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

E. Field quality-control reports.

F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Ground loop conductor.

1.4 QUALITY ASSURANCE

A. Designer and Installer Qualifications: Certified by UL or LPI, trained and approved for installation of units required for this Project. The designer and installer shall be:

1. VFC INC.
2. OR Approved alternate.

B. System Certificate:

1. UL Master Label.
2. OR; LPI System Certificate.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures, snow and ice melting heat tape and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

1.6 SYSTEM DESCRIPTION

A. The entire lightning protection system shall be designed and installed in accordance with:

1. Lightning Protection Institute (LPI) Standard #175
2. National Fire Protection Assoc. (NFPA) Document #780
3. Underwriters Laboratories, Inc. (U/L) Standard #96A
4. NEC

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Designer and Installer shall be:

1. VFC INC.
2. OR Approved alternate.

C. Roof-Mounted Air Terminals: NFPA 780, Class I, copper unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ERICO International Corporation.
   b. Heary Bros. Lightning Protection Co. Inc.

c. Harger, Inc.
d. Lyncole
e. Robbins Lightning, Inc.
f. Thompson Lightning Protection, Inc.

D. Main and Bonding Conductors: Copper.

E. Ground Loop Conductor: The same size and type as the main conductor except tinned.

F. Ground Rods: Copper-clad steel, 3/4 inch diameter by 96 inches long.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design and Install lightning protection components and systems according to article 1.6 above.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.

D. The lighting protection system shall be grounded to the building ground ring.

E. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Engineer at least 48 hours in advance of inspection before concealing lightning protection components.

B. The contractor shall furnish an LPI-IP Certificate or a UL Certificate upon completion of the installation.

END OF SECTION

SECTION 26 85 50
HEAT TRACING

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop Drawings

B. Manufacturer's descriptive literature.

PART 2 - PRODUCTS

2.1 ROOF AND GUTTER HEAT TRACING

A. The standing seam metal roof, eaves, gutters, and downspouts shall be heat-traced as indicated on the Drawings and as specified herein. The heat-tracing system shall be UL Listed and shall include heating cable, components, and controls for keeping the eaves, gutters and downspouts free of ice and snow.

B. The self-regulating heating cable shall be specifically designed for use with standing seam metal roofs and shall consist of two 16 AWG nickel coated copper bus wires embedded in a self-regulating polymer core that varies its power output to respond to temperature along its length, allowing the cable to be crossed over itself without overheating and allowing the cable to be cut-to-length in the field. The cable shall have a nominal power output of 12 watts per foot in snow and ice and 5 watts per foot in air, per IEEE 515. The heating cable shall operate on a 208 volt, single phase power supply and shall be the "IceStop GM-2XT" as manufactured by Raychem Corporation, or approved equal.

C. All heating components shall be UL Listed. Component enclosure shall meet NEMA 4X requirements. The system shall be controlled by an ambient sensing thermostat directly or through an appropriate contractor. The Contractor shall be a three-pole contractor in a NEMA 4X enclosure. Accessories shall include mechanical roof clips and adhesive. Refer to Section 07 72 00 – Roof Accessories.

D. The heating cable shall be laid in gutters; shall be suspended in downspouts either as a single length and held in place by a downspout hanger; and shall be attached to the roof using the appropriate roof clip, use sealed tee kits at locations required. The heating system shall be installed per the manufacturer's instructions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install in accordance with the manufacturer's instructions and recommended practices.

2. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
3. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
4. Provide end of circuit lighted end seals in bottom of down spouts.
5. Provide and install thermostat at each circuit to turn the heat trace off in warm weather.

3.2 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

DIVISION 31
EARTHWORK

SECTION 31 10 00
SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes all those measures required during the Contractor's initial move onto the site to protect existing fences, structures and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees or other objects dislodged during the construction process: clearing, grubbing and stripping; and regrading of areas to receive embankment fill.

B. The Contractor is required to protect and preserve all things designated to remain. Where Contractor's operation causes damage or injury to trees and plants designated to remain, an arborist or other qualified professional shall be employed by the Contractor, at no additional cost to the Owner, to repair the damage or provide adequate replacement to the Owner's satisfaction where damage is beyond repair.

1.2 SITE INSPECTION

A. Prior to moving onto the Project site, the Contractor shall inspect the site conditions and review maps of the existing plant site and off-site pipeline routes and facilities delineating the Owner's property and right-of-way lines.

B. Contractor shall submit photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site preparation.

C. The Contractor shall identify and accurately locate utilities and other subsurface structural, electrical, and mechanical conditions. Existing conditions shall be incorporated into the record drawings for the project.

1.3 DEFINITIONS

A. The following definitions apply to the Work of this Section:
   1. Clearing is defined as cutting trees, removing fences and posts, removing curbs and other improvements to prepare the site for grubbing and stripping.
   2. Grubbing is defined as the below grade part of clearing to remove roots, small piping, irrigation systems, etc., to prepare the site for stripping.
   3. Stripping is defined as removing a surface layer of soil and organic material, sod, topsoil, and other unsuitable material as defined in Section 31 23 00 – Earthwork, to a depth that earthwork can proceed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
   1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
   2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.

B. Do not excavate within drip line of trees, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
   1. Cover exposed roots with burlap and water regularly.
   2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
   3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
   4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.
   1. Employ a qualified arborist, licensed in jurisdiction where project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
   2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.4 PRIMARY PLANT SITE ACCESS

A. Develop any necessary access to the site, including barrier facilities to be installed at the beginning of construction in order to prohibit entry of unauthorized persons.

B. Utility Interference: Where existing utilities interfere with the Work of this Section, notify the Engineer and work around the interferences until a directive is issued.

3.5 CLEARING, GRUBBING, AND STRIPPING

A. All construction areas shall be cleared of grass and weeds to at least a depth of six inches and cleared of structures, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the Work's subsequent usefulness or obstruct its operation. Loose boulders within 10 feet of the top of cut lines shall be incorporated in landscaping or removed from the site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the Engineer.

B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Debris or waste shall be totally removed if they are found on the site. All objectionable material from the clearing and grubbing process shall be removed from the site and wasted in approved safe locations in compliance with state and federal regulations.

C. The area to be affected by construction that have not been pre-excavated to the subgrade elevation shall be removed and placed in the designated stockpile areas, and/or incorporated into landscaped areas or other nonstructural embankments.

D. For all areas that have not been previously disturbed, including staging areas and temporary construction easements, topsoil-salvaging operation shall immediately follow clearing operations. The area shall be stripped of topsoil to a depth of 8 inches. Unsuitable materials, specified in Section 31 23 00, shall not be considered topsoil. The Contractor shall strip to the depth indicated regardless of the material encountered. All stripped topsoil shall be stockpiled within stripped areas in stockpiles not to exceed 15 feet in height. Vegetation shall be ground or chipped to a mulching consistency and mixed with the stripped soil. Stockpiles shall be placed away from high construction traffic areas and shall be fenced and signed to prevent accidental use as fill prior to topsoil replacement.

E. Upon completion of Work within the construction areas stripped of topsoil, the stored topsoil shall be respread over the disturbed areas. Topsoil shall be spread in about a 6-inch layer. Respread topsoil shall match the existing terrain as much as possible. Interfaces between restored disturbed areas and undisturbed areas shall be chain dragged to eliminate obvious edges. All tracks and equipment marks shall be chain dragged or hand raked away. Replaced topsoil shall be thoroughly watered for dust control upon completion of the respreading operations. Once topsoil replacement has been completed, no vehicles or other motorized equipment shall be allowed to travel on the finished surface.

F. Unless otherwise indicated, native trees larger than three inches in diameter at the base shall not be removed without the Engineer's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if not necessary for the Contractor's choice of means and methods, shall be arranged with the property owner and be removed and replaced at no increased cost to the Owner.

G. Except in areas to be excavated, holes and other holes resulting from Work of this section shall be backfilled with suitable material in accordance with Section 31 23 00 – Earthwork.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincides with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 23 00
EARTHWORK

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all earthwork indicated and required for construction of the Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

29 CFR 1926	OSHA Safety and Health Regulations for Construction
ASTM C150	Portland Cement
ASTM D 422	Method for Particle-Size Analysis of Soils
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3) (2,700 kN-m/m^3)
ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2901	Test Method for Cement Content of Freshly Mixed Soil Cement
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods
ASTM D 4253	Test Methods for Maximum Index Density of Soils using a Vibratory Table
ASTM D4254	Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4832	Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D 5971	Practice for Sampling Freshly Mixed Controlled Low Strength Material (CLSM)
ASTM D 6023	Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)
ASTM D 6024	Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application
ASTM D 6103	Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)

1.3 CONTRACTOR SUBMITTALS

A. The Contractor's attention is directed to the provisions of Subpart P, 29 CFR 1926 of the OSHA Safety and Health Standards for Construction, which relate to protection of employees in excavations. The Contractor shall submit, for information to the Engineer, the project excavation plan and the name of the Contractor's competent person, prior to commencing any excavation.

B. Submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01 33 00 - Contractor Submittals. Sample sizes shall be as determined by the testing laboratory.

C. Submit dewatering and water removal plan prior to performing any dewatering or water removal.

PART 2 - PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General: Fill, backfill, and embankment materials shall be suitable material.

B. Suitable Materials: Suitable material is defined as selected or processed clean, well graded earth material, sands and gravels free of excessive fines, less than 20 percent rock and boulders larger than 4 inches, grass, roots, brush, vegetation, or other deleterious materials.

C. Fill and backfill materials within 6 inches of any structure or pipe shall be smaller than 1 inch in any dimension.

1. Suitable materials may be obtained from onsite excavations, may be processed onsite materials, or may be imported. If imported materials are required by this Section or to meet the quantity requirements of the Project, provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule. Onsite materials shall be stockpiled and segregated prior to use.

2. The following types of suitable materials are defined:

Type A (Granular Backfill): Crushed rock or gravel, and sand well graded and readily compacted, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
No. 40	15 - 60
No. 200	0 - 15

Type B (Crushed Rock): Manufactured angular, crushed rock, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
3/8-inch	100
No. 4	30 - 50
No. 200	0 - 5

Type C (Sand Backfill): Sand non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	80 - 100
No. 10	30-50
No. 40	10-30
No. 200	7 - 15

Squeegee is not acceptable as sand backfill.

Type D (Select Backfill): Suitable material that can be readily compacted and meets the requirements of AASHTO M 145 classification A-1-a, non-plastic, well graded with a maximum particle size of 2 inches.

Sieve Size	Percentage Passing
2-inch	100
No. 10	30-50
No. 40	15-30
No. 200	0 - 15

Type E (Pea Gravel Backfill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a No. 4 sieve.

Type F (Drainrock): Crushed rock or gravel conforming to one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing		
Sieve Size	3-inch Max.	2-inch Max.	3/4-inch Max.
3-inch	100	-	-
2-inch	90 - 100	100	-
1-1/2 inch	70 - 100	90 – 100	-
3/4 inch	0 - 50	0 – 15	100
1/2-inch	-	-	95 - 100

3/8-inch	0 - 10	0 - 5	70 - 100
No. 4	0 - 25	-	-
No. 8	0 - 5	-	-
No. 200	0 - 3	-	0 - 3

Type G (Type II Aggregate Base): Well-graded, clean, hard, tough, durable, and sound mineral aggregates consisting of crushed stone, or crushed gravel, free of organic matter and contamination from chemical or petroleum products meeting State specification requirements and conforming to the following Table and gradations:

Aggregate Properties			
	Aggregate Class		
	A	**B**	
Dry Rodded Unit Weight	Not less than 75 lb/ft^3		AASHTO T 19
Liquid Limit/Plastic Index	Non-plastic	PI ≤ 6	AASHTO T 89 AASHTO 90
Aggregate Wear	Not to exceed 50 percent		AASHTO T 96
Gradation	Table 2		AASHTO T 11 AASHTO T 27
CBR with a 10 lb surcharge measured at 0.20 inch penetration	70% Minimum	N/A	AASHTO T 193
Two Fractured Faces	50% Min	N/A	AASHTO T 335

Sieve Size	Percentage Passing
1 ½ -inch	100
1-inch	90 - 100
3/4-inch	70 - 85
1/2-inch	65 - 80
3/8-inch	55 - 75
No. 4	40 - 60
No. 16	25 - 40
No. 200	7 - 11

Type H (Graded Drainrock): Graded drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting and drying. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
3/4 inch	90 - 100
3/8-inch	40 - 100
No. 4	25 - 40
No. 8	18 - 33
No. 30	5 - 15
No. 50	0 - 7
No. 200	0 - 3

Type I: (Levee Material): Clayey sand to sandy clay obtained from off-site borrow sources or from onsite excavations, processed to the extent required to produce a material with a maximum size of 4 inches, well-graded from coarse to fine, and free from roots, sticks, organic matter, concrete, asphalt and other deleterious material. Levee material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
4-inch	100
No. 4	50 - 70
No. 200	30 - 50

Type J (Cement-Treated Backfill): Material which consists of Type F material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633.

Type K (Topsoil): Stockpiled topsoil material which has been obtained at the site by removing soil to a depth as defined in Section 31 10 00 - Site Preparation. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

Type M (Aggregate Subbase): Crushed rock aggregate subbase material non-plastic that can be compacted readily by watering and rolling to form a stable base. The sand equivalent value shall not be less than 18 and shall meet one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing	
Sieve Size	3-inch Max.	2-inch Max.
3-inch	100	-
2-inch	90 - 100	100
1-1/2 inch	-	95 - 100
1-inch	70 - 90	-
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	2 - 12	2 - 12

Type N (trench plug): Low permeable fill material, a nondispersable clay material having a minimum plasticity index of 10.

Type O (Controlled Low Strength Material (CLSM)): CLSM shall consist of a mixture of portland cement, aggregate, fly ash, water, and approved admixtures conforming to the following requirements:

3. Portland Cement: ASTM C150, Type V.
4. Aggregate: Clean imported sand and gravel or selected material from the excavation, imported material, or a combination thereof as approved by the Engineer. Maximum aggregate size shall be 1 to 3 inches. The soluble sulfate content of aggregate in the mixture shall not exceed 0.3 percent by dry weight.
5. Water: Potable quality.

6. Fly Ash: Class C, ASTM C 618 or approved alternate.
7. The minus 200 sieve fraction shall be nonplastic, as defined by ASTM D 4318. By this standard, a soil is considered nonplastic if either the liquid or plastic limit cannot be determined, or if the plastic limit is equal to or greater than the liquid limit.
8. Proportion the CLSM to be a flowable, nonsegregating, self-consolidating low shrink slurry. The Contractor shall determine the materials and proportions used to meet the requirements of these Specifications.
9. The unconfined compressive strength at 7 days shall be a minimum of 100 psi and a maximum of 300 psi. Contractor shall form a minimum of six test cylinders with proposed materials to confirm design strength and mix design. Four of the cylinders shall be broken at 7 days in conformance with applicable concrete cylinder specifications and results provided to Engineer. The remaining two cylinders shall be broken by Contractor at discretion of Engineer. Initial mix design and cylinder breaks shall be completed at least 21 days prior to use of the material on the jobsite. Final mix approval and use of the material shall not occur prior to confirmation of strength by the cylinder breaks.
10. The temperature of the CLSM discharged into the trench shall be below 90 degrees F.
11. CLSM backfill under concrete structures shall be protected during curing as specified Section 03300 - Cast-in-Place Concrete.
12. CLSM shall be tested in accordance with ASTM D 4832, ASTM D 5971, ASTM D 6023, and ASTM D6103

Type P: (Suitable Trench Backfill): Suitable material that can be readily compacted, with less than 35 percent passing the No. 200 sieve and a plasticity index of 10 or less.

2.2 UNSUITABLE MATERIAL

A. Unsuitable materials include but are not limited to the materials listed below.
   1. Soils which, when classified under ASTM D 2487 - Classification of Soils for Engineering Purposes, fall in the classifications of Pt, OH, CH, MH, or OL.
   2. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use.
   3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, slag, and any material which may be classified as hazardous or toxic according to applicable regulations.
   4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing onsite soils.
   5. Topsoil, except as allowed below.

B. [All unsuitable excavated material shall be disposed off site.]

2.3 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

A. Use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.

B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, notify the Engineer immediately. In case of conflict between types of pipe embedment backfills, use the agency-specified backfill material if that material provides a greater degree of support to the pipe, as determined by the Engineer. In case of conflict between types of trench or final backfill types, use the agency-specified backfill material if that material provides the greater in-place density after compaction.

C. Fill and backfill types shall be used in accordance with the following provisions:

1. Embankment fills shall be constructed of Type P material, as defined herein, or any mixture of Type P and Type A through Type F materials.
2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" below, shall consist of the following materials for each pipe material listed below.
    a. Mortar coated pipe, concrete pipe, and uncoated ductile iron pipe shall be provided with Type A or C material in the pipe zone.
    b. Coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other nonmortar coated pipe shall be backfilled with Type C material in the pipe zone.
    c. Plastic pipe and vitrified clay pipe shall be backfilled with Type C material in the pipe zone.
    d. Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a No. 4 sieve, trench plugs of Type J or N material shall be provided at maximum intervals of 200 feet unless indicated otherwise.
    e. Type O material shall be used in the pipe zone where shown on plans, specified, or required by the Engineer for special crossings or other locations, or where otherwise approved.
    f. Type E material will not be allowed for backfill within the pipe zone.
3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type D backfill material.
4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill.
5. Trench backfill and final backfill for pipelines under structures shall be Type A or B, except where concrete encasement is required by the Contract Documents.
6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses indicated. Aggregate subbase shall be Type M material.
7. Backfill around structures shall be Type P material, or Types A through Type F materials, or any mixture thereof, except as shown.
8. Backfill materials beneath structures shall be as follows:
    a. Drainrock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Type H material.
    b. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Types F, G or H materials shall be used.
    c. Under structures where groundwater must be removed to allow placement of concrete, Type F material shall be used. Before the Type F material is placed, filter type geotextile fabric shall be placed over the exposed foundation.
    d. Under all other structures, Type F, G or H material shall be used.

9. Backfill used to replace pipeline trench overexcavation shall be a layer of Type F material with a 6-inch top filter layer of Type E material or filter fabric to prevent migration of fines for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet.

2.4 PIPELINE MARKING TAPE

A. Metallic Tape: Tape shall be minimum 5.5 mils thick aluminum foil imprinted on one side, encased in high visibility inert polyethylene jacket. Tape shall be a minimum of 6 inches wide. Imprinted lettering shall be 1 inch tall, permanent black, as indicated. Joining clips shall be manufacturer's standard tin or nickel coated. Tape shall be as manufactured by Reef Industries (Terra "D"), Allen (Detectatape), or equal.

B. Plastic Tape: Tape shall be minimum 4-mil thick polyethylene which is impervious to alkalais acids, and chemicals and solvents which are likely in the soil. Tape shall be a minimum of 6 inches wide and lettering shall be 1-inch tall permanent black on a colored background. Tape shall be manufactured by Reef Industries (Terra Tape), Allen (Markline), or equal.

C. Warning Tape: Warning tape manufactured for marking and identifying underground utilities continuously inscribed with a description of utility, colored as follows:
1. Red; Electric.
2. Yellow; Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water Systems.
5. Green: Sewer Systems.

2.5 MATERIALS TESTING

A. All soils testing of samples submitted by the Contractor will be done by a testing laboratory of the Owner's choice and at the Owner's expense. At its discretion, the Engineer may request that the Contractor supply samples for testing of any material used in the work.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. Unified Soil Classification System: References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

E. The testing for chloride, sulfate, resistivity, and pH will be done by a testing laboratory of the Owner's choice and at the Owner's expense.

PART 3 - EXECUTION

3.1 EXCAVATION – GENERAL

A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including rock and all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. Furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Excavations shall be sloped or otherwise supported in a safe manner in accordance with safety requirements of the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Maximum Length of Open Trench: The maximum length of open trench in urban and rural areas shall not exceed 500-feet at each pipe installation heading beyond the end of the installed pipeline, or the requirements of the agency with jurisdiction, whichever is lesser.

C. Construction Delays: In the case of any construction delay in excess of five calendar days, whether Contractor or Owner caused, the Contractor shall backfill the excavation, install temporary paving including temporary traffic markings, and restore traffic to pre-construction condition to minimize disruption to traffic and the community at no additional cost to the Owner.

D. Removal and Exclusion of Water: Remove and exclude water, including storm water, groundwater, irrigation water, and wastewater, from all excavations. Dewatering wells, well points, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation work begins at each location. Water shall be removed and excluded until backfilling is complete and all field soils testing has been completed.

3.2 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

A. Excavation Beneath Structures and Embankments: Except where otherwise indicated for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the footing or slab. Where indicated or ordered, areas beneath structures or fills shall be overexcavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched. When such overexcavation is indicated, both overexcavation and subsequent backfill to the required grade shall be performed. When such overexcavation is not indicated but is ordered by the Engineer, such overexcavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or overexcavation has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Excavation Beneath Concrete Reservoirs: Excavation under reservoirs shall extend to the bottom of the drainrock layer. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock. Areas under the reservoir upon which fill is to be placed shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density with moisture content within plus and minus 2 percent of the optimum moisture content.

C. Excavation Beneath Paved Areas: Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the bottom of the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. Notification of Engineer: Notify the Engineer at least 3 days in advance of completion of any structure excavation and allow the Engineer a review period of at least 1 day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

A. General: Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated.

B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe zone. Excavations for pipe bells and welding shall be made as required.

C. Open Trench: The maximum amount of open trench permitted in any one location shall be [500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater]. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be protected in accordance with Section 01 71 50 – Protection of Existing Facilities. The Contractor shall provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations with the exception of unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to provide safe access without the use of shoring devices. Temporary fencing panels shall fully enclose open excavations and trenches, and shall remain in place during all non-working hours.

D. Trench Overexcavation: Where trenches are indicated to be overexcavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade of the bottom of the pipe bedding.

E. Overexcavation: When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be overexcavated beyond the depth and/or width shown. Such overexcavation

shall be to the dimensions ordered. The trench shall then be backfilled to the grade of the bottom of the pipe bedding. Overexcavation less than 6 inches below the limits on the Drawings shall be done at no increase in cost to the Owner. When the overexcavation ordered by the Engineer is 6 inches or greater below the limits shown, or wider, additional payment will be made. Said additional payment will be made under separate unit price bid items for overexcavation if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.

F. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

G. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3.4 OVEREXCAVATION NOT ORDERED OR INDICATED

A. Any overexcavation carried below the grade ordered or indicated, shall be backfilled to the required grade with the indicated material and compaction. Such work shall be performed at no additional cost to the Owner.

3.5 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled to preserve it for replacement. Excavated material may be placed on the lawn; provided, that a drop cloth or other suitable method is employed to protect the lawn from damage. The lawn shall not remain covered for more than 72 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner so as to restore the lawn as near as possible to its original condition. Provide new sod if stockpiled sod has not been replaced within 72 hours.

3.6 EXCAVATION IN VICINITY OF TREES

A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation by any means previously reviewed by the Engineer.

3.7 BACKFILL – GENERAL

A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed. Structures shall not be constructed on CLSM backfill until the CLSM has obtained a 7-day minimum cure.

B. Except for drainrock materials being placed in overexcavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally. Do not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

D. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and rock materials removed. All materials disturbed from their intact condition that are 4 inches or larger in least dimension or aggregates of soil material thicker than 4 inches shall be removed from the excavation walls and base prior to placing pipe or any backfill material. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.8 PLACING AND SPREADING OF BACKFILL MATERIALS

A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness.

B. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.

C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

D. Where the backfill material moisture content is too high to permit the indicated degree of compaction the material shall be dried or mixed with drier material until the moisture content is satisfactory.

3.9 COMPACTION OF EARTH FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Each layer of Types A, B, C, G, H, I, and K backfill materials as defined herein, where the material is graded such that at least 10 percent passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.

B. Each layer of Type E and J backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at the top of the pipe zone or at vertical intervals of 24 inches, whichever is the least distance from the subgrade.

C. Fill on reservoir and structure roofs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not

be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.

D. Pipe zone backfill materials that are granular, shall be compacted by using vibratory compactors.

E. Equipment weighing more than 10,000 pounds shall not be used closer to structure walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.

F. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

G. Compaction Requirements: The following compaction test requirements shall be in accordance with ASTM D 1557, method C. Compaction shall be obtained with the moisture content within plus or minus 2 percent of the optimum moisture content. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	Percentage of Maximum Density
Pipe embedment backfill for flexible pipe	90
Pipe bedding and overexcavated zones under bedding for flexible pipe, including trench plugs	90
Pipe embedment backfill for steel yard piping	---
Pipe embedment backfill for rigid pipe	90
Pipe zone backfill portion above embedment for rigid pipe	90
Pipe bedding and overexcavated zones under bedding for rigid pipe	90
Final backfill, beneath paved areas or	

structures	95
Final backfill, not beneath paved areas or structures	85
Trench zone backfill, beneath paved areas and structures, including trench plugs	95
Trench zone backfill, not beneath paved areas or structures, including trench plugs	90
Embankments and fills	90
Embankments and fills beneath paved areas or structures	95
Backfill beneath structures and hydraulic structures	95
Backfill and fill around structures on reservoir or structure roof	90
Topsoil (Type K material)	80
Aggregate base or subbase (Type G or M material)	95

H.

3.10 PLACEMENT OF CLSM

A. Following placement and anchoring of the pipe, remove all loose soil from trench walls and floor. Remove any unstable soil at the top of the trench, which might fall into the trench during placement of the CLSM.

B. Prior to placement of CLSM, the pipeline steel temperature shall be controlled as specified in Section 02570 - Steel Pipe.

C. Deliver the CLSM to the trench in ready mix trucks and utilize pump or chutes to place the CLSM in the trench. Direct CLSM to one side of the pipe, taking care not to displace the pipe at any time. Continue placing CLSM on one side of the pipe until CLSM has gone under the pipe and up the other side to a depth of 1.5 feet above the pipe bottom. Use at least two hand-held vibrators to continuously liquefy and move CLSM into all voids. Adjust water in mixture to maintain fluid consistency but maintain strength requirements. Continue placing CLSM on both sides of the pipe continuously using two vibrators for every 30 feet of pipe run.

D. Maintain stability of pipe throughout CLSM placement. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to the Owner. Remove all sloughed material or other debris from top of previously placed CLSM.

3.11 PIPE AND UTILITY TRENCH BACKFILL

A. Pipe Zone
   1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches below the bottom surface of the pipe and a plane at a point 12 inches above the top surface of the pipe. The bedding is defined as that portion of pipe zone backfill material between the bottom of the trench and the bottom of the pipe. The embedment is defined as that portion of the pipe zone material between the bedding and a plane at a point 6 inches above the top surface of the pipe.
   2. After compacting the bedding, perform a final trim using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.
   3. The pipe zone shall be backfilled with the indicated backfill material. Exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.
   4. If a moveable trench shield is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. Do not displace the pipe or backfill while the shield is being moved.

B. Trench Zone: After the pipe zone backfills have been placed, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

C. Marking Tape Installation
   1. Continuously install metallic marking tape along the pipe at a depth of 3 feet below finish grade.

2. Continuously install plastic marking tape along the pipe at the elevation indicated on the Drawings.

D. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

3.12 FILL AND EMBANKMENT CONSTRUCTION

A. The area where a fill or embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be scarified to a depth of 6 inches, moisture conditioned, and rolled or otherwise mechanically compacted. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the Engineer, the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness. The embankment, fill, and the scarified layer of underlying ground shall be compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.

B. When an embankment or fill is to be made and compacted against hillsides or fill slopes steeper than 5H:1V, the slopes of hillsides or fills shall be horizontally benched to key the embankment or fill to the underlying ground. A minimum of 12 inches normal to the slope of the hillside or fill shall be removed and recompacted as the embankment or fill is brought up in layers. Material thus cut shall be recompacted along with the new material at no additional cost to the Owner. Hillside or fill slopes 5H:1V or flatter shall be prepared in accordance with Paragraph A, above.

C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe.

D. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. Where needed to protect slopes and prevent movement of the drainrock, spray asphalt on the finished drainrock surface in accordance with Section 02460 - A. C. Pavement and Base.

3.13 FIELD TESTING

A. General: All field soils testing will be done by a testing laboratory of the Owner's choice at the Owner's expense except as indicated below.

B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Field density in-place tests will be performed in accordance with ASTM D 1556 or by such other means acceptable to the Engineer.

C. In case the test of the fill or backfill show noncompliance with the required density, perform remedies as may be required to ensure compliance. Subsequent testing to show compliance

shall be by a testing laboratory selected by the Owner, paid by the Contractor, at no additional cost to the Owner.

D. Provide test trenches and excavations including excavation, trench support, and groundwater removal for the Owner's field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the Owner. All Work for test trenches and excavations shall be provided at no additional cost to the Owner.

E. Frequency of Testing
   1. Backfill around structures and in embankments shall be tested every 300 square ft of each lift of placement.
   2. CLSM shall be tested each batch being placed or every 300 cubic yards that is placed.
   3. Pipe backfill shall have one test every 80 feet (2 joints) of backfill placed.

END OF SECTION

SECTION 31 23 19
DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes construction dewatering.

1.3 PERFORMANCE REQUIREMENTS

A. The Contractor shall provide all labor, materials, and equipment necessary to dewater site excavations, in accordance with the requirement of the Contract Documents.

B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
   1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
   4. Remove dewatering system if no longer needed.

C. To complete this Work, the Contractor shall secure a Utah Pollution Elimination Discharge System (UPDES) General Permit for Construction Dewatering and Hydrostatic Testing prior to commencing any dewatering work.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is included elsewhere in the Project Manual.

C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
   1. Maintain free water level below bottom of excavation during construction.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
   1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

DIVISION 32
EXTERIOR IMPROVEMENTS

SECTION 32 12 16
A.C.PAVEMENT AND BASE

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all work associated with A.C. Pavement and Base, as shown and specified herein including all labor, materials, equipment supplies and facilities associated with providing of finished product satisfying all the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Moisture-Density Relations of Soils and Soil - Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (45-mm) Drop7
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Saturated Surface-Dry Specimens.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the Engineer.

B. Prior to Delivery to Site:
   1. Mix Design: Submit current mix design dated within one year of submittal listing:
      a. Date of mix design
      b. Asphalt cement source, type and chemical composition.
      c. Aggregate gradation target.
      d. Asphalt cement target percentage, dust to asphalt ratio, moisture sensitivity (tensile strength ratio), stability, flow and voids in the bituminous mix.
   2. Before changing mix design, submit new design to Engineer 10-days prior to placing pavement for review and evaluation of changes.
   3. Type and number of compaction and finish rollers.

C. At Delivery: Supply a batch ticket identifying:
   1. Serial Number of ticket.
   2. Date and truck number.
   3. Job name, location and mix identification.
   4. Type, grade and weight of asphalt.
   5. Type, grade and weight of aggregate.
   6. Mix design method.

D. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the Engineer shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the Contractor for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the Contractor, and approved by the Engineer. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than two laboratory trial batch tests will be paid by the Owner but the Contractor shall furnish the materials at no cost to the Owner. Any additional trial batch testing required shall be performed at the expense of the Contractor.

1.4 QUALITY ASSURANCE

A. Use a laboratory that follows and complies with ASTM D 3666.

B. Do not change aggregate source, asphalt source or mix design without Engineer's prior written approval.

C. Reject product and work that does not meet the requirements of this Section.

D. Remove product that is found to be defective after installation and install acceptable product at no additional cost to the Owner.

E. Foreman of paving crew shall have completed at least five projects of similar size and nature.

1.5 WEATHER

A. Do not pave until air temperature is 45 degrees F and rising.

B. Cease paving if air temperature falls below 50 degrees F.

C. Do not pave is surface is wet or if rain, snow or other precipitation is expected.

D. Do not pave if wind or ground cools the mix material before compaction.

1.6 ACCEPETANCE

A. General: Acceptance is by lot.

B. Materials:
   1. Lot is one day's production.
   2. At the source:
      a. Aggregate: Verify gradation. Collect sample form the conveyor belt or stockpile if belt is not accessible.
      b. Paving Asphalt: Asphalt shall meet the requirements of this section and shall satisfy the limits identified in the Utah Department of Transportation's "Manual of Instructions – Part 8 Materials"
      c. Mix Temperature shall not exceed 325 degrees F in the transport vehicle.
   3. At the Site:
      a. A sub-lot is 500 tons.
      b. Obtain one random sample per sub-lot behind the paver before compaction or at locations exhibiting non-uniform appearance.
   4. At the Laboratory:
      a. Air voids shall be evaluated on the basis of laboratory compacted samples.
      b. Dust to asphalt ratio.
      c. Asphalt content and aggregate gradation.
   5. If material does not meet any requirement of the specification, the Engineer may direct that the sub-lot be removed and replace with a material meeting the specification requirements at no additional cost to the Owner.

C. Installation:
   1. Observation of Contractor's field quality control testing does not constitute acceptance.
   2. Opening a paved surface to traffic does not constitute acceptance:
   3. Reject any mixes exceeding 325 degree F in transport vehicle.
      a. Dispose of cold mix in paver hopper as thin spread underlay.
   4. Grade, Cross Slope: Verify that tolerance is not exceeded.
   5. Compaction:
      a. For compaction a lot is 1,000 square yards or any part thereof.
      b. Core Density: A lot is acceptable if the average core density does relative to ASTM D 2041 is 93 percent, with no individual test less than 89 percent.
      c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.

d. Cores shall be tested per ASTM D 2725 for core density and ASTM D 2041 (Rice) for maximum theoretical density.
e. Other non-destructive testing methods may be used during placement to aid in establishing a rolling pattern and determining the required compaction effort. However, density acceptance will be by core densities.

6. Thickness:
   a. For thickness a lot is 1,000 square yards or any part thereof.
   b. Core Thickness: A lot is acceptable if the average core thickness is not less than 0.25 inches less than the specified thickness.
   c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.
   d. Cores shall be tested per ASTM D 3549 for thickness.
7. Lots that are not acceptable may be rejected and the Engineer may direct that the lot be removed and replaced at no additional cost to the Owner.

PART 2 - PART 2 – PRODUCTS

2.1 UNTREATED BASE COURSE

A. The untreated base course shall consist of select material, either natural or crushed and shall be graded as follows:

Sieve Size	Gradation Ideal Gradation
3/4 inch	100
3/8-inch	75-95
No. 4 sieve	55-70
No. 16 sieve	30-40
No. 200 sieve	2-10

2.2 TACK COAT

A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt Grade AR-1000. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

2.3 ASPHALT CEMENT (AC)

A. Petroleum Asphalt that complies with table 2 of ASTM D 3381 except as follows:
   1. Replace ductility at 77 deg F. with ductility at 39.2 deg. F. Use the following values:
      a. AC - 10: greater than 15
      b. AC - 20: greater than 5
   2. Delete the loss on heating requirement on the residue from the “Thin-Film Oven Test”.

B. Substitute Performance Graded Asphalt Binder (PGAB)
   1. PGAB asphalt meeting the requirements of ASTM D 6373 may be substituted for AC asphalt cement as follows:

a. AC - 10 – PGAB 58-22 or PGAB 58-28
b. AC - 20 – PGAB 64-22

2.4 AGGREGATE

A. Aggregate shall be clean, hard, durable, angular and sound consisting of crushed stone, crushed slag, crushed gravel, sand, or a combination of two or more of these materials.

B. Source Suitability: Use the following requirements to determine the suitability of the aggregate source and not for project control.
1. Coarse Aggregates:
a. Angularity (fractured faces), ASTM D 5281: 50 percent maximum by weight of particles with at least 2 fractured faces.
b. Hardness (toughness), ASTM C 131: 40 percent minimum wear of aggregate retained above the No. 4 sieve unless specific aggregates having higher values are known to be satisfactory.
c. Flat or elongated particles, ASTM D 4791: 20 percent maximum retained above the 3/8 inch sieve has a 3:1 length to width ratio.
2. Fine Aggregates:
a. Friable Particles, ASTM C 142: 2 percent maximum passing the No. 4 sieve.
b. Plasticity, ASTM D 4318: Aggregate passing the no. 40 sieve shall be non-plastic even when filler material is added to the aggregate.
1) Liquid Limit: Less than 25
2) Plastic Limit: Less than 6

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.5 ADMIXTURES

A. Mineral filler shall comply with ASTM D 242.

B. Antistrip shall be heat stable cement slurry of lime slurry.

2.6 MIX DESIGN

A. Material Designation:
1. Asphalt Cement shall be AC-20.
2. Aggregate gradation shall be DM-3/4.
3. Traffic Classification shall be medium.

B. Design Aggregate Gradation: The job-mix formula for the asphalt-aggregate surface course mixture shall be within the following gradation limits as percent passing by weight, ASTM C 136:

Aggregate Gradations				
Sieve Size	DM-1	DM-3/4N	DM-3/4	DM-1/2
1 inch	100			
3/4 inch		100	100	
1/2 inch	75-91	74-99		100
3/8 inch		69-91	75-91	

No. 4	47-61	49-65	46-62	60-80
No. 8		33-47		
No. 16	23-33	21-35	22-34	28-42
No. 50	12-22	6-18	11-23	11-23
No. 200	3-7	2-6	3-7	3-7

1. Dry-rodded Unit weight per ASTM C 29 shall be a minimum of 75 pounds per cubic foot.
2. Weight Loss or soundness per ASTM C 88 shall be a maximum of 16 percent using sodium sulfate.
3. Clay Content or cleanliness per ASTM D 2419shall be determined by the sand equivalent value after passing through the dryer or prior to the drum mixer at the following levels:
   a. 45 percent minimum for Medium Traffic Classification
   b. 60 percent minimum for Heavy Traffic Classification.

C. Design Mixture Test Criteria: Use the Marshall volumetric mix design, AI MS-2: price and payment procedures

Mix Design Criteria			
Criteria	Traffic Classification		
	Light	Medium	Heavy
Number of Compaction Blows	35	50	75
Stability, lbs. (minimum), ASTM D 5581	750	1200	1800
Flow, in 0.01 inch units, ASTM D 5581	10-18		
Voids in Mineral Aggregate (VMA), percent min., ASTM D 3203 Nominal Maximum Particle Size 1” 3/4” 1/2” 3/8”	 13 14 15 16.5		
Voids in Bituminous Mix (percent)	3-5		
Dust to Asphalt Ratio	0.8 – 1.6		
Moisture Sensitivity, ASTM D 4867	>0.8 with freeze thaw conditioning and test specimen compacted at 6-8 percent air voids		

Notes
Traffic Classifications:
Light – Parking lots, driveways, light traffic residential streets, light traffic farm roads. (ESAL $<10^4$ per year)
Medium – Residential streets, rural farm and residential roads (Class II); Urban minor collector streets, rural minor collector roads (Class III). (10^4<ESAL<10^6 per year)
Heavy – Urban Minor arterial and light industrial streets, rural major collector and minor arterial highways (Class IV); Urban major arterial and heavy industrial streets, freeways, expressways, arterial highways, rural interstate, and other principal arterial highways (Class V). (ESAL > 10^6 per year)

2.7 SOURCE QUALITY CONTROL

A. General: Supplier shall randomly collect samples per ASTM D 3665. The same sample point shall be used for all samples of a particular material.
   1. Aggregate sampling shall be per ASTM D 75.
   2. Asphalt Cement sampling shall be per ASTM D 140.

B. Asphalt-aggregate mix shall be sampled per ASTM D 979 and test for:
   1. Air Voids per ASTM D 3203.
   2. Paving Asphalt Content per ASTM D 6307.
   3. Aggregate Gradation per ASTOM D 5444
   4. Tensile strength of bitumen-aggregate mixtures per ASTM D 4867.

C. Mixing plant shall meet the requirements of ASTM D 3515.

2.8 PAVEMENT MARKING PAINT

A. Pavement marking paint shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability. The paint striping materials shall conform with the State of Utah Standard Specifications for Road and Bridge Construction and its addenda.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 31 23 00 – Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the specified grade and cross section.

3.2 UNTREATED BASE COURSE

A. Untreated base course shall be provided where shown and to the thickness indicated. Imported untreated base course shall be delivered to the job site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6 inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6 inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. The relative compaction of each layer of aggregate base shall be not less than 96 percent of maximum density when measured in accordance with ASTM D 1557 with no test below 92 percent of maximum density. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the specified grade or cross-section.

3.3 TACK COAT

A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

3.4 CONSTRUCTION EQUIPMENT

A. Lay Down Machine shall have tracks when operating on fabrics, geogrids or pavement mats hotter than 180 degrees F.

B. Compactors shall be static or vibratory, steel wheel rollers. Pneumatic tire rollers may be used for intermediate rolling only.

3.5 ASPHALT CONCRETE

A. At the time of delivery to the work site, the temperature of mixture shall not be higher than 320 degrees F, and shall not be less than indicated below:

Minimum Asphalt Concrete Temperature, degrees F						
Air	Compacted Mat Thickness					
Temperature	3/4 inch	1 inch	1-1/2 inch	2 inch	3 inch	4 inch +
45-50	-	-	-	-	280	265
50-59	-	-	-	280	270	255
60-69	-	-	285	275	265	250
70-79	285	285	280	270	265	250
80-89	280	275	270	265	260	250
90+	275	270	265	260	250	250

B. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.

C. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed especially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the Engineer may waive the self-propelled requirement.

D. Spreading, once commenced, shall be continued without interruption.

E. The mix shall be compacted immediately after placing. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall

eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

F. Compaction shall be completed before temperature drop to 180 degrees F.

G. Do not leave unsafe butt joints if paving operations stop.

H. Barricade or eliminate fall off edges.

I. Joints
   1. Construct joints to have the same texture, density and smoothness as other section of the new pavement course.
   2. Clean contact surfaces and apply tack coat. Ensure continuous bond between old and new pavement or between successive day's work.
   3. Offset longitudinally joints a minimum of 12 inches in succeeding courses and offset transverse joints a minimum of 6 feet to avoid a vertical joint through more than one course. In the tops course restrict longitudinal joints to either side of the lane lines.
   4. Prevent traffic, including construction traffic, from crossing vertical edges. Apply tack coat to vertical edges prior to making another pass with the paver if the mix has cooled to 90 degrees F.

3.6 TOLERANCES

A. Lift thickness shall not be less than 2 times the maximum aggregate size nor more than 3 inches (compacted thickness) or the limits established by the pneumatic or vibratory compactor equipment manufacturer, whichever is less.

B. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

3.7 BITUMINOUS SURFACE PATCHING

A. Where pits are excavated through bituminous surfaced roads, driveways, parking areas, etc., the surface shall be restored and maintained as follows:
   1. A temporary gravel surface shall be placed and maintained after the required backfill and compaction of the trench has been accomplished.
   2. The gravel shall be placed to such depth as to provide six inches below the pavement and shall be brought flush with the paved surface.
   3. The area over trenches to be resurfaced shall be graded and rolled with a roller weighing not less than twelve tons, or with the rear wheels of a five-yard truck loaded to capacity, until the subgrade is firm and unyielding. Mud or other soft or spongy material shall be removed and the void filled with gravel and rolled and tamped thoroughly in layers not exceeding six inches in thickness. The edges of trenches which are broken down during the making of subgrade shall be removed and trimmed neatly before resurfacing.

4. Before any permanent resurfacing is placed, the Contractor shall trim the existing paving to clean, straight lines as nearly parallel to the centerline of the trench as practicable.
5. Existing bituminous paving shall be cut back a minimum of six inches beyond the limits of any excavation of cave-in along the trench so that the edges of the new paving will rest on at least six inches of undisturbed soil.
6. As soon as is practical, weather permitting, the bituminous surface shall be restored by standard paving practices to the thickness specified herein.
7. Pavement restoration shall include tacking of pavement of edges and subbase with MC 70-250 bituminous material and placing rolling plant hot mix bituminous material to the level of the adjacent pavement surfaces.

3.8 PROTECTION AND REPAIR

A. General: All work is at no additional expense to the Owner.

B. Protection:
1. Protect all structures, including curb, gutter, sidewalks, street fixtures, delineators, signs, guard rails and guide posts.
2. Remove all spatter, over-coat or mar.
3. Do not discharge bituminous materials into borrow pits, roadside ditches, gutters or other areas.
4. Protect hot pavement from traffic until mixture has cooled enough not to become marked.
5. Protect neighborhood, storm drains and downstream wetland and fish habitats.

C. Repair
1. When thickness is deficient, place additional material over deficient areas. Do not skin patch. If necessary, mill for inlay.
2. Repair defective seams, edges and joints.
3. Remove and replace unacceptable paving.

3.9 PAVEMENT MARKING

A. Pavement marking paint shall be applied where indicated only when the pavement surface is dry and clean, and when the air temperature is above 40 degrees F. Pavement marking shall commence no sooner than 21 days after completion of pavement installation. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well-defined edges that conform to the details and dimensions shown. Drips, overspray, improper markings, and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the Engineer.

END OF SECTION

SECTION 32 13 73
PAVEMENT JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes joint sealants for exterior site concrete pavement work including parking lots, ,driveways, sidewalks, curbs, curb and gutters, waterways, etc:
   1. Joint Void-former
   2. Cold-applied joint sealants.
   3. Hot-applied joint sealants.

B. Related Sections:
   1. Division 2 Section 32 12 16 - "Asphalt Cement Pavement and Base" for constructing joints between concrete and asphalt pavement.
   2. Division 7 Section 07 92 00 - "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.3 SUBMITTALS

A. Product Data: Provide Manufactures product data and sample for each joint-sealant product indicated.

B. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

C. Manufacturer's instructions for joint preparation, type of cleaning and installation for each type of joint sealant.

1.4 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.5 SYSTEM PERFORMANCE

A. Pavement joints include longitudinal and transverse expansion joints, isolation joints, contraction joints, and crack control joints.

B. Provide joint sealants that maintain watertight and airtight continuous seals.

1.6 QUALITY ASSURANCE

A. Installation of joint systems shall follow manufacturer's published instructions.

B. For cold applied joint sealant installation, use installers that are approved by the joint sealant supplier. Provide written proof on sealant supplier's approval.

C. Obtain joint sealing materials from a single manufacturer for each different product required.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site in original, unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, cure time, and mixing instructions for multi-component materials.

B. Store and handle materials in compliance with manufacturer's recommendations to prevent deterioration; or damage due to moisture, high or low temperatures, contaminants or other causes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

2.2 JOINT VOID-FORMER

A. Plastic, with a water stop.

B. ¼ depth of concrete slab thickness.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crafco Inc., an ERGON company; RoadSaver Silicone.
      b. Dow Corning Corporation; 888.
      c. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crafco Inc., an ERGON company; RoadSaver Silicone SL.

b. Dow Corning Corporation; 890-SL.
c. Pecora Corporation; 300 SL.

C. Single-Component, Self-Leveling, Polyurethane Joint Sealant for Concrete: ASTM D 5893, Type SL.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Sikaflex – 1C SL - Polyurethane SL.

D. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Pecora Corporation; Urexpan NR-200.

2.4 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Crafco Inc., an ERGON company; Superseal 444/777.

B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Meadows, W. R., Inc.; Sealtight 3405.
b. Right Pointe; D-3405 Hot Applied Sealant.

2.5 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.6 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Immediately after sawcutting control joints, wash freshly sawed joints with a high pressure wash to remove saw slurry from the joint faces.

C. Immediately prior to installing joint sealant, remove oil, grease, wax, form-release agents, curing compounds, bitumens, laitance and old chalking material by sandblast, as recommended by manufacturer of sealant. Maximum sand blast angle, 25 degrees plus or minus 5 degrees. Complete two full passes for each joint to be sealed, one blast for each face.

D. Clean and dry with air blast. Do not contaminate air blast with oils or lubricants.

E. Remove frost and moisture in concrete joint substrates before commencing sealing.

F. Install bond breaker tape where needed or required by manufacturer’s recommendations to ensure that elastomeric sealants will perform properly.

G. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Depths: Saw cut joints if necessary to provide the required sealant thicknesses and depth. Install sealant to the depths indicated or, if not indicated, as recommended by the sealant manufacturer, but within the following general limitations measured at center (thin) section of bead:

1. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth

equal to 75 percent of joint width, but not more than 5/8 inch deep nor less than 3/8 inch deep.

2. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than ½ inch deep nor less than ¼ inch deep.
3. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints full depth.

D. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place joint sealants so they directly contact and fully wet joint substrates.
2. Install joint sealants in uniform, continuous ribbons without gaps or air pockets, with complete bonding of joint surfaces on opposite sides.
3. Completely fill recesses in each joint configuration, unless otherwise indicated.
4. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
5. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

F. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

G. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

H. Spillage: Do not allow poured sealant compound to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces to eliminate evidence of spillage.

I. Heating: Do not use overheated hot-applied sealants.

J. Edges: Unless indicated otherwise, recess exposed edges of gasket and exposed joint filler slightly behind adjoining surfaces so compressed units will not protrude from joints.

3.4 CURING AND CLEANING

A. Cure joint sealant compounds per manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength, and surface durability.

B. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.
   1. Joint Location:
      a. Expansion and isolation joints in cast-in-place concrete pavement.
      b. Contraction joints in cast-in-place concrete slabs.
      c. Other joints as indicated.
   2. Silicone Joint Sealant for Concrete: Single component, nonsag or Single component, self-leveling.
   3. Urethane Joint Sealant for Concrete: Multicomponent, pourable, traffic-grade.
   4. Hot-Applied Joint Sealant for Concrete: Single component.
   5. Joint-Sealant Color: Color shall match the color of adjacent concrete surfaces

B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement.
   1. Joint Location:
      a. Joints between concrete and asphalt pavement.
      b. Joints between concrete curbs and asphalt pavement.
      c. Other joints as indicated.
   2. Hot-Applied Joint Sealant for Concrete and Asphalt: Single component.

END OF SECTION

SECTION 32 16 00
DRIVEWAYS, SIDEWALKS, CURBS, GUTTERS, AND OTHER CONCRETE FLATWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes exterior cement concrete flatwork such as but not limited to the following:
   1. Driveways.
   2. Curbs ,gutters and waterways
   3. Sidewalks and Walkways.
   4. Other exterior site concrete flatwork

B. Related Sections include the following:
   1. Division 2 Section 31 23 00 – Earthwork for subgrade preparation, grading, and base course.
   2. Division 2 Section 32 13 73 – Pavement Joint Sealants for joint sealants of joints in concrete flatwork and at isolation joints of concrete flatwork with adjacent construction.
   3. Division 3 Section 03 30 00 – Cast-in-Place Concrete for general building applications of concrete.

1.3 REFERENCES

AASHTO M 6	Standard Specification for Fine Aggregate for Portland Cement Concrete
AASHTO M 154	Standard Specification for Air-Entraining Admixtures for Concrete
AASHTO M 80	Standard Specification for Coarse Aggregate for Portland cement Concrete
AASHTO M 182	Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings; American Concrete Institute International; 1996.
ACI 305 R	Hot Weather Concreting; American Concrete Institute International; 1991.

ACI 306 R	Cold Weather Concreting; American Concrete Institute International; 1988.
ACI CP-1(08)	Technical Workbook for ACI Certification of Concrete Field Testing Technician-Grade
ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A 615/A 615M	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 1996a.
ASTM C 31/C31 M	Standard Practice for Making and Curing Concrete Test Specimens in the Field.
ASTM C 33	Standard Specification for Concrete Aggregates; 1993.
ASTM C 39/C39 M	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 1996.
ASTM C 94/C94M	Standard Specification for Ready-Mixed Concrete; 1996.
ASTM C 143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	Standard Specification for Portland Cement; 1996.
ASTM C 171	Standard Specification for Sheet Materials for Curing Concrete; 1997.
ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method; 1994a.
ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete; 1995.
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete.
ASTM C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete; 1996a.
ASTM C 881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 1990.
ASTM C 1017/C 1017M	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

ASTM C 1059/C1059 M	Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete
ASTM C 1064	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM D 1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 1983 (reapproved 1991).
ASTM D 1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E 329	Standard Specification for Agencies Engaged in Construction Inspection and/or Testing
FS TT-P-1952	Pavement Markings

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with fly ash.

1.5 SUBMITTALS

A. Design Mixtures: For each concrete flatwork mixture satisfying the requirements of this section and Section 03 30 00 Cast-in-place Concrete. Include alternate mixture designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments
   1. Mix designs will be approved based on results of trial batches or on past history of mix design successes from project(s) within the last year.
   2. Use the same components in the trial batches that are to be used in the project. The Contractor assumes responsibility for the compatibility of all admixtures with the mix design and their potential effects on concrete properties.
   3. Personnel performing and witnessing trial batches, and performing compressive and flexural strength testing, must be performed by an AASHTO accredited laboratory paid for by Contractor.
   4. The Owner or Engineer may witness trial batch preparation and testing.

B. Product Data: For each type of manufactured material and product indicated.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
2. For any proposed mix design, provide test results for potential reactivity of coarse and fine aggregates in accordance with the requirements of this section.
3. When using potentially reactive aggregates in a mix design, provide results from appropriate testing to determine the ability of the combinations of cementitious materials and aggregates to control the reactivity

D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

E. Joint Layout Plan: Submit plan showing location and type of each joint to be placed in the concrete flatwork.

F. Proof of finishers' ACI Certifications

G. Manufactures recommended installation procedures for joint sealing material which, when accepted by Engineer, will become the basis for accepting or rejecting the actual installation procedures used in the Work.

H. Delivery tickets per Section 03 30 00 – Cast-in-place Concrete

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1(08) or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: All concrete testing will be done by a testing laboratory of the Owner's choice at the Owner's expense.

E. Do not change concrete Supplier until Engineer accepts new source and new mix design.

F. Remove product found defective after installation and install acceptable product at no additional cost to Owner.

G. Foreman of paving crew shall have completed at least three (3) projects of similar size and nature.

1.7 ACCEPTANCE

A. General: Acceptance is by lot. Lot size is specified below for each component.

B. Concrete Mix:
1. Lot size is 50 cu. yd. or fraction thereof of each concrete mix placed each day.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each omposite sample.
5. For slump, air and temperature reject non-complying batches until 2 consecutive batches are compliant then continue in random batch testing for acceptance.

C. Strength
1. Lot size is 50 cu. yd. or fraction thereof of each concrete mix placed each day.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of five standard cylinder specimens for each composite sample.
3. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
4. Strength of each lot will be satisfactory if the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
5. Remaining cylinders shall be held to verify test results, if required.

D. Installation:
1. Grades, finishes, cross-slopes and dimensions of completed pavement shall be checked for compliance with plan requirements. Standing water in curb and gutter or “bird baths” in flatwork are not permitted and shall be immediately corrected by removal of failed areas and replacement per these specifications and directions of the Engineer at no additional cost to the owner.

E. Test Results: Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design

compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

G. Additional Tests: Engineer may direct testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met.

H. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

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

1.8 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Weather: Concrete placement shall conform to the requirements of ACI 305 R and ACI 306 R for hot and cold weather, respectively in addition to the requirements of Section 03 30 00 – Cast-in-place Concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
   2. Products: Subject to compliance with requirements, provide one of the products specified.
   3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves with a radius 100 feet or less.

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

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed, epoxy coated

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
   1. Portland Cement: ASTM C 150, Type II.
   2. Do not use cement that contains lumps or is partially set.
   3. Do not mix cements originating from different sources.
   4. Do not use air-entrained cement.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar concrete flatwork applications and service conditions using similar aggregates and cementitious materials.
   1. Maximum Coarse-Aggregate Size: 3/4 inch nominal
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Mixing Water:
   1. For standard Type II Cement: ASTM C 94/C 94M

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. /sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete. Evaporation Retarder shall not be used as a finishing aid.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
   1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:
   1. Compressive Strength (28 Days): 4000 psi.
   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.44.
   3. Do not exceed water/cementitious ratio.
   4. Calculate the water/cementitious ratio (w/c) according to the following formula:
      a. W = Water
      b. C Cement + Pozzolan
   5. Concrete Slump Limits:
      a. For concrete not containing water reducers, 4 inches, plus or minus 1 inch.
      b. For concrete containing low range water reducers: 1 inch to 5 inches for all classes of concrete.
      c. For concrete containing high range water reducers: 4 inches to 9 inches for all classes of concrete.
   6. Cement Content: 6.5 bags

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete having an air content as follows:
   1. Air Content: 6 percent plus or minus 1.0 percent for 3/4-inch nominal maximum aggregate size at point of placement.
   2. The range listed represents air content at point of placement. Make necessary adjustments for impacts to air content due method of placement.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals:

2.8 POZZOLAN

A. Fly Ash:

1. Fly ash must conform to ASTM C 618 Class F specifications with the following modifications:
    a. Loss on Ignition (LOI): not to exceed 3 percent.
    b. Maximum allowable CaO content: not to exceed 15 percent.
    c. Label the storage silo for fly ash to distinguish it from cement.
    d. Use different size unloading hoses and fittings for cement and fly ash.
    e. When used as partial portland cement replacement, the fly ash may replace 20% of the cement by weight.
2. Fly ash may be sampled and tested for compliance at any time.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
    1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. When automatic machine placement is used for placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce sidewalks, curbs, curbs and gutters, and other flatwork to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.
    1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

3.2 EXAMINATION

A. Examine exposed subgrades and base surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proceed with concrete flatwork operations only after nonconforming conditions have been corrected and subgrade and base is ready to receive flatwork.

3.3 PREPARATION

A. Assure the subgrade or base for the concrete has a firm even surface and is compacted meeting the requirements of Section 31 23 00 – Earthwork.

B. Remove loose material from compacted base surface immediately before placing concrete.

C. Remove sand, leaves, trash, rubbish, topsoil, and other objectionable materials prior to placing concrete.

D. Coat the surface of street fixtures with oil to prevent bond with concrete flatwork.

E. Notify Engineer a minimum of 48 hours prior to commencing laying operations.

3.4 LAYOUT

A. Curb, Gutter, Curb and Gutter, Waterways: Set lines, forms, screeds, etc to meet the following requirements:
   1. Line: Less than ½ inch variance in 10 feet and not more than 1 inch from true line at any location.
   2. Grade: Not more than ¼ inch variance in 10 feet. Flood curb and gutter and waterway with water after final cure has been reached. Remove and replace any area where ponding is found.

B. Sidewalk and Walkways: Set forms, screeds, etc to meet the following requirements:
   1. Cross-slope shall not be less than 1.5% nor more than 2%.
   2. Landings and doorway aprons shall not slope more than 2% in any direction.

C. Layout shall meet the requirements as given in the construction plans.

3.5 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for flatwork to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Check formwork for grade and alignment variance from the following tolerances:
   1. Top of forms shall not be more than ¼ inch from design grade
   2. Vertical face on longitudinal axis shall not be more than ¼-inch from true line.

C. Place joint filler in vertical position, in straight lines and secure to formwork during concrete placement.

D. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, grade lines, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work. Inspect formwork for line and grade and make corrections as required.

B. Remove snow, ice, or frost from base surface before placing concrete. Do not place concrete on frozen surfaces.

C. Obtain Engineer's review of base, forms, lines, etc. before placing concrete. Engineer's review does not relieve the Contractor's responsibility to ensure all Work is in compliance with the contract documents and these requirements and correct defective Work as required.

D. At the beginning of concrete placement, test slump, temperature and air entrainment. If corrections are necessary, placement may proceed after 2 subsequent and consecutive batches pass testing.

E. Moisten base to provide a uniform dampened condition, without standing water, at time concrete is placed.

F. Do not place concrete around manholes or other structures until they are at required finish elevation, cross-slope and alignment.

G. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

H. Do not add water to concrete during delivery to the Project site.

I. Water may not be added to the delivery truck at the project site prior to discharge unless approved by the Engineer. If water is added at the project site, record quantity of water added on delivery ticket.

J. Site-added air-entrainment. (Meet AASHTO M 154)
   1. Limit the use of site-added air-entraining agents to one addition (regardless of quantity) per load
   2. Use pre-measured admixtures.
   3. Record amount used on batch ticket.
   4. Rotate the drum at least 30 revolutions at the mixing speed recommended by the manufacturer.

K. Do not add water to fresh concrete after testing.

L. Deposit and spread concrete in a continuous operation. Prevent segregation of concrete mix. If placement operations are interrupted for more than 30 minutes, place a construction joint.

M. Place concrete so time between end of placement and beginning of finishing is less than 15 minutes.

N. Consolidate concrete with vibrator or other acceptable method. Do not use mechanical vibrators. Prevent dislocation of inserts.

O. Cold-Weather Placement: Comply with ACI 306.R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 JOINTS

A. General:
1. Review joint layout plan with Engineer.

B. Isolation/Expansion Joints:
1. Geometrics: ½ inch wide full depth filler that is flush with concrete surface. Do not place seal over top of filler.
2. Sidewalks, Walkways, Sidewalk Ramps:
   a. Place isolation joints to separate sidewalk from utility poles, hydrants, manhole frames, buildings, abutting sidewalks and other street fixtures or structures.
   b. Place isolation joints between the sidewalk and the back of curb returns and between the sidewalk and sidewalk ramps.
   c. Do not place isolation joints in sidewalk ramp surfaces.
3. Curb, Gutter, Curb and Gutter, Waterway:
   a. Do not place longitudinal joints in gutter flow-lines.
   b. Where gutter transitions extend beyond the curb return, place expansion joints at the ends of the gutters transition.
   c. Place isolation joints at beginning of curb radius and end of curb radius.
4. Slip Form Work: Expansion joints are not required except at beginning of curb radius, end of curb radius, structures, street fixtures, inserts, foundations and other structures.
5. Driveway approach: Do not place isolation joints in curb returns.

C. Contraction Joints: Contraction joints (crack control joints) are scorelines made to force crack joint location in concrete. Form weakened-plane contraction joints, sectioning concrete into areas as indicated.
1. Geometrics:
   a. Tooled Joints (score lines)
   b. Construct contraction joints to a depth equal to at least one-fourth ($1/4^{th}$) of the concrete thickness
   c. Top radius of joints shall be ½ inch.
   d. Saw Cut Joints: Saw joints before uncontrolled shrinkage cracking occurs. Do not tear or ravel concrete during sawing.
   e. Template Joints: 1/8 to 3/16 inch wide, ¼ depth of concrete.
2. Sidewalks.
   a. Place contraction joints at intervals equal to the width of the sidewalk and transverse to the direction of travel.
   b. Place radial contraction joints curves and curb returns.

c. Place longitudinal contraction joints in walks when width of walk in feet is greater the 2 times the walk thickness in inches. (e.g. maximum width of a 4 inch thick walk before placement of a longitudinal contraction joint is 8 feet.) Make longitudinal joints parallel to, or concentric with, the lines of the walk.

d. In walk returns make one joint radially midway between the beginning of curb return and end of curb return. Match the longitudinal and transverse joints with adjacent walks.

3. Curb, Gutter, Curb and Gutter, Waterway.
   a. Place joints at intervals not exceeding 12 feet.
   b. At curb radius and walk return make the joints radial.
   c. Where integral curb and gutter is adjacent to concrete pavement, align the joints with the pavement joints, where practical.

4. Other Flatwork:
   a. Joint Spacing, in feet, shall be twice the slab thickness measured in inches, unless otherwise indicated. (i.e. Slab thickness is 6-inches, joint spacing shall be 12-feet.) Joint spacing shall not exceed 15 feet.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
   c. Keep a minimum of three (3) working power saws on site when concrete operations are underway.
   d. Longitudinal joint spacing shall match the transverse joint spacing.
   e. Transverse joints shall extend across the width of the pavement and meet the joints of the adjoining concrete surfaces (i.e. sidewalk, curb and gutter, etc.).

D. Volunteer Crack Joints: If a volunteer crack joint occurs within any flatwork of this section, sawcut and remove cracked section at nearest contraction joints and replace the section at no additional cost to the owner.

3.8 FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/2-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

C. Apply broom finish longitudinal to curb, gutter, curb and gutter, and waterway flowline.

D. Apply broom finish transverse to sidewalk, walkway and other flatwork centerline as follows:
   1. Fine hair finish where grades are less than 6 percent.
   2. Rough hair finish where grades exceed 6 percent.

E. Remove form marks, tool marks, and other irregularities from finish surfaces.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306 R for cold-weather protection.

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

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
   1. Curing Compound: Use a Type ID, Class A (clear with fugitive dye) membrane forming compound. Apply total coverage in 2 directions after texturing. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   2. Eliminate thermal shock of concrete by keeping cure temperatures even throughout extent and depth on concrete slab.

3.10 REPAIRS AND PROTECTION

A. Protect concrete in compliance with requirements of Section 03 30 00 – Structural Concrete. Remove and replace concrete flatwork that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Protect concrete from damage. Do not allow steel wheel rollers or steel wheel vehicles on the concrete flatwork.

C. Exclude traffic from concrete flatwork for at least 14 days after placement or until 100 percent of the design strength has been achieved as demonstrated by concrete cylinder compression tests.

D. If construction traffic is permitted, maintain concrete flatwork as clean as possible by removing surface stains and spillage of materials as they occur.

E. Protect fresh concrete from vandals, damage, pedestrian traffic, etc. Repair damaged section immediately to the satisfaction of the Engineer.

F. Remove saw-cut dust immediately. Do not allow saw-cut dust to be flushed down storm drains or into adjacent wetlands or landscaping areas.

G. Maintain concrete flatwork free of stains, discoloration, dirt, and other foreign material. Sweep concrete flatwork not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCING AND GATES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide chain link fencing, three strand barb wire, and swing gates and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer: Chain link fencing, swing gates, accessories, fittings, and fastenings shall be products of a single manufacturer.

1.2 RELATED SECTIONS

A. The requirements in Section 03 30 00 – Cast-in-Place Concrete apply to this section.

1.3 REFERENCE STANDARDS

ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 392	Zinc-Coated Steel Chain Link Fence Fabric, Class I
ASTM F 668	Poly (Vinyl Chloride)(PVC) - Coated Steel Chain Link Fence Fabric, Class 2b

1.4 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. The Contractor, at a minimum, shall submit the following information for Engineer approval prior to installing any chain link fencing:
   1. Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations.
   2. Scale layout of fencing, pedestrian gates, and accessories. Drawings shall show fence height, post layout, including sizes and sections; post setting and bracing configuration, details of gates and corner construction, and other accessories which may be necessary.

C. Samples: Samples of proposed fence components, at least 12 inches long, to illustrate the selected color and finish.

PART 2 - PRODUCTS

2.1 GENERAL

A. Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.

B. Fence fabric height shall be 6 feet unless otherwise indicated.

C. All fencing materials shall be hot-dip galvanized after fabrication, and coated with either PVC coating, or powder coating as specified below. The coatings shall be black.
   1. All PVC coatings shall be made from virgin PVC resin with plasticizer, stabilizers, and ultraviolet inhibitor. Coatings shall have a tensile strength of 2500 psi; maximum elongation of 200 percent, coating thickness shall be at least 7 mils thick and a shore durometer hardness of 40 to 46 unless specified otherwise.
   2. Powder coatings shall be made of 'degassing' grade polyester powder only. Pretreatment shall be used to ensure surface is perfectly clean and pre-heat work prior to powder application. Check for correct curing by solvent testing. Adjust pre-heat and line speed to ensure full cure. Coating thickness shall be at least 3 mils thick.

2.2 STEEL FABRIC

A. Fence fabric shall be No. 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.

B. Fabric Finish: Fabric shall be galvanized according to ASTM A 392 - Zinc-Coated Steel Chain Link Fence Fabric, zinc per square foot of coated surface, followed by a thermally fusion bonded poly vinyl chloride coating at least 7 mils thick.
   1. PVC coating shall comply with ASTM F 668 - Poly (Vinyl Chloride)(PVC) - Coated Steel Chain Link Fence Fabric, Class 2b, except that the wire core shall measure 9 gauge prior to application of coating.

2.3 FRAMING AND ACCESSORIES

A. Steel Framework, General: Unless otherwise indicated, framework components shall be fabricated of galvanized steel conforming to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, or ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, with not less than 1.8 ounces zinc per square feet of coated surface.
   1. Fittings and accessories shall be galvanized in accordance with ASTM A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware, with zinc weights per Table I of that standard, except that no coating shall be less than 1.8 ounce zinc per square foot of coated surface.
      a. After galvanizing, posts, braces, top rails, framework, fittings, and accessories shall be finished with: manufacturer's standard thermally fusion bonded PVC finish, not less than 10 mils thick. PVC coating shall comply with ASTM F 668 - Poly (Vinyl Chloride)(PVC) - Coated Steel Chain Link Fence Fabric, Class 2b.
   2. Concrete shall completely encase the bottom of the post.
      a. At the Contractor's option, gate frameworks, fittings and accessories may have a powder coat finish. Powder coatings shall be made of 'degassing' grade polyester powder only. Pretreatment shall be used to ensure surface is

perfectly clean and pre-heat work prior to powder application. Check for correct curing by solvent testing. Adjust pre-heat and line speed to ensure full cure. Coating thickness shall be at least 3 mils thick.

B. End, Corner and Pull Posts: Posts shall be one-piece without circumferential welds, 3 inch schedule 40 pipe, 5.79 pounds per linear foot.

C. Line Posts: Line posts shall be spaced no more than 10 feet on center and shall be 2-1/4 inch "H" column section, 4.1 pounds per linear foot, or schedule 40, 2-1/2 inch pipe, 3.65 pounds per linear foot.

D. Gate Posts: Gate posts shall be 4 inch schedule 40 pipe, 9.1 pounds per linear foot for leaf widths up to 13 feet. For leaf widths between 13 and 18 feet, gate posts shall be 6-5/8 inch schedule 40 pipe, 28.55 pounds per linear foot.

E. Top Rail: Top railing shall be provided in manufacturer's longest lengths, with expansion type couplings, approximately 6 inches long, for each joint. Fence design shall provide positive, secure attachment of top rail to each gate post, corner post, pull post and end post. Top rail and braces shall be 1-5/8 inch schedule 40 pipe, 2.27 pounds per linear foot, or 1-½ inch "H" column section, 2.00 pounds per linear foot.

F. Tension Wire: Tension wire shall be located at the bottom of the fabric and shall consist of No. 7 gauge coated coil spring wire of metal and finish to match fabric. Tension wire shall be interlaced with the fabric or attached to the fabric along the extreme bottom of the fence. Tension wire attachment shall be with fabric tie wires at a spacing of no more than 24 inches apart.

G. Fabric Tie Wires: Fabric tie wires shall be No. 9 gauge galvanized steel wire of the same finish as the fabric. Aluminum ties shall not be used. Ties shall be spaced 14 inches apart on posts and 24 inches apart on rails.

H. Post Brace Assembly: Post brace assembly shall be manufacturer's standard adjustable brace assembly provided at each end post, gate post and at both sides of each corner post and intermediate brace post. Material used for brace shall be same as top rail. Truss bracing between line posts shall be achieved with 0.375-inch diameter rod and adjustable tensioner.

I. Post Tops: Post tops shall be weather-tight closure caps, designed for containment of top rail and positive permanent attachment to post. One cap shall be provided for each post.

J. Stretcher Bars: Stretcher bars shall be one-piece lengths equal to the full height of the fabric, with minimum cross-section of 3/16 inch by 3-1/2 inch. One stretcher bar shall be provided for each gate and end post, and two for each corner and intermediate brace post.

K. Stretcher Bar Bands: Stretcher bar bands shall be one-piece fabrications designed to secure stretcher bars to end, corner, intermediate brace, and gate posts. Bands shall have a minimum cross-section of 1/8 inch by 3/4 inch. Stretcher bar bands shall be spaced no more than 15 inches on center.

L. Barbed Wire Supporting Arms: Supporting arms shall be manufacturer's standard fabrication, of metal and finish to match fence framework, with provision for anchorage to

each post and attachment of three rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap. Supporting arm shall be single 45-degree arm type and shall be capable of withstanding 250 pounds of downward pull at outermost end.

M. Barbed Wire: Barbed wire shall be two-strand, No. 12-1/2 gauge zinc-coated steel or iron wire with four-point, 14 gauge barbs spaced no more than 5 inches apart.

2.4 GATES

A. Fabrication: Perimeter frames of gates shall be fabricated from same metal and shall be finished as specified in paragraph 2.1 - GENERAL. Gate frames shall be assembled by welding. Welds shall be ground smooth. Horizontal and vertical members shall be provided to ensure proper gate operation and attachment of fabric.
   1. Fabric shall be installed with stretcher bars at all perimeter edges. Stretcher bars shall be attached to gate frame with stretcher bar bands spaced no more than 15 inches on center.
   2. Each gate shall be diagonally cross-braced with a 3/8-inch diameter adjustable length truss rod to ensure frame rigidity without sag or twist.

B. Swing Gates: Perimeter frames of swing gates shall be constructed of the same pipe or "H" column members as the top rails and shall be fabricated by welding. Welds shall be ground smooth prior to hot-dip galvanizing.
   1. Hardware and accessories shall be provided for each gate, galvanized in conformance with ASTM A 153, and in accordance with the following:
      a. Hinges: Hinges shall be of size and material to suit gate size, non-lift-off type, offset to permit 180-degree gate opening. Three hinges shall be provided for each leaf 6 feet or more in height.
      b. Latch: Latch shall be forked type or plunger-bar type, permitting operation from either side of the gate, with padlock eye as an integral part of the latch.
      c. Keeper: Keeper shall be provided which automatically engages the gate leaf and holds it in the open position until it is manually released.

2.5 RELATED ITEMS

A. Concrete: Concrete shall be provided according to Section 03 30 00 – Cast-In-Place Concrete.

B. Nuts, bolts and screws shall be steel, minimum size 3/8-inch diameter, hot-dip galvanized after fabrication. Upon completion of installation, bolts, nuts and exposed threads shall be painted to match with an exterior acrylic paint in accordance with Section – 09 90 00 Protective Coatings and Linings.

2.6 MANUFACTURERS

A. Manufacturer's Qualifications: Chain link fencing and gates shall be products of a single manufacturer which has been successfully engaged in the production of such items for a period of at least 5 years.

B. Installer's Qualifications: Installation of the chain link fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.

C. Manufacturers, or equal
   1. American Fence Company Inc.
   2. Mountain States Fence.
   3. United Fence Company

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to commencing installation, require Installer to inspect all areas and conditions within which Work of this Section will be performed. Dimensions and clearances shall be verified. Final grading shall be completed and all earth, brush, or other obstructions which interfere with the proper alignment and construction of fencing shall be removed.

3.2 INSTALLATION

A. General: Unless otherwise indicated, all posts shall be set in concrete. Gate and related posts, corner posts, and other critical elements shall be provided with concrete foundations which are designed by an engineer to safely accommodate the loads to which they will be subjected. The soils report is appended to the Contract Documents and contains information regarding soil properties in the vicinity of the site.

B. Excavation: Holes for posts shall be drilled or hand excavated to the diameters and spacings indicated, in firm, undisturbed or compacted soil. Post foundations which are not designed by an engineer shall comply with the following:
   1. Holes shall be excavated to a diameter not less than 12 inches or not less than five times the largest dimension of the item being anchored, whichever is larger.
   2. Depth for holes shall be not less than 42 inches; excavated approximately 6 inches lower than the post bottom, with bottom of posts set not less than 36 inches below finish grade surface, or as indicated in the Drawings.
   3. Concrete shall completely encase the bottom of the post.

C. Setting Posts: Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of the posts, parallel to the ground slope. Posts shall be set plumb and shall be centered in holes, 4 inches above the bottom of the excavation, with posts extending not less than 36 inches below finish grade surface.
   1. Corner posts shall be installed where changes in the fence lines equal or exceed 15 degrees, measured horizontally.
   2. Each post shall be properly aligned vertically and its top aligned parallel to the ground slope. Posts shall be maintained in proper position during placement and finishing operations.

D. Concrete
   1. Concrete for footings may be placed without forms, providing the ground is firm enough to permit excavation to neat line dimensions. Prior to placing concrete, the earth around the hole shall be thoroughly moistened.
   2. Encasement concrete for footings shall be placed immediately after mixing in a manner such that there will be no concentration of the large aggregates. The concrete shall be consolidated by tamping or vibrating.

3. Concrete footings shall have a neat appearance and shall be extended 2 inches above grade and troweled to a crown to shed water.
4. A minimum of 7 days shall elapse after placing the concrete footings before the fence fabric or barbed wire is fastened to the posts.

E. Bracing: Bracing shall be provided at all ends, corners, gates, and intermediate brace posts. Corner posts and intermediate brace posts shall be braced in both directions. Horizontal brace rails shall be set midway between the top rail and the ground, running from the corner, end, intermediate brace or gate post to the first line post. Diagonal tension members shall connect tautly between posts below horizontal braces.
1. Braces shall be so installed that posts remain plumb when diagonal rod is under proper tension.

F. Intermediate Brace Posts: Where straight runs of fencing exceed 500 feet, intermediate brace posts shall be installed, spaced equally between ends or corners; with additional posts provided as required, such that the spacing between intermediate brace posts does not exceed 500 feet. Intermediate brace posts shall be equivalent in size to corner posts and shall be braced with horizontal brace rails and diagonal tension members in both directions.

G. Top Rails: Top rails shall be run continuously through post caps, bending to radius for curved runs. Expansion couplings shall be provided as recommended by the fencing manufacturer.

H. Tension Wire: Continuous bottom tension wire shall be stretched tight with turnbuckles at end, gate, intermediate, and corner posts. Tension wire shall be installed on a straight grade between posts, with approximately 2 inches of space between finish grade and bottom selvage, unless otherwise indicated. Tension wire shall be tied to each post with not less than 6-gauge galvanized wire.

I. Fabric:
1. Chain-link fabric shall be fastened on the secured side of the posts.
2. Fabric shall be stretched and securely fastened to posts. Between posts, top and bottom edges of the fabric shall be fastened to the top rail and bottom tension wire, respectively.
3. Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.

J. Tie Wires: Tie wire shall be bent to conform to the diameter of the pipe to which it is attached, clasping pipe and fabric firmly with ends twisted at least two full turns. Ends of wire shall be bent back to minimize hazard to persons or clothing.
1. Fabric shall be tied to line posts with tie wires spaced at 12 inches on center.
2. Fabric shall be tied to rails and braces with tie wires spaced at 24 inches on center.
3. Fabric shall be tied to tension wires, with hog rings spaced 24 inches on center.

K. Stretcher Bars: Fabric shall be fastened to end, corner, intermediate brace, and gate posts with stretcher bars. Bars shall be threaded through or clamped to fabric at 4-inches on center and secured to posts with stretcher bar bands spaced no more than 14 inches on center.

L. Fasteners: Nuts for tension bands and hardware bolts shall be installed on the side of fence opposite the fabric side. Ends of bolts shall be peened or the threads scored to prevent removal of nuts.

M. Galvanized coating damaged during construction of the fencing shall be repaired by application of Galvo-Weld; Galvinox; or equal.

N. Damage to PVC coating shall be repaired with material equivalent in color and thickness to the original coating.

3.3 GROUNDING

A. Fences crossed by power lines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 50 feet on each side of the crossing.

B. All fences, gates, and appurtenances enclosing electrical equipment areas, gas yards, or other hazardous areas shall be electrically continuous and grounded.

C. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be ¾-inch by 10-foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below the grade.
   1. Where driving is impracticable, electrodes shall be buried a minimum of 12 inches deep and radially from the fence. Top of electrode shall be not less than 2 feet or more than 8 feet from the fence

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING

A. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware, and other moving parts.

END OF SECTION

DIVISION 33
UTILITIES

SECTION 33 05 16
PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide precast concrete manholes, catch basins, drop inlets, potable water vaults; meter vaults, and other pre-cast concrete structures complete and in place, in accordance with the Contract Documents.

1.2 RELATED SECTIONS

A. Section 03 30 53 – Cast-in-place Concrete

B. Section 31 23 00 – Earthwork

1.3 SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

ASTM A 48	Gray Iron Castings
ASTM C 150	Portland Cement
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 877	Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
ASTM C 990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

1.4 CONTRACTOR SUBMITTALS

A. General: Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings:
1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
2. Structural design calculations for vaults and boxes shall be stamped and signed by a structural engineer registered in the state of Utah.

C. Manufacturer's Certification for Manholes and Vaults: Written certification that the structure complies with the requirements of this Section.

D. Manufacturer's Test Results: Pull out force for manhole steps.

1.5 QUALITY ASSURANCE

A. Inspection: After installation, the Contractor shall demonstrate that manholes and vaults have been properly installed, level, with water-tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

B. Any precast concrete which arrives on site with voids, cracked, or damaged, or is cracked or damaged during installation shall be cause for rejection. Contractor shall remove precast section(s) from the project site and replace with new undamaged sections at no additional cost to OWNER.

1.6 DELIVERY, STORAGE AND HANDLING

A. Handle precast units in positions consistent with their shape and design. Lift and support only from the support points indicated on the shop drawings.

B. Embedded Lifting or Handling Devices: Capable of supporting units in positions anticipated during manufacturing, storage, transportation and installation.

C. Block and brace units during storage. Provide lateral bracing which is sufficient to prevent bowing and/or warping and will not inhibit curing of the exposed surfaces.

PART 2 - PRODUCTS

2.1 MANHOLES

A. The Contractor shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Cement used in manufacturing the manholes shall be Type II modified portland cement in accordance with ASTM C 150

1. Manholes, adjusting rings, grout channels and other concrete components of manholes and vaults used in raw sewage, plant drain, drain, or other potentially corrosive environments shall be constructed of polymer concrete that is resistant to hydrogen sulfide corrosion. Shop drawings for these manholes shall clearly indicate that the polymer concrete is used and each component shall be clearly marked for ready identification in the field of structure containing polymer.

B. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

C. Axial length of sections shall be selected to provide the correct total height with the fewest joints. Joints shall be minimized and shall be located as close as possible to the top of the structure to help minimize opportunity for groundwater infiltration.

D. Conical sections shall have an eccentric shape and shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

E. Design Criteria: Manhole walls, transitions, conical sections, and base shall be designed per ASTM C 478 for the depths indicated and the following:
   1. AASHTO H-20 loading applied to the cover.
   2. Unit weight of soil of 120 pcf located above all portions of the manhole.
   3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.
   4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.
   5. External pressures and uplift forces due to groundwater elevations 2 feet below finish grade.
   6. Dead load of manhole sections fully supported by the base and transition.
   7. Additional reinforcing steel in walls to transfer stresses at openings.
   8. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches or one-half of the diameter of the smaller penetration, whichever is greater.

F. Joints shall have lipped male/female ends which shall provide uniform and continuous interior wall surfaces and shall be watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990.

G. Raw Sewage, Plant Drain, drain manholes, plant effluent and all vaults shall also have each joint wrapped with an external joint sealant meeting ASTM C 877. Concrete for base and channel formation shall be 4000 psi concrete conforming to Section 03300 – Cast-In-Place Concrete.

H. Barrel section to sewer pipe (Raw sewage, plant drain, drain, and plant effluent) connections shall be sealed with flexible, resilient connectors complying with ASTM C 923 and appropriate for the pipe material being used. Mechanical devices shall be stainless steel.

I. Manhole steps shall be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches. Furnish test results demonstrating step capability to resist a pull out force of 2200 pounds.

J. Manhole riser sections shall be greater than 12 inches in height.

K. Manhole Manufacturers, or Equal
   1. AMCOR Precast, Ogden, Ut
   2. Geneva Pipe, Orem, Ut

2.2 FRAMES AND COVERS

A. Castings: Castings for manhole frames, covers, and grates shall be non-rocking with machined flat bearing surfaces, and shall conform to the requirements of ASTM A 48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter. Covers shall have cleated surfaces with pick holes and shall be ventilated in improved areas and have a solid lid design in landscape or native areas.

B. Manhole covers shall be with embossed with lettering saying "Sewer", "Storm Sewer", or “Water”.

C. All frames and covers shall be designed for H-20 traffic loading. Grates and curb inlets in traffic areas shall be designed for H-20 traffic loading.

D. Castings Manufacturers, or Equal
   1. D & L Supply
   2. Neenah Foundry Co.
   3. Olympic Foundry

2.3 VAULTS

A. The Contractor shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V or Type II modified portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:
   1. L = 90 h, plus surcharge of 240 psf in areas of vehicular traffic
   2. Where L = loading in psf
   3. h = depth of fill in feet.

D. Design loading shall also take into account the lateral and uplift pressure resulting from a groundwater elevation 2 feet below existing grade.

E. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint. All openings through the precast structure shall be reinforced to transfer loads.
   1. Joints shall be sealed watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990. In addition, all joints shall be wrapped with an external joint sealant meeting ASTM C 877.

F. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

G. Covers for access openings shall be provided. Frames for covers shall be fabricated from aluminum, and shall be integrally cast into the vault concrete sections. All covers shall be tight

fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

H. Where penetrations of the pre-cast concrete vaults are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or wall sleeves, as indicated. Storm drain structures may also use thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. With the exception of vaults on pressurized water system, vaults need not be designed to resist thrust from piping passing through the vault.

I. Lifting holes shall be plugged with a precast concrete plug sealed with a non-shrink grout.

J. Vault Manufacturers, or Equal
   1. AMCOR Precast, Ogden, Ut
   2. Geneva Pipe, Orem, Ut

2.4 FABRICATION

A. Maintain plant records and quality control program during fabrication of structural precast concrete sections. Make all quality control records available to ENGINEER upon request.

B. Use molds that are rigid, and constructed of material that will result in uniform finished surfaces.

C. If self consolidating concrete is not used, thoroughly vibrate concrete to ensure proper consolidation, elimination of cold joints, and to minimize trapped air on at the concrete surface.

D. Fabricate and provide the required lifting devices which are compatible with embedded components.

E. Ensure reinforcing steel, anchors, inserts, plates, angle and other cast-in items are sufficiently embedded, properly secured, and correctly located. Ensure the reinforcing steel is properly supported to prevent movement or shifting during fabrication. Inadequate concrete cover over reinforcing shall be cause for rejection.

F. Cure precast concrete sections under identical conditions to develop specified concrete quality.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to accepting manholes on site, ensure that manhole meet the requirements of these specifications, are constructed of the correct materials, and are not cracked or damaged in any other way.

B. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the Contractor shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.

C. Buried pre-cast concrete vaults and manholes shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults and manholes shall be set to grade, plumb and level, and oriented to provide the required dimensions and clearances from pipes and other structures.

D. Prior to backfilling vaults, pipe and conduit penetrations and other, openings shall be sealed with polyurethane sealant or as indicated in the drawings. With the authorization of the Engineer, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

3.2 MANHOLES

A. Connect pipe to manhole with flexible connection, as recommended by connection manufacturer. Provide a pipe joint or additional flexible connection 18 inches from the outside of the manhole. Grout around pipe after installation is complete, unless otherwise indicated. All connections shall be watertight.

B. Place top section, cone section or flat slab on top riser section, with the opening positioned over the steps. Top of cone section or flat slab shall be from 10 to 18 inches below finished grade.

C. Install grade rings as required to adjust top of lid and frame to match finish grade elevation. Maximum height of grade rings shall be 12 inches. Maximum number of grade rings shall be two.

D. In paved areas and as indicated in the plans, concrete collars shall be constructed around manhole covers as indicated. Collars shall be of 4000 psi concrete. Collars shall be constructed after pavement has been placed.

E. Steps shall be cast-in-place or vibrated into green concrete.

F. Steps shall be installed 12-inches on centers vertically, not more than 1/2 inch out of plumb. The top step shall be no more then 12-inches below the manhole cover.

G. After manhole base has been completed, furnish and install temporary pipe plugs to seal all interior pipe opening. Plugs shall remain in place until final review and acceptance of completed pipeline. Plugs shall then be removed and shall be property of Contractor.

3.3 QUALITY CONTROL

A. Manholes shall be tested and accepted per the requirements of Section 33 08 00 – Gravity Piping Testing and Inspection.

B. Do not install precast concrete units until concrete has attained its design compressive strength.

END OF SECTION

SECTION 33 05 19
PRESSURE PIPING TIED JOINT RESTRAINT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide Chlorinated Polyvinyl Chloride (CPVC) pressure pipe, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 00 - Piping, General, apply to the WORK of this Section.

PART 2 - PRODUCTS

2.1 PIPE MATERIAL

A. CPVC pipe shall be in accordance with ASTM F 441 - Chlorinated Poly (Vinyl Chloride) (CPVC), Plastic Pipe, Schedules 40, and 80, from all new compounds, meeting the requirements of Class 23447 per ASTM D 1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (PVC) Compounds. CPVC pipes shall be Schedule 80 pipe, unless otherwise indicated. CPVC material shall be listed as compliant with NSF Standard 61.

2.2 PIPE JOINTS

A. Pipe joints shall be solvent-welded with solvent cement in accordance with ASTM F 493 - Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings, and with primer in accordance with ASTM F 656 - Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings. Screwed joints which are necessary to match up to threaded valves or fittings shall be made up with appropriate thread sealant, either paste or tape. Flanged joints shall be made with solvent-welded CPVC flanges, drilled to ANSI/ASME B 16.5 - Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated. For CPVC or PVC pipe used in chemical service, solvent welded joints shall be done using IPS Corp Type 724 cement or another cement certified by the manufacturer for chemical service.

2.3 FITTINGS

A. Solvent-Welded Fittings: Solvent-welded fittings shall be Schedule 80 CPVC fittings in accordance with ASTM F 439 - Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

B. Threaded Fittings: Threaded fittings shall be Schedule 80 CPVC fittings in accordance with ASTM F 437 - Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

C. Flanged Fittings: Flanged fittings shall be fabricated Schedule 80 CPVC fittings with 150 lb. flanges to ANSI/ASME B 16.5. Gaskets shall be ANSI 150 lb. full face, 1/8-inch thick Neoprene

for water or wastewater service. Gasket material for chemicals shall be suitable for use with the chemical service.

2.4 COATINGS

A. Outside of CPVC piping and fittings shall be coated to conform to the requirements of Section 09 90 00 – Protective Coatings and Linings.

PART 3 - – EXECUTION

3.1 INSTALLATION

A. General: CPVC pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. The entire installation shall be acceptable to the ENGINEER. It is recommended that the CONTRACTOR obtain the assistance of the pipe manufacturer's field representative to instruct the pipe fitters in the correct installation and support of all CPVC piping.

B. Supports and Anchors: Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 40 05 10 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Where piping support is metallic, Contractor shall provide and install unicusion or other acceptable piping protective shield to encompass the entire portion of pipe in contact with the support material.

C. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection. Valves and flanges attached to CPVC pipe shall be provided with adequate supports.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and straightened, if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly.

3.3 PIPE JOINTS

A. Threaded Joints: Pipe threads shall conform to ASTM F 1498-Taper Pipe Threads 600 for Thermoplastic Pipe and Fittings, and shall be full and cleanly cut with sharp dies or molded. Joints shall be mode with Teflon tape or thread sealant.

B. Solvent-Welded Joints: Solvent-welded joints shall be made with fresh primer and solvent cement on clean, dry pipe ends. The primer and cement cans shall be kept closed at all times

and the joints shall be made up at the recommended ambient temperatures, to the pipe or cement manufacturer's written recommendations. Pipe ends shall be inserted to the full depth of the socket.

C. Flanged Fittings: Flanged joints shall be made with gaskets and Type 316 stainless steel bolts and nuts. Care shall be taken not to over-torque the bolts, in accordance with the manufacturer's written recommendations.

3.4 INSPECTION AND FIELD TESTING

A. Inspection: Finished installations shall be carefully inspected for proper joints and sufficient supports, anchoring, interferences, and damage to pipe, fittings, and coating. Any damages shall be repaired by the Contractor to the satisfaction of the ENGINEER.

B. Field Testing: The CONTRACTOR shall allow adequate time for the solvent cement joints to cure. Curing time shall be per the solvent cement manufacturer's recommendation. Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. CAUTION – DO NOT use air or gas for testing CPVC pipe. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish all test equipment, labor, materials, and devices.

C. Leakage shall be determined by loss of pressure. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

D. Leaks shall be repaired by the Contractor to the satisfaction of the ENGINEER and the system shall be re-tested as required until no leaks are found.

END OF SECTION

SECTION 33 08 00
GRAVITY PIPING TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall perform all pipeline flushing and testing, complete, for gravity piping systems or other yard piping systems as required in the Contract Drawings, and as specified herein; in accordance with the requirements of the Contract Documents.

B. The Contractor shall be responsible for providing and conveying flushing water to the point of usage and also for disposal, as required, of water used in the flushing operations.

C. For the purpose of this specification, gravity piping, sewer or gravity sewer piping refers to all pipes with flows that are driven by gravity in an open channel flow condition and convey liquids associated with the treatment plant processes and byproducts (e.g. plant drain, raw sewage, etc).

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM F1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
ASTM C924	Standard Practice for Testing Concrete Pipe Sewer Line by Low-Pressure Air Test Method
ASTM C1244	Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test Prior to Backfill
UNI-B-6	Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.3 CONTRACTOR SUBMITTALS

A. The Contractor's proposed plans for testing, and for water conveyance, control, and disposal, shall be submitted in writing. The Contractor shall also submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. Temporary valves, plugs, bulkheads, and other air pressure testing and water control equipment and materials shall be provided by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to pipeline structure and future

function. Air test gages shall be laboratory-calibrated test gages and shall be recalibrated by a certified laboratory at the Contractor's expense prior to the leakage test, if required by the Engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. All testing operations shall be performed in the presence of the Engineer.

B. All water required for cleaning and testing of the sewer pipes shall be furnished by the Contractor.

3.2 CLEANING

A. Do not allow dirt, grease, mud, groundwater, tools, equipment and all other foreign matter to enter the pipe at any point during construction.

B. All pipes shall be completely flushed at a rate with water velocities no less than 4.0 feet per second for pipes up to 12 inches in diameter and 3.0 feet per second for all other pipes. For large diameter pipes, alternate methods, including pigging, or cleaning the pipe may be proposed by the Contractor, subject to the approval of the Engineer, provided proposed method will provide a clean pipe equivalent to flushing as determined by the Engineer.

C. No debris, rubbish, dirt, rocks, or other foreign material shall be permitted to enter downstream sections of the pipeline or system.

D. Furnish, install and permanently remove all cross-connections, piping, valving, ports, etc required to complete the cleaning process. Obtain approval of the Engineer prior to adding any components to the pipeline.

3.3 TESTING OF PIPING

A. General: All gravity sewer pipes and service laterals shall be air tested and mainlines shall be checked for deflection, as specified. All manholes, vaults and boxes directly conveying flows shall be tested for leakage, as specified. Manholes and piping shall be tested following backfill placement. All leakage tests shall be completed and approved prior to the placement of permanent surfacing. When leakage exceeds the amount allowed by the Specifications, the Contractor shall locate the leaks and make the necessary repairs or replacements required to eliminate the leakage. Any individually detectable leaks shall be repaired, regardless of the results of the tests.

B. Leakage Tests: Gravity sewer systems shall be tested for leakage as follows:
   1. Air Pressure Test - Gravity sewers shall be air pressure tested in accordance with UNI-B 6 and/or ASTM F1417 as outlined below.
      a. The Contractor shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the Engineer.
      b. The Contractor may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of lateral connection

sewers. Such tests will be considered to be for the Contractor's convenience and need not be performed in the presence of the Engineer.

c. Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the main sewer line and the upper ends of all lateral connection sewers. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

d. Test pressure shall be 4.0 psig, unless groundwater elevation exceeds the invert elevation of the pipe. Where the normal groundwater elevation exceeds the invert elevation of the new pipe, the test pressure shall be adjusted for back pressure created by the groundwater. The new test pressure shall be determined by:

$$P_t = 4.0 + \frac{H}{2.35} \leq 9.0 \text{ psig}$$

e. Where P_t is the new test pressure and H is the difference in feet between the groundwater elevation and the lowest invert elevation of the pipe being tested. In no case shall the test pressure exceed 9.0 psig or the maximum pressure allowed by the pipe manufacturer.

f. After a manhole to manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked, the plugs shall be placed in the line at each manhole and inflated to manufacturer's recommended inflation pressure. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches test pressure. At least two minutes shall be allowed for the air pressure to stabilize. After the stabilization period minimum pressure (at the beginning of test time shall be test pressure minus 0.5 psig), the air hose from the control panel to the air supply shall be disconnected.

g. For pipe diameters 4"-36", the portion of line being tested shall be termed "Acceptable" if the allocated line pressure decreases less than 1.0 psi in the time shown for the given diameters and lengths in Table 1.

h. For pipe diameters greater than 36", the portion of line being tested shall be termed "Acceptable", if the allocation line pressure decreases less than 0.5 psi in the time shown for the given diameters and lengths in Table 2.

i. Required test times for lines consisting of multiple pipe diameters shall be determined in accordance with UNI-B-6 and or ASTM F1417.

j. If the installation fails to meet these requirements, the Contractor shall determine the source of leakage. He shall perform a leak location test and then repair or replace all defective materials and/or workmanship. This work shall be completed at no additional cost to the Owner.

Table 1
Low Pressure Air Test Times for 1.0 PSig Pressure Drop

Pipe Diameter (in.)	Minimum Time for 1.0 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
4	03:47	597	.380 L

6	05:40	398	.854 L
8	07:33	298	1.520 L
10	09:27	239	2.374 L
12	11:20	199	3.418 L
15	14:10	159	5.342 L
18	17:00	133	7.692 L
21	19:50	114	10.470 L
24	22:40	99	13.674 L
27	25:30	88	17.306 L
30	28:20	80	21.366 L
33	31:10	72	25.852 L
36	34:00	66	30.768 L

Table 2
Low Pressure Air Test Times for 0.5 PSIg Pressure Drop

Pipe Diameter (in.)	Minimum Time for 0.5 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
42	19:50	57	20.939 L
48	22:40	50	27.349 L
54	25:30	44	34.614 L
60	28:30	40	42.733 L
66	31:10	36	51.707 L
72	34:00	33	61.535 L
78	36:50	31	72.219 L
84	39:40	28	83.756 L
90	42:30	27	96.149 L
96	45:20	25	

C. Deflection Test: All flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent surfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

D. Video Inspection: After the sewer pipe has been installed and cleaned; and the trench has been backfilled, the sewer pipe shall be visually inspected by video camera to locate defects in the sewer pipe. Video Inspection shall be performed by an independent testing agency acceptable to the Owner. All sewer pipes shall be video inspected.
   1. Notify the Engineer, 48 hours prior to any televised inspections.
   2. The inspection shall be in digital video format, saved to an electronic media and shall be given to the Engineer for review and final records

3. The Contractor shall ensure safe access to each manhole as required by the testing agency.
4. Video equipment shall include a pipe inspection video camera with the following capabilities: panorama tilt, radial viewing, pans plus and minus 75 degrees, rotates 360 degrees, and has optical zoom from 6 or less inches to infinity. Equipment shall produce a high quality, full color video image.
5. Video equipment shall be equipped with a device that can accurately measure the depth of any ponding encountered in the pipe. Measuring device shall be clearly visible in the video image.
6. The video equipment shall have an accurate footage counter accurate to within 1 foot per 500 foot of pipe. Footage shall be continuously displayed on the video at all times.
7. Pipelines shall be cleaned and flushed immediately prior to video inspection. Pipelines that were cleaned and flushed more than 24 hours prior to video inspection shall be cleaned and flushed again. All dirt/debris, including pipe grease, in the line which could cover a defect shall be removed.
8. Jetting of the lines in conjunction with the video inspection is prohibited.
9. If during the video inspection, foreign material which prohibits an acceptable video inspection is discovered the line shall be cleaned and video inspected again.
10. The video camera shall travel through the pipe at a maximum rate of travel of 30 feet per minute. Video shall be continuous for each pipe segment between manholes or other access points.
11. The video camera shall pause at each tee, lateral or other connection and the camera shall be rotated and tilted to provide an image of the branch for inspection. The image shall remain clear and in focus at all times while zooming to the full extent of the camera. The camera operator shall stop at each fitting and change in pipe type and complete a 360 degree view of the fitting at a rate slow enough to identify any defects.
12. Glare shall be avoided and shall not interfere with viewing the pipe segment.
13. Provide DVDs or CDs with labels indicating project number, segment number, date televised, date submitted, starting manhole number, ending manhole number, pipe diameter, pipe length and street name.
14. Lines to be video inspected shall be flushed within 24 hours prior to beginning of inspection.
15. The video inspection shall be used to identify defective construction such as sags, debris, separated joints, etc. Any Work not conforming to the Specifications or Drawings shall be promptly removed, replaced and retested at no cost to the Owner. The Engineer shall make all final determinations if the severity of the defect constitutes failure and requires subsequent removal or repair of the segment in question.
    a. Conditions identified by the video inspection that require removal and replacement or, but are not limited to:
        1) Alignment (Vertical or Horizontal) is outside the specified limits.
        2) Water ponds in any section with depths equal to or greater than 2 times the grade tolerance specified in the Contract Documents.
        3) Pipe section with visible defects, such as: open joints, pinched gaskets, cracked barrels or bells, leaks, or other defects as determined by the Engineer.

3.4 TESTING OF MANHOLES AND OTHER APPURTENANT STRUCTURES

A. Manholes and other structures

1. Vacuum tests shall be conducted on the newly constructed manholes. Preliminary manhole testing may take place following construction after all connections are made, and before backfilling. Test results derived from this test will allow time for necessary repairs to be completed before further construction proceeds and hinders such repairs. Final tests must be performed after the manhole has been backfilled.

B. Procedures

1. Plug all manhole entrances and exits other than the manhole top access using suitably sized pneumatic or mechanical pipeline plugs and follow all manufacturer's recommendations and warnings for proper and safe installation of such plugs. Plugs should be inserted a minimum of 6 inches beyond manhole wall. Make sure such plugs are properly rated for the pressures required for the test. The standard test of 10 inches Hg. (mercury) is equivalent to approximately 5 PSIG (.3 bar) backpressure. Unless such plugs are mechanically restrained, it is recommended that the plugs are used with a minimum two times (2x) safety factor or a minimum of 10 PSIG (0.7 bar) backpressure usage rating.
2. Close vacuum inlet/outlet ball valve and monitor vacuum for specified test period (see table). If vacuum does not drop in excess of 1" Hg., manhole is considered acceptable and the manhole passes the test. If manhole fails the test, complete necessary repairs and repeat test procedures until satisfactory results are obtained.

Minimum Test Times for Various Manhole Diameters													
Depth, Feet	Diameter, Inches												
	48	54	60	66	72	78	84	90	96	102	108	114	120
	Time, Seconds												
8	20	23	26	29	33	35	38	41	45	48	51	54	57
10	25	29	33	36	41	44	48	52	56	60	63	67	71
12	30	35	39	43	49	53	57	62	67	71	76	81	85
14	35	41	46	51	57	62	67	72	78	83	89	94	100
16	40	46	52	58	67	70	76	83	89	95	101	108	114
18	45	52	59	65	73	79	86	93	100	107	114	121	128
20	50	53	65	72	81	88	95	103	111	119	126	135	142
22	55	64	72	79	89	97	105	114	122	131	139	148	156
24	59	64	78	87	97	106	114	124	133	143	152	161	170
26	64	75	84	94	105	114	124	134	144	155	164	175	185

28	69	81	91	101	113	123	133	145	155	167	177	188	199
30	74	87	98	108	121	132	143	155	166	178	189	202	213

3. The values listed above are taken from ASTM Specification C1244-93 "Standard Test Method for Concrete Manholes by the Negative Air Pressure (Vacuum) Test."
4. Repeat the above test procedure after backfilling manhole for final acceptance test.
5. Manholes shall be watertight. All joints, penetrations, etc., shall be sealed watertight prior to acceptance of manhole.

END OF SECTION

SECTION 33 11 11
STEEL PIPE (AWWA C200, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide mortar-lined steel pipe coated as specified herein, complete, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards: The following standards are listed for convenience only. All specified standards, whether listed or not, shall apply to the Work.

ANSI/ASTM A 20	General Requirements for Steel Plates for Pressure Vessels
ASTM E 165	Practice for Liquid Penetrant Examination
ASTM A 370	Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 516	Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ANSI/AWWA C200	Steel Water Pipe 6 In and Larger
ANSI/AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In and Larger - Shop Applied
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks Service 4 in to 144 in
ANSI/AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
ANSI/AWWA C209	Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
ANSI/AWWA C214	Tape Coating Systems for the Exterior of the Steel Water Pipelines
ANSI/AWWA C215	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines
ANSI/AWWA C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

ANSI/AWWA C218	Coating the Exterior of Above Ground Steel Water Pipelines and Fittings
ANSI/AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
ANSI/AWWA C602	Cement-Mortar Lining of Water Pipelines 4-In (100 mm) and Larger - In Place
ANSI/ASTM A 36	Carbon Structural Steel
ANSI/ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 570	Steel Sheet and Strip, Carbon, Hot-Rolled Structural Quality
ASTM A 572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM C 150	Portland Cement
ANSI/AWS D1.1	Structural Welding Code – Steel
API Standard 1104	Welding Pipelines and Related Structures
AWWA M-11	Steel Water Pipe - A Guide for Design and Installation
ASME	Boiler and Pressure Vessel Code

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: Submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 00 – Submittal Procedures, and the following supplemental requirements as applicable. Fittings and specials shall conform to Contractor's submittals for steel pipe and specials shall be coordinated between the sections.

B. Fabrication Information

a. Pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; manufacturing tolerances; maximum angular joint deflection limitations; and all other pertinent information required for the manufacture and installation of the product.

b. Welded joint details shall be submitted for all joint types, including beveled ends for alignment conformance and deep bell or butt strap joints required for control of temperature stresses.

c. Rubber gasket joint design and details complete with dimensions, tolerances, and performance or test data.

d. Pipe Fabricator's Credentials: Submit the credentials of the pipe manufacturer/fabricator. Credentials shall include reference names, telephone numbers, and descriptions of projects for pipe conforming to AWWA C200 that is of similar diameter, length, and wall thickness to the pipe

in this project. Project description shall include length, diameter, wall thickness, steel metallurgy, location of facility where pipe was manufactured/fabricated, and names of key plant personnel responsible for the manufacturing process. Submit names and qualifications of current plant personnel to be responsible for manufacture of the pipe in this project. To demonstrate ability to meet the schedule requirements of this project, submit project descriptions and manufacturing/fabrication schedules for other currently contracted pipe projects at the Fabricator's plant. The manufacturing / fabrication schedule for the pipe in this project shall be identified on schedule submittals under Section 01 32 16 – Construction Progress Schedule Bar Chart Schedule.

e. Manufacturer's Written Quality Assurance/Control Program.

2. Materials: Material lists and steel reinforcement schedules which include and describe all materials to be utilized. Metallurgical test reports for steel proposed for use on the project. Submit chemical and physical test reports from each heat of steel that indicate the steel conforms to the Project Specifications.

3. Line Layout Information

   a. Line layout and marking diagrams compatible with the requirements of AWWA Manual 11 (M-11) and which indicate the specific mark number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line. In addition, the line layouts shall include: the pipe station and centerline elevation at all changes in grade or horizontal alignment; the station and centerline elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment. The location of all mitered pipe sections, beveled ends for alignment conformance, and deep bell or butt strap joints for temperature stress control shall be clearly indicated on the diagrams.

   b. Dimensional drawings of all valves, fittings, and appurtenances as specified in Section 40 05 00 – Piping, General.

   c. Drawings showing the location and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining.

   d. Details and locations of closures for length adjustment, temporary access manways, vents, and weld lead pass holes as indicated and as required for construction convenience.

4. Welding Information

   a. Information regarding location, type, size, and extent of all welds with reference called out for Welding Procedure Specifications (WPS) numbers shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints, and the preparation of parent metal required to make them.

   b. Written welding procedures for shop and field welds, including Welding Procedure Specifications (WPS's) and Procedure Qualification Records (PQR's).

   c. Written nondestructive testing procedure specifications, and nondestructive testing personnel qualifications for shop and field welds.

   d. Current welder performance qualifications (WPQ's) shall be submitted for each welder used prior to its performing any Work either in the shop or field.

Qualification testing shall be as specified in Article 1.4 - Quality Assurance, Paragraph F, in this Section.

e. Submit the credentials of the Contractor's certified welding inspectors (CWI's) and quality control specialist for review prior to starting any welding in the shop or field. The credentials shall include, but not be limited to, American Welding Society QC-1 Certification.

f. Submit all nondestructive testing (NDT) data for each shop-welded and field-welded joint. This data shall include all testing on each weld joint, including re-examination of repaired welds, using radiographic, magnetic particle, dye penetrant examination, ultrasonic, or air test examination methods specified. Test data shall be reviewed and signed by the welding inspector(s).

g. Submit a welder log for field and shop welding. Log shall list all welders to be used for the Work and the types of welds each welder is qualified to perform.

h. Submit a welding map showing the sequence of welds for all field welds.

i. Submit a written weld repair procedure for each type of shop and field weld proposed for use on the Project.

j. Submit a written rod control procedure for shop and field operations demonstrating how the Contractor intends to maintain rods in good condition throughout the Work. The rod control procedure shall also demonstrate how the Contractor intends to ensure that the proper rods are used for each weld.

5. Handling and Support Information: Detail drawings indicating the type, number and other pertinent details of the slings, strutting and other methods proposed for pipe support and handling during manufacturing, transport, and installation. Calculations supporting the handling and support system design shall be submitted. Drawings and calculations shall be sealed by a registered professional engineer.

6. Control of Temperature Stresses

   a. Submit proposed sequencing of events to control temperature stresses in the pipe wall during installation prior to starting of any field welding.

   b. Submit the proposed sequencing of events or special techniques to minimize distortion of the steel as may result from shop welding procedures.

   c. Submit plan for monitoring pipeline temperatures.

7. Field Lining

   a. Submit field lining contractor’s credentials.

   b. Submit a description of lining equipment and personnel to be used.

   c. Submit written procedures for pipe surface preparation, lining application, and curing.

   d. Submit cement mortar mix design.

C. Certifications: Furnish a certified affidavit of compliance for all pipe and other products, materials, or related work provided under this Section, as specified in ANSI/AWWA C200, C205, C602, and C206, respectively, and the following supplemental requirements:

1. Compliance with the additional requirements included in these Contract Documents.
2. Physical and chemical properties of all steel.
3. Hydrostatic test reports.
4. Results of production weld tests.
5. Sand, cement, and mortar tests.
6. Rubber gasket tests.
7. All materials are NSF approved for use with potable water where applicable.

8. Pipe temperature complies with Specifications prior to pouring pipe zone material, during and between periods of CLSM placement, and prior to and during welding temperature control joints (including supporting data).
9. All welds were performed in conformance with these documents.

D. All expenses incurred in making samples or collecting data for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe, linings, welds, coatings, and related work shall be subject to inspection at the place of manufacture and/or the place the Work is performed in accordance with the provisions of ANSI/AWWA C200, C205, C206, C602, C209, C214, C215, and C222 as applicable, as supplemented by the requirements herein. Notify the Engineer in writing not less than 14 calendar days prior to the start of any phase of the pipe manufacture, welding, lining, coating, testing, or field operations.

B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of ANSI/AWWA C200, C205, C206, and C602, as applicable.
1. After the joint configuration is completed and prior to lining with cement-mortar, if applicable, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 75 percent of the minimum yield strength of the pipe steel. Test pressure shall be maintained for a sufficient time to observe the weld seams. There shall be no leaks. Any leaks shall be repaired and the pipe retested.
2. Production weld tests as required in ANSI/AWWA C200, except weld tests shall be conducted on each 5,000 feet of production welds at a minimum, and at least one set of tests per operator per work shift shall be performed.

C. Perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

D. In addition to those tests specifically required, the Engineer may request additional samples of any material including mixed concrete and lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

E. Welding Procedure Specifications: All welding procedures used to fabricate and install pipe shall be in accordance with the ASME Boiler and Pressure Vessel Code (BPVC) for shop welds and ANSI/AWS D1.1 for field welds. Written welding procedures shall be required for all welds, both shop and field. Welds qualified per the ASME BPVC shall include Supplementary Essential Variables for notch-tough welding. All provisions of ANSI/AWS D1.1 pertaining to notch-tough welding shall apply.

F. Welder Performance Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified by the Contractor under the provisions of ASME BPVC for

shop welds and ANSI/AWS D1.1 for field welds. Furnish all material and bear the expense of qualifying welders.

G. Shop Nondestructive Testing: Nondestructive testing shall be performed for various weld categories as specified below. Testing shall include submitting written documentation of procedures per Section V, and acceptance criteria shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.
   1. Butt Joint Welds: Spot radiographically examine pipe in accordance with Paragraph UW-52 of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1. If, in the opinion of the Engineer, the butt joint welds cannot readily be radiographed, they shall be 100 percent ultrasonically examined.
   2. Fillet Welds: 100 percent examine all fillet welds using the magnetic particle inspection method.
   3. Groove Welds: 100 percent ultrasonically examine all groove welds that cannot be readily radiographically spot examined.
   4. All Welds: Certified welding inspector shall 100 percent visually examine all welds as a minimum.
   5. In addition to weld tests hereinbefore specified, doubler pads shall be air tested as stated in AWWA C206.
   6. Refer to Section 33 13 00 – Water Pipeline Testing and Disinfection for field nondestructive testing.

H. Onsite Observation: The pipe fabricator shall provide an experienced staff member to train the contractor's installation crews regarding pipe handling, jointing, and backfilling. Training shall be provided for a minimum of two weeks at the beginning of the project, and as needed during construction. The staff member's duties shall include, but not be limited to, the following:
   1. Observe the installation and welding of the pipe and fittings.
   2. Report any concerns to the Engineer's onsite observer.
   3. Answer questions and provide assistance to the Engineer and the Contractor.

I. Certified Welding Inspector (CWI): Furnish the services of a certified welding inspector(s) for all shop and field welding as specified in AWWA C200 and C206. The certified welding inspector(s) shall 100 percent visually inspect all welds, verify proper procedures are being followed using qualified welders, supervise Contractor's non-destructive testing, and witness Engineer's non-destructive testing. The welding inspector(s) shall submit written certification that all welds were performed in conformance with these documents. All shop weld tests shall be reviewed and signed by the inspector(s).

J. Pipe Manufacturer/Fabricator: The manufacturer or fabricator of the pipe shall be experienced in fabricating pipe of similar diameters and wall thicknesses required for this Work and shall have the manufacturing capability to meet the schedule requirements of this project. Experience shall include successful fabrication to AWWA C200 standards of at least 5,000 linear feet of 24-inch and larger pipe with wall thicknesses 0.375- inch or larger within the 4-year period preceding the bid date. This experience requirement shall apply to the fabrication plant facility and responsible personnel, not to the firm which owns the facility or employs the personnel.

K. Single Manufacturer: A single manufacturer shall be made responsible for coordination of design, fabrication, testing, and furnishing of mainline pipe and fabricated specials. Separate suppliers for mainline pipe and specials will not be allowed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, steel pipe, linings and coatings shall conform to ANSI/AWWA C200, C205, C602, C209, C214, C215, C216, and C222, as applicable, subject to the following supplemental requirements. The pipe shall be of the diameter and wall thickness shown, shall be furnished complete with welded or gasket joints, as indicated in the Contract Documents. For pipe larger than 24 inches in diameter, the inside diameter after lining shall not be less than the nominal diameter indicated unless otherwise shown. Pipe 24 inches in diameter and smaller may be provided in standard outside diameters.

B. Markings: Legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All special pipe sections and fittings shall be marked at each end with top field centerline. The word "top" shall be painted or marked on the outside top spigot of each pipe section.

C. Handling and Storage: The pipe shall be handled by use of wide slings, padded cradles, or other devices, designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be suitably supported and shall be secured to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 1 inch in diameter. The ends of all pipe shall be securely bulkheaded or otherwise sealed during transport to the jobsite. All pipe handling equipment and methods shall be acceptable to the Engineer.

D. Pay the cost of replacement or repair of pipe which is damaged at no increased cost to the Owner.

E. Strutting: Adequate strutting (stulling) shall be provided on all specials, fittings, and straight pipe so as to avoid damage or distortion to the pipe and fittings during handling, storage, hauling, and installation. The following requirements shall apply:
   1. The strutting shall be placed as soon as practicable after the pipe is fabricated or the mortar lining has been applied and shall remain in place while the pipe is loaded, transported, unloaded, installed and backfilled at the jobsite.
   2. The strutting materials, size and spacing shall be the responsibility of the Contractor and shall be adequate to prevent deflection and support the earth backfill plus any greater loads which may be imposed by the backfilling and compaction equipment. One strut shall be placed vertical oriented with the top of pipe. One set of struts shall be set 2 feet from each end of each pipe section and at a maximum interval of 15 feet in-between

3. Any pipe damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.

F. Laying Lengths: Maximum pipe laying lengths shall not be limited unless specifically required by the Drawings. Contractor shall select lengths to accommodate the Contractor's operation.

G. Lining: The pipe lining shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness.

H. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated. The locations of correction pieces and closure assemblies shall be shown on the pipe layout diagrams and shall be subject to the Engineer's review. Any change in location or number of said items shall be approved by the Engineer.

I. Shop-Welded Surfaces: All weld seams on pipe surfaces that will have a flexible tape or polyolefin coating in accordance with Section 09 90 10 - Pipeline Coatings and Linings shall be ground such that the maximum weld bead height will not exceed 1/32 inch. All ground weld seams shall be smooth and free of all burrs. Do not grind into, or gouge, the adjacent pipe wall material.

2.2 MATERIALS

A. Cement: Cement for mortar shall conform to the requirements of ANSI/AWWA C205; provided, that cement for mortar coating shall be Type V, and mortar lining shall be Type II or V, per ASTM C 150. Fly ash or pozzolan shall not be used as a cement replacement.

B. Steel: Provide steel coils for spiral welded steel pipe or steel plate for straight seam welded steel pipe per AWWA C200 and as follows:
1. Yield Strength: 42,000 psi minimum. Measured yield strength shall not exceed 85% of measured tensile strength.
2. Minimum Tensile Strength: 60,000 psi
3. Coils: Steel coils shall be made from the continuous cast process or continuous cast slabs, fully killed, fine-grain practice conforming to the physical and chemical characteristics of ASTM A1018/A1018M, SS Grade 45. For sheet steel, the maximum allowable thickness variation shall be 0.010 inch under or over the nominal thickness.
4. Plate: Steel plate shall be fully killed, conform to ASTM A20, and be manufactured to fine-grain practice conforming to the physical and chemical characteristics of ASTM A572/A572M, Grade 50. For plate steel, the maximum allowable thickness variation shall be 0.010 inch under or over the nominal thickness.

C. Pipe shall be manufactured as fabricated pipe per AWWA C200 as modified herein. ASTM pipe manufacturing standards referenced in AWWA C200 shall not be used. Pipe sections shall be fabricated by either of the following methods:
1. Pipe sections may be spirally welded or fabricated from short cylindrical courses joined circumferentially by complete penetration butt joint welds with not more than

two longitudinal seams per course. Longitudinal seams shall be staggered on both sides of the pipe.

2. Pipe sections may be rolled or pressed from no more than three sheets the full length of the pipe and welded with no more than three longitudinal seams. Patching inserts, overlays, or pounding out of dents will not be permitted. Repair of notches or laminations on second ends will not be permitted. Damaged ends shall be removed as a cylinder and the section end properly prepared. Distorted or flattened lengths shall be rejected. A buckled section shall be replaced as a cylinder.

D. Charpy Tests

1. General. Steel used in production manufacturing of pipe and specials shall be tested for notch toughness using Charpy V-Notch tests per ASTM A 370. The test acceptance shall be 25 foot-pounds at a test temperature of 30 degrees F.
2. Charpy V-Notch tests shall be conducted on all steel used in fabricating pipe and reinforcement materials 0.5-inch or greater in thickness. Test outside diameter wrap of two coils minimum per heat lot.
3. The Owner may elect to increase the Charpy testing to include more steel than indicated above at a negotiated price.

2.3 SPECIALS AND FITTINGS

A. Unless otherwise required, all specials and fittings shall conform to the dimensions of ANSI/AWWA C208.

2.4 DESIGN OF PIPE

A. General: The pipe shall be steel pipe, mortar-lined and flexible or mortar-coated as shown on the Drawings, with field welded joints or gasket as indicated. The pipe shall consist of a steel cylinder, lined with portland cement-mortar as indicated, with an exterior coating as indicated in Section 09 90 10 – Pipeline Coatings and Linings. Field lining will only be allowed where specifically indicated on the Drawings.

B. The pipe shall be manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C200.

C. Pipe Dimensions: The pipe shall be of the diameter and wall thickness shown on the Drawings. The minimum steel cylinder thickness for each pipe size shall be as indicated.

D. Specials Dimensions: The specials shall be of the diameter and wall thickness indicated on the Drawings.

E. Joint Design: Unless otherwise shown on the Drawings, the standard field joint for steel pipe shall be a double-welded (fully circumferential) lap joint. Mechanically coupled, or flanged joints shall be required where indicated on the Drawings. Butt-strap joints shall be used only where required for closures or where indicated. The joints furnished shall have the same or higher pressure rating as the abutting pipe. Provide air test tapped holes for each double welded lap joint as defined in Section 33 13 00 - Water Pipeline Testing and Disinfection.

F. Lap joints prepared for field welding shall be in accordance with ANSI/AWWA C200. The method used to form, shape and size bell ends shall be such that the physical properties of the steel are not substantially altered. Unless otherwise approved by the Engineer, bell ends shall be formed by an expanding press or by the pipe being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. The ends shall not be rolled. Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.

G. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths of pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels and maximum joint deflections are not exceeded. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be 75 percent of the manufacturer's recommendations or the angle which results from a ¾-inch pull out from normal joint closure, whichever is less. In no case shall pulled joints result in a gap between the bell and spigot at the weld location that exceeds 1/8 inch. All horizontal deflections or fabricated angles shall fall on the alignment, as shown.

H. All vertical deflections shall fall on the alignment within laying tolerance as described in Section 3.1.

I. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as indicated or as otherwise acceptable to the Engineer. Holdback areas shall be coated as hereinafter specified.

J. Temperature Control Lap Joint: A special longer bell end (temperature control lap joint) shall be provided at a maximum spacing of 400 feet to account for movement of the installed pipe due to temperature changes. The pipe manufacturer shall determine the length required for the longer bell as defined by the Contractor's pipe laying procedures and the location of the special bell. Minimum temperature control lap joint length shall be as shown on the Drawings.

K. Joint Shop Coating: All holdback areas for welded joints, all butt straps, and all bell and spigot joint rings for rubber-gasketed joints shall be thoroughly cleaned and given a shop coat of rust-inhibitive primer. The surface preparation and primer shall be compatible with the intended finish coating as specified in Section 09 90 01 – Protective Coatings and Linings, Section 09 90 10 – Pipeline Coatings and Linings, as applicable.

L. Shop Fit Test
   1. To ensure that joints may be fully assembled and that excessive annular space between spigots and bells does not exist, and that the pipe meets the requirements of AWWA C200, the pipe fabricator shall perform a shop fit test on a minimum of five joints. The joints to be tested shall be selected by the Engineer based on pipe measurements.
   2. The shop fit test shall join the pipe ends in the shop with the proposed adjacent pipe end.
   3. Record the actual annular space, with the data to include as a minimum:

4. Maximum space at any point.
5. Minimum space at any point.
6. Space at 90-degree intervals--top, bottom, and spring line on both sides.

M. The pipe ends shall be match marked after shop assembly.

2.5 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Where indicated on the Drawings, interior surfaces of all steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C205. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work and shall be approved by the Engineer. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at the delivery site, or after installation, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications at no additional cost to the Owner.

B. The minimum lining thickness shall be in accordance with Section 09 90 10 Pipeline Coatings and Lining.

C. The pipe shall be left bare where field joints occur as indicated. Ends of the linings shall be left square and uniform. Feathered or uneven edges will not be permitted.

D. Defective linings, as determined by the Engineer, shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather edged joints. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired. Pipe, specials, or fittings with cracks wider than 1/16 inch shall be rejected or repaired per C205 at the discretion of the Engineer.

E. The progress of the application of mortar lining shall be regulated in order that all hand work, including the repair of defective areas is cured in accordance with the provisions of ANSI/AWWA C205. Cement-mortar for patching shall be the same materials as the mortar for shop or machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

F. Cement-Mortar Lining: Unless otherwise indicated, all steel pipe shall be mortar-lined. The materials and design of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602 and the following supplementary requirements:
1. Pozzolanic material shall not be used in the mortar mix.
2. Admixtures shall contain no calcium chloride.
3. The minimum lining thickness shall be as indicated for shop-applied cement-mortar lining and finished inside diameter after lining shall be as indicated.
4. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired. Pipe, specials, or fittings with mortar cracks wider than 1/16 inch shall be rejected or repaired at the discretion of the Engineer.
5. Field applied mortar lining shall meet the requirements of this Subparagraph F.

6. Grout mixture for field applied joint lining shall include two parts sand to one part Type II Portland Cement by volume and potable water. NSF approved acrylic latex admixture (Flex-Con, or equal) shall be added to mortar as needed to make dough like consistency for hand packing into joint area.

G. Protection of Pipe Lining/Interior: For all pipe and fittings with plant-applied cement-mortar linings, provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.6 EXTERIOR COATING OF PIPE

A. Exterior Coating of Steel Pipe: The exterior coating of all steel pipe shall be in accordance with Section 09 90 10 – Pipeline Coatings and Linings.

2.7 PIPE APPURTENANCES

A. Pipe appurtenances shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

2.8 PIPELINE MARKING TAPE

A. Metallic tape: Terra Tape Sentry Line Detectable manufactured by Reef Industries, Inc., 9209 Alemeda Genoa Road, Houston, TX 77075, www.reefindustries.com; or approved equal, having the following essential characteristics:
   a. Aluminum foil encased in high visibility inert polyethylene jacket.
   b. Total thickness: 6.0 mils, minimum.
   c. Core foil thickness: 0.30 mils, minimum.
   d. Width: 6 inches, minimum.
   e. Imprinted on one side, 1-inch-tall, permanent black lettering.
   f. Color: as listed below.
   g. Joining clips shall be manufacturer's standard tin or nickel coated.
   h. Tape shall read for example “JVWCD-Buried Pipeline Below”.

B. Plastic tape: Terra Tape Extra Stretch manufactured by Reef Industries, Inc., 9209 Alemeda Genoa Road, Houston, TX 77075, www.reefindustries.com; or equal, having the following essential characteristics:
   a. Polyolefin or similar chemically inert material unsusceptible to alkalies, acids, and chemicals and solvents likely in the soil.
   b. Thickness: 8.0 mil, minimum.
   c. Width: 12 inches minimum.
   d. Color: as listed in below.
   e. Imprinted on one side, 1-inch-tall, permanent black lettering on a colored background.
   f. Tape shall read for example “**[JVWCD]-**Buried Pipeline Below”.

2.9 MARKERS

A. Provide pipeline markers at the locations indicated. Markers in open areas shall be High Visibility Tri-View Utility Marking Posts as manufactured by Rhino Marking and Protection Systems (www.rhinomarkers.com). Coordinate color and lettering with Owner prior to installation. Markers shall be provided at the following locations:
   1. Both sides of street and canal crossings.
   2. At locations of cathodic protection test stations (see test station table).
   3. At the beginning and end of open areas and at a maximum interval of 500-ft.

B. Brass Caps: Caps shall be 2-1/2-inch diameter brass caps with posts set by epoxy into holes drilled into the curb adjacent to the pipeline. Brass caps and monuments shall be provided in locations as described in the plans. Caps shall be stamped as shown on the details and shall be provided at the following locations:
   1. Fittings or elbows.
   2. Both sides of street and canal crossings.
   3. Within deck of concrete structures (manholes, vaults, etc.)

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE

A. Handling and Storage: All pipe, fittings, and specials shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. Pipe shall be handled and stored at the trench site in accordance with the requirements stated below. No pipe shall be installed when the lining or coating/interior or exterior surfaces show cracks or other damage that may be harmful as determined by the Engineer. Such damaged lining and coating/interior and exterior surfaces, shall be repaired to the satisfaction of the Engineer, or a new undamaged pipe shall be furnished.

B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor at no additional cost to the Owner.

C. Inspect each pipe and fitting to insure that there are no damaged portions of the pipe. Remove or smooth out any burrs, gouges, weld splatter or other small defects prior to laying the pipe.

D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.

E. Lifting points shall be no closer than the 1/3 and 2/3 points along the length of the Section. Contractor shall be responsible for selecting lifting points that when used, do not result in damage to the pipe.

F. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

G. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, short lengths of pipe, by the use of beveled joint rings, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer or the amount that results in more than a 1/8-inch gap at the weld location, whichever is less. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.

H. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.

I. Pipe struts shall be left in place until backfilling operations have been completed for pipe 42 inches in diameter and larger. Struts in pipe smaller than 42 inches may be removed immediately after laying, provided, that the deflection of the pipe during and after backfilling does not exceed that specified. After the backfill has been placed to a minimum of 3-feet, the struts shall be removed by the Contractor and shall remain the property of the Contractor. Struts shall not be removed with a torch or any other method that may damage the pipe lining or coating. The parent pipe material shall not be nicked, gouged, or damaged during strut removal. All repairs of gouges or nicks in the parent material shall be made using 3/32-inch maximum diameter E-6010 welding electrodes with a maximum heat input of 5.6 kj per inch. Tack welds, stull metal, weld splatter, slag, and burrs that remain attached to the parent metal surface after cutting shall be ground to within 1/32 inch of the parent metal. Grinding shall not penetrate the parent metal. The Contractor shall notify the Engineer prior to grinding. Following grinding, all pipe surfaces at the tack weld shall be visually inspected for defects. All defects deeper than 1/16 inch shall be repaired by welding in accordance with ANSI/AWSD.1.1 and AWWA/ANSI C206. All inspection work shall be performed by a certified welding inspector.

J. For pipe backfilled with CLSM, the pipe shall be laid directly on moist sandbags or other suitable supports approved by the Engineer in preparation for CLSM pipe zone material. Sandbags shall be placed to provide at least 6 inches of CLSM below the bottom of the pipe. Sandbags shall be spaced at a maximum interval of 8 feet and one set shall be placed within 3 feet on both sides of each joint. The Contractor shall provide additional sandbags as needed to support the pipe on line and grade. For pipe bedded in granular material, no blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

K. At all times, means shall be provided to prevent the pipe from floating. Take all necessary precautions to prevent the pipe from floating due to water entering the trench or from backfilling with CLSM. The Contractor shall assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floating. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.

L. Bulkheads
   1. Prior to shipment of pipe with cement mortar lining the lining shall be wetted then a suitable bulkhead shall be attached to each end of the pipe section. This bulkhead shall remain in place and in good condition through transit to the Project.
   2. During construction the openings of all pipe and specials where the pipe and specials have been cement-mortar lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water or any undesirable substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe. Introduce water into the pipe as needed to keep the mortar moist where moisture has been lost due to damaged bulkheads.

M. Pipe Cleanup: As pipe laying progresses, keep the pipe interior free of all debris. Completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

N. Installation Tolerances: Each section of pipe shall be laid in the order and position shown on the laying diagram and the following requirements:
   1. Each section of pipe having a nominal diameter less than 48 inches shall be laid to line and grade, within plus or minus 2 inches horizontal deviation and plus or minus 1 inch vertical deviation.
   2. Each section of pipe having nominal diameter 48 inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.
   3. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.
   4. Pipe deflection, after backfill but prior to installation of field-applied cement mortar lining, if applied, shall not exceed 2.25 percent for flexible coated pipe and 1.5 percent for cement mortar coated pipe. Deflection shall be measured by the difference in vertical inside diameter in the installed pipe and the manufactured pipe.
   5. Pipe not conforming to these criteria or which otherwise impact the ability to complete the Work shall be removed and reinstalled in full conformance with the Contract Documents at no additional cost to the Owner.
   6. For each section of pipe, record the invert elevation at the lower end and incorporate the data on the Record Drawings.

O. Protection of Pipe: At locations where the Contractor proposes to cross the installed pipeline with heavy equipment, precautions as approved by the Engineer shall be taken to protect the pipe from damage. Acceptable precautions include: backfilling the pipe trench as necessary to protect the pipe, concrete encasing the pipe, and placing steel plating over the pipe. Any damage to the pipe caused by the Contractor's operation or his equipment shall be repaired at no additional cost to the Owner.

3.2 WELDED JOINTS

A. Welding Procedures, Welding Qualifications, and Testing

1. Field welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in Section 3 of ANSI/AWWA C206 or ANSI/AWWA C200, as applicable. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.
2. For field welding, the welder qualification testing shall be performed at the site. Previous qualifications will not be accepted. The Contractor shall obtain the services of an independent testing laboratory to perform the welder qualification onsite. Copies of all test data and certifications shall be provided to the Engineer. All costs for welder qualification testing shall be at no increased cost to the Owner.
3. Upon completion of each field-welded joint, the welding operator shall mark his regularly assigned identification number and the last two numbers of the year in which the Work was completed, or the Contractor may have a records system that traces a welder's work completion to a specific joint. Steel stamping directly on piping will not be permitted unless "low stress" die stamps, such as interrupted dot or round nose types, are used.
4. All single welded lap joints will be inspected by the CONTRACTOR in the presence of the Engineer using magnetic particle or dye penetration methods. Field butt welds will be inspected by the CONTRACTOR in accordance with the requirements of API 1104 by the radiographic method and the acceptance criteria of API 1104. Magnetic particle testing is not required for seal welds.
5. All double welded lap joints and butt strap joints shall be air tested by the CONTRACTOR in the presence of the Engineer in accordance with Section 33 13 00 - Water Pipeline Testing and Disinfection. Repairs and retesting shall be required if any loss of pressure occurs. All double welded lap joints will also be inspected by the CONTRACTOR in the presence of the Engineer using magnetic particle or dye penetration methods.
6. The Contractor shall inform the Engineer before completed weld joints are to be backfilled so that the joint may be inspected. The Contractor shall assume all costs of exposing backfilled joints for inspection when backfilling preceded the inspection.
7. Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing nondestructive tests shall be qualified and certified to the requirements of SNT-TC-1A.
    a. The Engineer may also order nondestructive testing by an independent testing laboratory in addition to any testing specified herein. Except as otherwise specified herein, all costs for the independent testing laboratory to inspect and test field welds will be paid for by the Owner. If the weld is defective, the inspection costs shall be paid for by the Contractor. Defective welds shall be repaired and retested at the Contractor's expense.
    b. Test reports of all laboratory tests shall be submitted as provided in the quality control section.

B. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.

C. Lap Welded Joints: During installation of welded steel pipe in either straight alignment or on curves, the pipe shall be laid so that at any point around the circumference of the joint there is a minimum lap as shown on the Drawings.

D. Butt Straps: Where used or required, shall be as shown on the Drawings.

E. After the pipe and pipe joint are properly positioned in the trench, weld and provide external joint protection for all joints except the special temperature control lap joint hereinafter specified. The length of pipe between special temperature control joints shall be backfilled to at least one foot above the top of the pipe as hereinafter specified. The special temperature control joints shall be welded after the pipe is backfilled to at least one foot above the top of the pipe for the full distance between the temperature control joints upstream and downstream. Joint protection shall be provided for special temperature control joints after completion of the joint welds and tests as specified. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the special temperature control joint.

F. Control of Temperature Stresses

1. Control temperature stresses in accordance with AWWA C206, the approved temperature stress control submittal, and these Specifications. Provide special temperature control lap joints at intervals of 400 feet or less, unless otherwise approved by the Engineer.
2. To control temperature stresses, the unbackfilled special temperature control joint areas of all pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials until the pipe is backfilled at least 1 foot over the top of the pipe. The "temperature control joint area" is defined as the entire length of pipe left exposed near a control joint after placing the pipe backfill between it and the other control joints in each direction. The term "special temperature control joint area" is defined as the entire length of pipe left exposed near a control joint after placing the backfill between it and the other control joints in each direction. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.
3. At intervals not exceeding 400 feet along welded reaches of the pipeline, at the first regular lap-welded field joints outside concrete encasements and structures, and where shown, the pipe shall be supplied with a special temperature control lap joint and laid with an initial lap of not less than 3 inches greater than the typical lap joint. Where temperature control lap joints occur in a traveled roadway or other inconvenient location, the location of the joint may be adjusted, as acceptable to the Engineer.
4. Provide and install thermocouple temperature gauges to monitor the temperature of the steel pipe wall on the inside top of the pipe as it lays in the trench. All pipe temperature requirements specified herein shall be measured at the top inside of the steel cylinder. Specific temperature requirements for the pipeline steel cylinder shall be met prior to installation of the controlled low strength material (CLSM), during and after placement of CLSM, and during welding of the special temperature control joints. If atmospheric conditions do not allow the conditions to be met, supplemental

cooling shall be required by the Contractor. The following outlines the specific temperature control requirements.

a. Prior to and during placement of the CLSM, the pipeline steel temperature shall be at or below 90 degrees F. The specified temperature shall be maintained for at least three hours after the placement of CLSM. The specified temperature shall be maintained until the line is fully backfilled. Provide supplemental cooling as required.

b. Placement of CLSM shall proceed in the direction of pipe laying from one special temperature control joint to the next. During placement of CLSM, the lead end of the pipe section (toward the next special temperature control joint) shall be left unbackfilled or otherwise unrestrained such that the end of the pipe is free to move in response to expansion or contraction due to temperature changes. CLSM shall not be placed in a direction which would result in CLSM placement proceeding in a direction toward previously or simultaneously placed CLSM without the written permission of the Engineer. The direction of CLSM placement will not be limited for placement at the short unbackfilled section immediately adjacent to the special temperature control joints.

c. During periods between CLSM placement operations, any section of pipeline that is backfilled with CLSM shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials until the pipe is backfilled at least 1 foot over the top of the pipe. The temperature of the partially backfilled pipe shall not be allowed to exceed 110 degrees Fahrenheit at any time. Provide supplemental cooling as required. Shading materials shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the partially backfilled pipe need not be performed when the Contractor can demonstrate to the satisfaction of the Engineer, using thermocouple data, that shading is not necessary to the Contractor to meet the specified temperature requirement.

d. Prior to welding the special temperature control joints, the pipeline extending 400 feet each direction from the joint shall be maintained at or below 85 degrees F. Additionally, the pipeline extending 400 feet each direction from the joint shall be backfilled with CLSM to at least one foot over the top of the pipe. At the specified temperature, the special temperature control joints can be welded. Begin and complete the weld during the coolest interval of suitable length within a 24-hour day. Use the thermocouple temperature data to demonstrate to the Engineer the coolest interval of the day.

e. After welding any temperature control joint, the pipe temperature for 150 feet in each direction from the control joint shall be maintained below 110 degrees F for a minimum of 24 hours after the temperature control joint area has been backfilled to at least 1 foot over the top of the pipe. This requirement is in addition to the shading and CLSM placement temperature requirements indicated herein.

G. Prior to the beginning of pouring CLSM or beginning the welding procedure, any tack welds or joint stops used to position the pipe during laying shall be removed. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means. The weld shall then

be made in accordance with ANSI/AWWA C206. Where more than one pass is required, all dirt, slag, and flux shall be removed before the succeeding bead is applied.

H. Testing of Joints: The pipeline joints shall be tested as specified herein and in Section 33 13 00 - Water Pipeline Testing and Disinfection.

I. Following tests of the joint, the exterior joint spaces shall be coated in accordance with these Specifications after which backfilling may be completed.

J. Joints: The pipe ends shall be cut straight on joints where butt straps are used for realignment, adjustment, or deflection, and fillet welds shall be made as indicated.

K. Repair of Welds: All welds that are defective shall be repaired by the Contractor to meet the requirements of this Section at no additional cost to the Owner. Defects in welds or defective welds shall be removed, and that section of the joint shall then be rewelded. Only sufficient removal of defective material that is necessary to correct the defect is required. After the repair is made, the joint shall be checked by repeating the original test procedure. Welds deficient in size shall be repaired by adding weld metal.

3.3 JOINT COATING AND LINING

A. General: The interior and exterior joint recesses shall be thoroughly wiped clean and all water, loose scale, dirt and other foreign material shall be removed from the inside surface of the pipe. The grout for joint coating and lining shall be cement grout in accordance with Section 03 60 00 - Grouting, except that composition shall be one part cement to two parts sand and sufficient water for dry-pack consistency

B. Joint Coating: In accordance with the requirements of Section 09 90 10 – Pipeline Coatings and Linings.

C. Joint Lining:
1. Clean joint to remove dirt, debris, and other contaminants.
2. Apply a single application of NSF approved acrylic latex bonding admixture (Flex-Con, or equal) to wet out joint for the promotion of adhesion.
3. The grout for joint lining shall be cement grout in accordance with Section 03 60 00 – Grouting, except that composition shall be one part cement to two parts sand and sufficient water for dry-pack consistency. NSF approved acrylic latex admixture shall be added to develop a dough like consistency.
4. Mortar mixture is hand packed into the joint area.
5. Joint is troweled smooth to create a uniform transition between existing mortar lined pipe.
6. Joint area is swept clean of debris.
7. After the backfill has been completed to final grade, the interior joint recess of shop-lined pipe shall be filled with grout, tightly packed into the joint recess and troweled flush with the interior surface. All excess shall be removed. At no point shall there be an indentation or projection of the grout exceeding 1/16 inch. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout containing one part cement to two parts sand. The spigot end then

shall be forced to the bottom of the bell and excess mortar on the inside of the joint shall be swabbed out.

3.4 CEMENT-MORTAR LINING, FIELD-APPLIED

A. Unless otherwise indicated, the Contractor shall construct the cement-mortar lining in-place after the pipeline is backfilled to approximate finished grade. The application of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602.

1. The lining machine shall be of a type that has been used successfully for a similar size of pipe. Perform all Work in a thorough and workmanlike manner by trained personnel, under the supervision of experienced personnel skilled in machine application of cement-mortar lining to pipelines of size comparable to this Work.
2. Curing of the in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602, except the Contractor shall be responsible for curing and maintaining the lining until final acceptance by the Owner. Provide a system to maintain a suitably moist environment within the pipe to properly cure and maintain the lining. Provide additional protective devices as required to ensure that the airtight covers, which maintain a moist condition in the pipeline, are not damaged.
3. Defective areas encompassing the full diameter of the pipe shall be replaced by machine wherever the length measured along the pipe centerline is greater than 5 feet; otherwise defective areas may be replaced by hand.

3.5 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is concrete or coated with cement mortar, buried appurtenances shall be coated with a minimum thickness of one inch of cement mortar having one part cement to not more than two parts plaster sand. Following coating with cement mortar, the appurtenances shall be coated with a protective overcoat in accordance with the paragraph entitled "Protective Coating."

B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. Adjust all stem packing and operate each valve prior to installation to insure proper operation. Valves (body and seat) shall not be subjected to test pressures greater than manufacturer's recommendation. In some cases this may require an increase in the valve pressure class.

C. All buried valves shall be coated and protected in accordance with Section 09 90 10 - Pipeline Coatings and Linings.

D. All valves shall be installed so that the valve stems are plumb and in the location indicated.

E. Installation of Flanged Joints: Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. All bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable, approved and calibrated torque wrench. All clamping torque shall be applied to the nuts only.

F. All buried flanges shall be coated and protected in accordance with Section 90 10 01 - Pipeline Coatings and Linings.

G. Flexible Coupled Joints: When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets and couplings. The couplings shall be assembled and installed in conformity with the recommendation and instruction of the coupling manufacturer.

H. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the follower rings and the body of the pipe with all bolts tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly. Final tightening shall be done with a suitable, approved and calibrated torque wrench set for the torque recommended by the coupling manufacturer. All clamping torque shall be applied to the nut only.

I. Upon completion of the coupled joint, the coupling and bare metal of the pipe shall be cleaned, primed and protected in accordance with the requirements of Section 09 90 10 - Pipeline Coatings and Linings.

3.6 MARKING TAPE INSTALLATION

A. As shown on the Drawings.

3.7 PIPELINE TESTING

A. The steel pipe shall be hydrostatically tested as specified in Section 33 13 00 – Water Pipeline Testing and Disinfection.

END OF SECTION

SECTION 33 13 00
WATER PIPELINE TESTING AND DISINFECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall perform flushing and testing of all pressure pipelines and appurtenant piping and disinfection of all pipelines and appurtenant piping for potable and fire water, complete.

B. This specification applies to all pipelines requiring hydrostatic tests (water medium) regardless of the pipeline service medium.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C651	Disinfecting Water Mains

1.3 CONTRACTOR SUBMITTALS

A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval a minimum of 7 days before testing is to start.

B. A copy of the Utah Pollutant Discharge Elimination System (UPDES) permit application shall be submitted a minimum of 30 days prior to the proposed date to start testing. A copy of the approved UPDES permit shall be submitted prior to the start of testing.

C. Chlorine residual test data and bacteriological test data shall be submitted to document the results of the pipeline disinfection. Tests shall be conducted 24 hours after the start of disinfection.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

B. Used pressure gauges shall be recertified prior to testing.

C. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

D. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301. Liquid chlorine shall be used only:
   1. In combination with appropriate gas flow chlorinators and ejectors;
   2. Under the direct supervision of an experienced technician;
   3. When appropriate safety practices are observed.

E. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300 - Hypochlorite.

PART 3 - EXECUTION

3.1 GENERAL

A. Water for testing and disinfecting water pipelines shall be furnished by the Contractor. The Contractor shall make all necessary provisions for conveying the water from the source to the points of use, and disposal of the water (and dechlorinating - where applicable).

B. All pressure pipelines shall be tested. Disinfection shall be accomplished by chlorination for all pipelines providing potable water or connected to a potable water system. All chlorinating and testing operations shall be performed in the presence of the Engineer.

C. Disinfection operations shall be scheduled as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner. Samples for bacteriological testing shall be collected by the Contractor, and testing shall be performed by the Owner laboratory and at the expense of the Contractor. Results of the bacteriological testing shall be satisfactory with the State Department of Health or other appropriate regulatory agency.

D. Pipeline pressure tests will include the following tests:
   1. Air test of double welded lap joints.
   2. Hydrostatic pressure test of the complete pipeline, in segments as required to match pipe pressure class.
   3. Contractor shall conduct the discharge in accordance with the Utah Pollutant Discharge Elimination System (UPDES) permit from the Utah Division of Environmental Quality (UDEQ). The Contractor shall apply a reducing agent to the discharged water to neutralize the chlorine residual and meet the chlorine residual limit required under the permit. The Owner shall conduct the water quality sampling of the discharge as required by the permit. The Contractor shall notify local agencies, secure appropriate other permits and approvals, and provide erosion control measures for any releases as appropriate. Release of water after pipeline testing and disinfection have been completed shall be only if acceptable to the Engineer.

E. Notification: Notify the Engineer at each of the following stages:
   1. Three working days prior to the start of filling the pipeline with water.

2. Three working days prior to the start of chlorination.
3. Twenty-four hours before withdrawing samples for bacteriological testing.
4. Three working days prior to the start of flushing.

3.2 VISUAL INSPECTION

A. All welds shall be 100% visually inspected in accordance with ANSI/AWS D1.1, Table 6.1; Visual Inspection Acceptance Criteria for Statically Loaded Non-Tubular Connections.

3.3 AIR TEST

A. All double welded lap joint or double gasket Carnegie joint shall be pressure tested to a minimum of 40-psi air pressure for a period of 10 minutes per AWWA C206. No air leakage will be allowed.

B. If the test pressure drops below 40 psi, paint the welds with a soap solution. Mark any leaks indicated by the escaping gas bubbles.

C. Any joints which leak shall be repaired and retested.

3.4 HYDROSTATIC TESTING OF PIPELINES

A. Prior to hydrostatic testing, all pipelines shall be flushed or blown out as appropriate. Test all pipelines either in sections or as a unit. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained an age of 14 days. The test shall be made by closing valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. The Contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Any unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment. Provide sufficient temporary air tappings in the pipelines to allow for evacuation of all entrapped air in each pipe segment to be tested. After completion of the tests, such taps shall be permanently plugged. Care shall be taken to see that all air vents are open prior to and during filling.

B. The pipeline shall be filled at a rate not to exceed 2-feet per second as calculated by using the cross-sectional area based on the inside diameter of the pipe and which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pocket. No personnel shall be within or enter any vault or confined space subject to flooding during the initial filling and for a 24 hour period. After the 24 hour period bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.

C. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for distribution and transmission pipelines shall be 150 percent of the working pressure in the pipeline measured at the lowest point of the pipeline section being tested. The test pressure for yard piping shall be as indicated on the Piping Schedule

measured at the lowest point of the pipeline section being tested. No pressure test will be required for a reservoir overflow line. All visible leaks shall be repaired in a manner acceptable to the Engineer.

D. The maximum allowable leakage for distribution and transmission pipelines shall be 10 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 40-foot or greater lengths between joints and with rubber-gasketed joints and 20 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 20-foot or less lengths between joints and with rubber-gasketed joints. The maximum leakage for yard piping shall be as shown on the Piping Schedule. Pipe with welded joints shall have no leakage.

E. In the case of pipelines that fail to pass the prescribed leakage test, determine the cause of the leakage, take corrective measures necessary to repair the leaks, and again test the pipelines at no additional cost to the Owner.

F. The pipeline shall be drained after successful completion of the hydrostatic test.

3.5 DISINFECTING PIPELINES

A. General: All potable water pipelines shall be disinfected in accordance with the requirements of ANSI/AWWA C651 - Disinfecting Water Mains as modified herein.

B. Prior to disinfecting the pipeline for potable water services and before placing into service for other water pipelines, flush the pipeline to remove any debris, rocks, or other foreign material that may have entered the pipe. Flushing shall be carried out such that the velocities in the pipe exceed 2.5 feet per second. Provide all required material, labor and equipment to complete flushing. Contractor shall provide the water for flushing. Make appropriate provision and preparations for disposal of flushing water, satisfying all local, state and federal rules, laws, regulations and ordinances.

C. Continuous Feed Method: Disinfect in accordance with ANSI/AWWA C651 except that:
   1. The water in the pipe shall contain 50 mg/l free chlorine.
   2. After 24 hours of disinfection, the residual free chlorine shall be at least 25 mg/l at the pipeline extremities.

D. Slug Feed Method: Disinfect in accordance with ANSI/AWWA C651.

E. Chlorinating Valves: During the process of chlorinating the pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with the heavily chlorinated water.

F. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize thoroughly the chlorine residual remaining in the water. See the appendix of AWWA C651 for acceptable neutralization methods for heavily chlorinated water.

G. Sampling Ports: The Contractor shall provide sampling ports along the pipeline as defined in AWWA C651. Taps may be made at manways and air valves to help facilitate the spacing requirement.

H. Bacteriological Testing: After final flushing and before the pipeline is placed in service, two consecutive sets of samples shall be collected at least 24 hours apart by the Contractor from the end of the line and at other locations as designated by the Engineer, and shall be tested by the Owner for bacteriological quality in accordance with the requirements of AWWA C651. For this purpose, the pipe shall be refilled with fresh potable water and left for a period of 24 hours before any samples are collected. If the initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed or slug method until satisfactory results are obtained – that being two consecutive sets of acceptable samples taken 24 hours apart.

3.6 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

END OF SECTION

SECTION 33 41 01
DRAINAGE PIPELINE SYSTEM TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall perform all pipeline flushing and testing, complete, for drainage system piping as specified herein and in accordance with the requirements of the Contract Documents.

B. The Contractor shall be responsible for conveying flushing water from the source to the point of usage and also for disposal, as required, of water used in the flushing operations.

C. For the purposes of this specification, drainage or drain pipelines are storm drains.

1.2 CONTRACTOR SUBMITTALS

A. The Contractor shall submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the Engineer. The Contractor's proposed plans for water conveyance, control, and disposal shall also be submitted in writing.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. All testing operations shall be performed in the presence of the Engineer.

B. All drainage pipes shall be tested for alignment, joint displacement and deflection as specified herein. All pipes shall be backfilled prior to testing. Any pipe found to be defective shall be repaired or replaced to the satisfaction of the Engineer.

C. Pipe sizes from 12-inch through 30-inch in diameter shall require a displacement test. Pipe sizes from 36-inch diameter and larger shall require a displacement test and visual walk-through inspection. All flexible and semi-rigid pipe shall require a deflection test.

3.2 TESTING OF PIPING

A. Deflection Test: All flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent resurfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular

portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

B. Displacement Test: The displacement test shall be performed by flashing a light between manholes or, if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipe shows broken, misaligned, or displaced pipe or other defects, the defects designated by the Engineer shall be repaired to the satisfaction of the Engineer.

C. Visual Test: A visual test shall be conducted on pipes 36-inch in diameter and larger. The test shall be conducted after the pipes have been flushed or otherwise cleaned. The test shall be performed by the Engineer or his representative and a representative of the Contractor. The interior of the pipe shall be visual inspected for alignment, cracking, displaced or improper joints or other defects. Defects shall be repaired to the satisfaction of the Engineer.

D. Televised Inspection: After the drain pipe has been installed and cleaned; and the trench has been filled, the Contractor shall televise the drain pipe to locate defects in the drain pipe.
   1. The Contractor shall arrange for the televised inspections.
   2. The Contractor shall ensure safe access to each manhole for the television trucks.
   3. Lines to be video inspected shall be flushed within 24 hours prior to beginning of inspection.
   4. Any Work not conforming to these Design Standards and Construction Specifications shall be promptly removed, replaced and retested at no cost to the Owner.
      a. In addition to other requirements identified in the Design Standards and Construction Specifications, the following conditions identified during video inspection shall be promptly corrected by removal, replacement and retesting of the unsatisfactory pipe by the Contractor at no cost to the Owner:
         1) Alignment (Vertical or Horizontal) is outside the specified limits.
         2) Water ponds in any section with depths equal to or greater than 2 times the grade tolerance specified in the Contract Documents.
         3) Pipe section with visible defects, such as: open joints, pinched gaskets, cracked barrels or bells, leaks, or other defects as determined by the Engineer.
   5. A copy of televised inspection shall be provided to the Owner in a format selected by the Owner (DVD, USB, etc.).
   6. Video equipment shall be equipped with a device that can accurately measure the depth of any ponding encountered in the pipe. Measuring device shall be clearly visible in the video image.

END OF SECTION

SECTION 33 41 03
PVC NON-PRESSURE PIPE, RUBBER JOINTS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide PVC non-pressure pipe and appurtenant work, complete and in place, in accordance with the Contract Documents.

B. This Section covers pipe from 4 to 48 inches diameter nominal size.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM D 1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM F 1803	Standard Specification for Poly (Vinyl Chloride)(PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter
ASTM D 2444	Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
ASTM D 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
ASTM D 3212	Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals
ASTM F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Gravity Sewer Pipe and Fittings
ASTM F 794	Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 913	Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings: The Contractor shall submit shop drawings and laying diagrams of pipe, joints, bends, special fittings, and piping appurtenances.

C. Certificates: The Contractor shall submit manufacturer's certificate that pipe conforms to these specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and minimum pipe stiffness in psi.

B. The Contractor shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

2.2 PIPE

A. Pipe shall conform to one of the following requirements
   1. Solid Wall Pipe (4" through 15") - ASTM D 3034, SDR 35.
   2. Solid Wall Pipe (18" through 48") -- ASTM F 679 – 46 psi.
   3. Ribbed Pipe (21" through 48") - ASTM F 794
   4. Closed Profile Wall Pipe (21" through 54") - ASTM F 1803 (Vylon or approved equal only)

B. Material for PVC pipe shall conform to the requirements of ASTM D 1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds, for cell classification 12454-C or 12364-A as defined therein. The manufacturer shall test a sample from each batch according to ASTM D 2444 - Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

C. Joints shall conform to ASTM D 3212. Elastomeric seals for compression type joints shall conform to the requirements of ASTM F 477, ASTM F 913 - Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

2.3 FITTINGS

A. All fittings shall be of the same material as the pipe, molded or formed to suit the pipe size and end design, in required configurations.

B. The stiffness of the fittings shall be not less than the stiffness of adjoining pipe.

PART 3 - EXECUTION

3.1 GENERAL

A. Laying, jointing, and testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.

B. Installation shall conform to the requirements of ASTM D 2321, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

A. Handling
   1. Handling of the PVC pipe shall be done with implements, tools, and facilities as recommended by the pipe manufacturer to insure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.
   2. Pipe shall be inspected both prior to and after installation in the trench and all defective lengths shall be rejected and immediately removed from the working area.
   3. Fittings shall be lowered into trench by means of rope, cable, chain, or other means without damage. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope, or other device be attached through the fitting interior for handling or shall pipe or fittings be dropped or dumped into the trench.

B. Storage: Pipe should be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 23 00 – Earthwork and the Drawings.

3.4 LAYING PIPE

A. Pipe sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointings, the bedding for the pipe shall be checked for firmness and uniformity of slope.

B. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, or any other method that may fracture the pipe or will produce ragged, uneven edges.

C. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

D. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the Work shall be the Contractor's responsibility.

E. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, protection of existing utility structures shall be the Contractor's responsibility.

3.5 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. A thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. Fittings shall be carefully connected to pipe, and joint shall be checked to insure a sound and proper joint.

D. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the Engineer, the trench conditions or weather are unsuitable.

3.6 SMALL DIAMETER LATERALS (SEWER LATERAL CONNECTIONS)

A. Laterals shall extend from the manhole, wye branch or similar fitting, as indicated in the Drawings. Wye fitting or other connection shall be positioned in the mainline such that it enters the mainline at an angle of at least 45 degrees from horizontal. Connections requiring a connection angle of less than 45 degrees shall be approved by the Engineer.

B. Install a 22.5 degree or 45 degree bend, or combination of bends, as required on the mainline wye to obtain the proper alignment and grade.

C. Lateral connections to manhole shall be made as directed in Section 33 05 16 – Precast Concrete Manholes and Vaults.

D. Laterals shall be installed along the indicated horizontal alignment with a uniform slope, free of low spots or adverse grades. Minimum slopes shall be 1/4 inch per foot for 4" diameter laterals and 1/8 inch per foot for 6" diameter laterals.

E. Cleanouts shall be installed on laterals at a horizontal spacing not to exceed 100 feet and at the locations indicated in the Drawings.

F. Any one bend (horizontal or vertical) shall not exceed 45 degrees and no more the two bends (horizontal or vertical) shall be installed without a cleanout.

G. Laterals shall be installed in accordance with all applicable requirements of the local plumbing codes.

3.7 INSTALLATION OF METALLIC LOCATING TAPE

A. Polyvinyl chloride pipelines shall be provided with a metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finished grade OR above top of pipe. The Contractor shall furnish manufacturer's literature, completely describing the tape proposed to be furnished. No tape shall be used prior to receipt of written approval of the Engineer.

3.8 TESTING

A. Field testing of gravity sewer pipe shall conform to the requirements of Section 33 08 00 – Gravity Piping Testing and Inspection.

END OF SECTION

SECTION 33 41 05
DUCTILE IRON PIPE (AWWA C151, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install ductile iron pipe and all appurtenant Work, complete in place, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE STANDARDS

A. Commercial Standards:

ANSI/AWWA C104/A21.4	Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile Iron Piping and Fittings for Water
ANSI/AWWA C110/A21.10	Ductile Iron and Gray Iron Fittings, 3-in. through 48-in. for Water and Other Liquids
ANSI/AWWA C111/A21.11	Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
ANSI/AWWA C115/A21.15	Flanged Ductile Iron and Gray-Iron Pipe with Threaded Flanges
ANSI/AWWA C150/A21.50	Thickness Design of Ductile Iron Pipe
ANSI/AWWA C151/A21.51	Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
ANSI/AWWA C153/A21.53	Ductile Iron Compact Fittings, 3-in. through 12-in. for Water and Other Liquids
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
ANSI/AWWA C600	Installation of Ductile Iron Water Mains and their Appurtenances
ASTM C150	Specification for Portland Cement

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements of Section 01 33 00 – Contractor Submittals, the requirements of the referenced standards and the following supplemental requirements as applicable and specified herein.
   1. Marking plan and details of standard pipe section showing dimensions, pipe joints, fitting and special fitting pressure rating and thickness, size, coating and lining data.
   2. Pipeline layout drawings showing the location of each pipe section, each special length, closure sections, location and angle of bends, outlets, location of valves, and other special fittings.

B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section, as specified in the referenced standards and the following supplemental requirements:
   1. Physical and chemical properties.
      a. Hydrostatic Test Reports

C. Sample Costs: All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture, in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Test: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

D. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Standards: Mortar-lined and polyethylene-wrapped ductile iron pipe shall conform to ANSI/AWWA C151, C104, and C105, subject to the following supplemental requirements.

The pipe shall be of the diameter and class shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all flanges, specials and fittings shall be provided as required under the Contract Documents.

B. Handling and Storage: The pipe shall be handled by devices acceptable to the Engineer, designed and constructed to prevent damage to the pipe coating/exterior. The use of equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be suitably supported and shall be secured to prevent accidental rolling. All other pipe handling equipment and methods shall be acceptable to the Engineer.

C. Laying Lengths: Maximum pipe laying lengths shall be 20 feet with shorter lengths provided as required by the Drawings.

D. Finish: The pipe shall have smooth and dense interior surfaces, and shall be free from fractures, excessive interior surface crazing, and roughness.

E. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Drawings. The locations of correction pieces and closure assemblies are shown on the Drawings. Any change in location or number of said items shall be acceptable to the Engineer.

F. Pipe shall be new and recently manufactured. Refurbished pipe shall not be provided.

2.2 PIPE DESIGN CRITERIA

A. General: Ductile iron pipe shall be designed in accordance with the requirements of ANSI/AWWA C150 as applicable and as modified in this Section.

B. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a net thickness to withstand the design pressure in accordance with the hoop stress formula.

C. Pipe Wall Thickness for External Load: The pipe shall also be designed with a net thickness to withstand internal loads using ANSI/AWWA C150 Design Equation (2) with the appropriate bending moment and deflection coefficients for Laying Condition Types 4 and 5 as applicable.

D. The pipe deflection shall be checked using ANSI/AWWA C150 Design Equation (3) and the coefficients stated above. The allowable deflection shall not exceed 0.0225 times the nominal diameter.

E. In lieu of ANSI/AWWA C150 Design Equation (4), the earth loads will be computed using the following two equations for trench or embankment loading as applicable:

1. Trench Condition:
   a. $W_d = C_d w B_d 2$,
   b. Where:
   c. W_d = Earth load in pounds per linear foot
   d. C_d = Calculation Coefficient
   e. Ku1 = 0.13
   f. w = 120 lb/ft3

g. B_d = Trench width at top of pipe, feet

2. Positive Projecting Embankment Condition:
   a. Wc = CcwBc2
   b. Where:
   c. Wc = Earth load in pounds per linear foot
   d. Cc = Calculation Coefficient (based on rsdP of 0.25)
   e. Ku1 = 0.13
   f. w = 120 lb/ft3
   g. Bc = Trench width at top of pipe, feet

F. The above two formulas are based on a depth of cover of 10 feet or greater. For depths of cover of less than 10 feet, HS-20 live load shall be included. For depths of cover of three feet or less, HS-20 live load plus impact shall be included. The determination of live load and impact factors shall be as recommend by AASHTO in "Standard Specifications for Highway Bridges."

G. If the calculated deflection, $Defl_x$, exceeds 0.0225 times the nominal diameter, the pipe class shall be increased.

H. Minimum Pipe Wall Thickness: In addition to the requirements of this Section, the minimum wall thickness shall be in accordance with Table 50.5 of ANSI/AWWA C150.

2.3 MATERIALS

A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C151.

B. Cement: Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104, provided that cement for mortar lining shall be Type V. A fly ash or pozzolan shall not be used as a cement replacement.

C. Polyethylene Sleeve: Material for the polyethylene sleeve shall conform to the requirements of ANSI/AWWA C105.

2.4 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10 for diameters 3-inch through 48-inch and shall have a minimum pressure rating of 250 psi. Ductile iron fittings larger than 48-inch shall conform to the above-referenced standard with the necessary modifications for the larger size.

2.5 DESIGN OF PIPE

A. General: The pipe furnished shall be ductile iron pipe, mortar-lined and polyethylene-wrapped with rubber-gasketed joints as shown.

B. Manufacturing Requirements: The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and, except as hereinafter modified, shall conform to ANSI/AWWA C151.

C. Pipe Dimensions**:** The pipe shall be of the diameter and class shown. The minimum wall thickness for each pipe size shall be as specified or shown.

D. Fitting Dimensions: The fittings shall be of the diameter and class shown.

E. Joint Design: Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, and restrained joints as required.
   1. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11.
   2. Restrained Joint:
      a. Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe without setscrews or devices with shoes or wedges activated by setscrews.
      b. The use of devices utilizing setscrews shall not be allowed. Primary permanent restraint for all buried pipe fittings shall be accomplished using concrete thrust blocks. Temporary fitting restraint for testing of pipelines can be accomplished using mechanical thrust restraint utilizing multiple gripping wedges incorporated into a follower gland meeting the requirements of ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21/53. Temporary (or secondary) fitting restraint shall be in addition to primary permanent restraint. Permanent restraint for straight-run pipe joints can be accomplished using manufacturer's proprietary joint (e.g. Tyton Lock with Sure Stop gasket, or equal) or with mechanical joint restraints (e.g. EBAA Iron Megalug, or equal) utilizing multiple gripping wedges incorporated into a follower gland meeting the requirements of ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21/53.
      c. Rated at minimum working pressure equal to or greater than that of the pipe class.
      d. The use of field-lock, gripper ring type restraining devices shall be limited to only locations where unforeseen field conditions or closure places require the pipe to be field fit, cut, and joined, and as approved by the Engineer. Where field locking, gripper ring type restraining devices are used, the gripper ring shall be installed a minimum of one full pipe length away from the fitting or closure. The installation of gripper ring type restraining devices where used shall be in strict accordance with the manufacturer's installation instructions.
      e. Field welding of ductile iron pipe and fitting shall not be allowed.
   3. Flanged joints shall conform to ANSI/AWWA C115/A21.15.

F. Joint Clearances: For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

G. Coating and Linings Held Back: Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as shown, or as otherwise acceptable to the Engineer.

2.6 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of all ductile iron pipe, fittings and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at the delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

B. Lining Thickness: The minimum lining thickness shall be as follows:

Nominal Pipe Diameter (in)	Minimum Lining Thickness (in)
3-12	1/8
14-24	3/16
30-54	1/4

C. Protection of Pipe Lining/Interior: All shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with ANSI/AWWA C104.

2.7 GLASS LINING

A. Pipe and fittings shall be glass lined where shown.

B. The glass lining shall be formulated for handling primarily sludge and scum. The formulation shall consist of special glasses and inorganic materials factory applied to chemically clean, gray iron. After application of the coating, the parts shall be placed in a specially designed furnace and brought up to temperature at which the glass melts and fuses to the base metal. Firing of the piece shall continue until fusion has completely taken place and the coating has an integral molecular bond with the metal.

C. The finished lining shall be from .008 to .012 inch thick. It shall have a hardness of from 5 to 6 mohs scale, and a density of from 2.5 to 3.0 grams per cubic centimeter as measured in accordance with ASTM D792. The glass shall be capable of withstanding thermal shock of 3560 degrees F without crazing, blistering, or spalling. There shall be no visible loss of surface gloss in the lining after immersion of a normal production run sample in an 8 percent sulfuric acid solution at 148 degrees F for a period of 10 minutes. In addition, when testing in accordance with ASTM C283, it shall show a weight loss of not more than 3 milligrams per square inch.

D. Factory assembled flanges on spool pieces shall be screwed on, unless otherwise specified. Bolt holes and flange faces shall be aligned before glassing. The pieces shall be sealed and tested prior to shipment.

E. The glass lining shall be in accordance with the manufacturer's standard tolerances for coverage, continuity, and gloss. Pinholes, crazing, or fishscales which substantially expose

the metal substrate shall be cause for rejection of the piece. Sizes, details, handling, stacking, etc. shall be in accordance with the manufacturer's recommendations.

F. Glass lining shall be Ferrock lining as manufactured by Ferro Enameling, Permutit SG-14 as manufactured by the Permutit Company, Bulwark Corporation, or approved equal.

2.8 EXTERIOR COATING OF PIPE

A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 09 90 00 – Protective Coatings and Linings.

B. Exterior Coating of Buried Piping: The exterior coating shall be an asphaltic coating approximately one mil thick.

2.9 SOURCE QUALITY CONTROL

A. Factory Tests: In accordance with AWWA C104, C105, C110, C111, C115, C150, C151, C153, and C606.

PART 3 - EXECUTION

3.1 GENERAL

A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.

B. Installation shall conform to the requirements of AWWA C600, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 INSTALLATION OF PIPE

A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner that will protect the pipe coating against injury whenever stored at the trench site or elsewhere. No pipe shall be installed where the lining or coating show defects that may be harmful as determined by the Engineer. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.

B. Damaged Pipe: All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

C. Contractor to Inspect Pipe: The Contractor shall inspect each pipe and fitting prior to installation to insure that there are no damaged portions of the pipe.

D. Trench excavation and backfill shall conform to the requirements of Section 31 23 00 – Earthwork. Care shall be taken to ensure that pipe zone material is compacted and in full contact with the haunches of the pipe and that the pipe is fully supported.

E. Clean Pipe: Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon, and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.
   1. Remove lumps, blisters, and excess asphaltic type coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.
   2. Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.

F. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600.
   1. Direction of Laying: Lay pipe with bell end facing in direction of laying. For lines on an appreciable slope, face bells upgrade at discretion of Engineer.
   2. Mechanical Joint, Push-On Joint, and Restrained Joint Pipe: After first length of pipe is installed in trench, secure pipe in place with approved backfill material tamped under and along sides to prevent movement. Keep ends clear of backfill. After each section is jointed, place backfill as specified to prevent movement. For restrained joint pipe and fittings, after each section is jointed and restraining devices are completely installed, fully extend the completed joint and place backfill as specified to prevent movement before installation of the next section of pipe or fitting.
   3. Take precautions necessary to prevent floating of pipe prior to completion of backfill operation.
   4. When using movable trench shield, take necessary precautions to prevent pipe joints from pulling apart when moving shield ahead.
   5. Do not allow foreign material to enter pipe while it is being placed in trench.
   6. Close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints when laying operations are not in progress, at close of day's work, or whenever workers are absent from job.

G. Joining Push-On Joint Pipe and Mechanical Joint Fittings:
   1. Join pipe with push-on joints and mechanical joint fittings in strict accordance with manufacturer's recommendations.
   2. Provide special tools and devices, such as, special jacks, chokers, and similar items required for installation.
   3. Lubricate pipe gaskets using lubricant furnished by pipe manufacturer. No substitutes will be permitted.
   4. Clean ends of fittings of dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush, after which, slip gland and gasket on plain end of pipe. If necessary, lubricate end of pipe to facilitate sliding gasket in place, then guide fitting onto spigot of pipe previously laid.

H. Founding Pipe: Pipe shall be laid directly on the Pipe Zone material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

I. Unforeseen Obstructions: Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum designed deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

J. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.

K. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

L. Pipe and Specials Protection: The openings of all pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

M. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying, pointing of joints and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

N. Cutting Pipe: General: Cut pipe for inserting closure pieces in a neat and workmanlike manner without damaging pipe or lining and so as to leave a smooth end, at right angles to axis of pipe.
   1. Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.
   2. Dressing Cut Ends: Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.

O. Field Welding:
   1. Field welding of ductile iron pipe shall not be allowed.
   2. Field welding of bars for restrained joint systems will not be allowed. All welding shall be performed in pipe manufacturer's shop.

P. Field Installed Outlets: Field outlets may be installed with a saddle; however, the maximum nominal diameter of outlet for saddle shall be 2-inch. Opening in pipe shall be machine cut. Flame cut openings shall not be allowed.

3.3 RUBBER GASKETED JOINTS

A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket, lubricated with an approved vegetable-based lubricant, shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.4 CORROSION PROTECTION

A. Polyethylene Encasement: Buried ductile iron pipe shall be polyethylene encased in accordance with the requirements of ANSI/AWWA C105/A21.5.
   1. Encase pipe, fittings, and valves in accordance with AWWA C105, Method A.
   2. Cut polyethylene tube approximately 2 feet longer than pipe length.
   3. Slip tube around pipe, centering to provide 1-foot overlap on each adjacent section.
   4. Pull encasement to take out slack and wrap snug around pipe.
   5. Secure overlap in place and fold at quarter points of pipe length.
   6. Wrap and tape encasement snug around fittings and valves.

3.5 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is tape-coated, buried appurtenances shall be coated with cold-applied tape in accordance with ANSI/AWWA C209, Type II. Where pipe is encased in polyethylene sleeves, buried appurtenances shall also be encased in polyethylene.

B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.

C. Valve Installation: All valves shall be installed so that the valve stems are plumb and in the location shown on the Drawings.

3.6 INSTALLATION OF METALLIC LOCATING TAPE

A. Buried pipelines shall be provided with a metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finished grade OR above top of pipe. The Contractor shall furnish manufacturer's literature, completely describing the tape proposed to be furnished. No tape shall be used prior to receipt of written approval of the Engineer.

3.7 FIELD TESTING AND DISINFECTION

A. Field testing shall conform to the requirements of Section 33 13 00 – Water Pipeline Testing and Disinfection as applicable.

END OF SECTION

DIVISION 40
PROCESS INTEGRATION

SECTION 40 05 00
PIPING, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, seismic restraints, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.

B. The piping shown is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/ASME B1.20.1	Pipe Threads, General Purpose (inch)
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
ANSI/AWWA C207	Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.
ANSI/AWWA C606	Grooved and Shouldered Joints
ANSI/AWS D1.1	Structural Welding Code
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile
ASTM A 325	Specification for High-Strength Bolts for Structural Steel Joints
ASTM D 792	Test Methods for Specific Gravity and Density of Plastics by Displacement
ASTM D 2000	Classification System for Rubber Products in Automotive Applications

1.3 CONTRACTOR SUBMITTALS

A. Submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in Section 01 33 00 – Submittal Procedures, and as indicated in the individual piping sections. The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports and seismic restraints necessary to accommodate the equipment and valves provided in a complete and functional system.

B. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

C. Submit as part of the shop drawings a statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

B. Tests: Except where otherwise indicated, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. Perform all tests at no additional cost to the Owner.

C. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing Work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. Furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

E. NSF/ANSI 61 for Drinking Water System Components: All materials that will contact potable water shall comply with the requirements of the NSF/ANSI 61 Standard.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain perfect pipe joints, supports, or special connections, furnish such assistance at no additional cost to the Owner.

1.6 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

1.7 CLEANUP

A. After completion of the Work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipes, fittings, and appurtenances shall be furnished in accordance with the requirements of the applicable Sections of Division 33 and this Section.

B. Miscellaneous Small Pipes: Miscellaneous small pipes and fittings shall be provided by the Contractor in accordance with the requirements of Section 40 05 10 - Mill Piping - Exposed and Buried and this Section.

C. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of Section 40 05 07 - Pipe Supports, and as indicated.

D. Lining: All requirements pertaining to thickness, applications, and curing of pipe lining, are in accordance with the requirements of the applicable Sections of Division 33, unless otherwise indicated.

E. Coating: All requirements pertaining to thickness, application, and curing of pipe coating, are in accordance with the requirements of the applicable Sections of Division 33, unless otherwise indicated. Pipes above ground or in structures shall be field-painted in accordance with Section 09 90 10 - Pipeline Coatings and Linings or 09 99 90 – Protective Coatings and Linings.

F. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined in Section 33 13 00 - Water Pipeline Testing and Disinfection, or as indicated on the piping schedule.

G. Grooved Piping Systems: Piping systems with grooved joints and fittings may be provided, if approved by the Engineer, in lieu of screwed, flanged, welded, or mechanical joint systems for steel and ductile iron yard piping above and below ground within the property limits of pump stations, and similar installations. All grooved couplings on buried piping must be bonded. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer. The Contractor shall make the coupling manufacturer responsible for the selection of the correct style of coupling and gasket for each individual location.

2.2 PIPE FLANGES

A. Flanges: Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 Class D or ANSI B16.5 150-pound class. Where the design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E, Class F, or ANSI B16.5 150-pound class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI B16.5 300-pound class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flanges for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.

B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.

C. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

D. Flange Bolts: Contractor shall supply all bolts and nuts in conformance with Section 05 50 00 – Metal Fabrications. Studs and bolts shall extend through the nuts a minimum of 1/4 inch. All-thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.

E. Insulating Flanges: Insulated flanges shall have bolt holes 1/4 inch diameter greater than the bolt diameter.

F. Insulating Flange Sets: Insulating flange sets shall be provided by the Contractor where shown. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2 inches or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be two-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A 325. Insulating gaskets shall be full-face.

G. Insulating Flange Manufacturers, or Equal
   1. JM Red Devil, Type E
   2. Maloney Pipeline Products Co., Houston
   3. PSI Products, Inc., Burbank, California.

H. Flange Gaskets: Contractor shall provide flange gaskets for all pipe flanges. Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of asbestos-free aramid fiber base, with nitrile binder and nonstick coating, suitable for temperatures to 700 degrees F, a pH of 1 to 11, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the

entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.

I. Flange Gasket Manufacturers, or Equal
   1. John Crane, Style 2160.
   2. Garlock, Style 3760

2.3 THREADED INSULATING CONNECTIONS

A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other nonconductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. Construction: Cast mechanical-type couplings shall be provided where shown. The couplings shall conform to the requirements of ANSI/AWWA C606. Bolts and nuts shall conform to the requirements of Section 05 50 00 – Metal Fabrications. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. The Contractor shall have the coupling Manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation.

B. Couplings for Steel Pipe, Manufacturers, or Equal
   1. Victaulic Style 44 with Type D Heavy Duty Grooved Adaptor Ends.

C. Ductile Iron Pipe Couplings, Manufacturers, or Equal
   1. Gustin-Bacon.
   2. Victaulic Style 31 (flexible or rigid grooving).
   3. Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

D. Couplings for PVC Pipe, Manufacturers, or Equal
   1. Gustin-Bacon.
   2. Victaulic Style 775.
   3. Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends. Grooved end couplings shall be used on PVC pipe only for Schedule 80 vent piping at the vaults. Grooved end couplings shall not be used for PVC C905 water pipe.

2.5 SLEEVE-TYPE COUPLINGS

A. Construction: Sleeve-type couplings shall be provided where indicated, in accordance with ANSI/AWWA C219 unless otherwise indicated, and shall be of steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings. The middle ring shall be not less than 1/4 inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05 50 00 – Metal Fabrications. Buried sleeve-type couplings shall be epoxy-coated at the factory.

B. Pipe Preparation: The ends of the pipe, where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64 inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer.
   1. The rubber in the gasket shall meet the following specifications:
      a. Color - Jet Black.
      b. Surface - Nonblooming.
      c. Durometer Hardness - 74 " 5.
      d. Tensile Strength - 1,000 psi Minimum.
      e. Elongation - 175 percent Minimum.
   2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be in accordance with the requirements of the appropriate reference standard, or as shown.

F. Manufacturers, or Equal
   1. Dresser, Style 38.
   2. Ford Meter Box Co., Inc., Style FC1 or FC3.
   3. Smith-Blair, Style 411.

4. Baker, Series 200

2.6 FLANGED END CONNECTORS

A. Flanged coupling adapters, shall be in accordance with AWWA C219.

B. Dismantling joints for connecting flanged pipe shall be AWWA C219 compliant. Provide studs and nuts to seal gasket separate and independent from tie-bar restraint system.

C. All dismantling joints shall be the restrained type per AWWA M-11. Tie-bar restraint system shall conform to ASTM A193-B7 per AWWA M-11 and be designed to withstand the test pressure shown on the Drawings.

D. All dismantling joints shall use standard flanges in accordance with AWWA C207. The thickness of the dismantling joint flanges shall be equal to or greater than the class of flange that is connected to as required by the test pressure as shown on the drawings. Buried flanges shall be wrapped with petroleum was tape per AWWA C217.

E. Manufacturers, or Equal
1. Smith-Blair, Style 972 or 975
2. Baker, Series DJ

2.7 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where shown. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise shown. The connectors shall be 9 inches long, face-to-face flanges, unless otherwise shown. The final material selection shall be approved by the manufacturer. Submit manufacturer's shop drawings and calculations.

2.8 EXPANSION JOINTS

A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement, without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. Submit detailed calculations and manufacturer's shop drawings, guaranteeing satisfactory performance of all proposed expansion joints, piping layouts showing all anchors and guides, and information on materials, temperature and pressure ratings.

2.9 PIPE THREADS

A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1.

2.10 AIR AND GAS TRAPS

A. Air and gas pipes shall be sloping to low points, provided with drip legs, shutoff valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-pound iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

B. Manufacturers, or Equal
   1. Armstrong Machine Works.
   2. Spirax Sarco, Inc.

PART 3 - EXECUTION

3.1 GENERAL

A. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Division 33. The lining manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints at screwed flanges shall be epoxy-coated, to assure continuous protection.

B. Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.

C. Flanges shall be installed at least 6-inches from a wall. Fittings shall be installed with sufficient clearance for maintenance and removal and reinstallation.

3.2 FIELD TESTING

A. All piping shall be tested in accordance with applicable standards and the contract documents.

END OF SECTION

SECTION 40 05 07
PIPE SUPPORTS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide pipe supports, seismic restraints, hangers, guides, and anchors, complete, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Shop drawings shall include the following information:
   1. Drawings of pipe supports, restraints, hangers, anchors, and guides.
   2. Calculations for special supports and anchors.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Code Compliance: Piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. Supports and parts thereof shall conform to the requirements of ASME B31.1 – Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members: Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided at no additional cost to the Owner. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction and shall be acceptable to the Engineer.

C. Pipe Hangers: Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. Hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. Hanger rods shall be subject to tensile loading only.

D. Hangers Subject to Horizontal Movements: At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger

rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Spring-Type Hangers: Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. Spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least four times the maximum travel due to thermal expansion.

F. Thermal Expansion: Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. Components shall be structurally suitable to withstand loads imposed.

G. Heat Transmission: Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.

H. Riser Supports: Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. Freestanding Piping: Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.

J. Materials of Construction:
   1. General: Pipe support assemblies, including framing, hardware, and anchors, shall be steel construction, galvanized after fabrication, unless otherwise indicated.
   2. Submerged Supports: Submerged piping, as well as piping, conduits, and equipment in hydraulic structures within 24 inches of the water level, shall be supported with support, assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated.
   3. Corrosive: Piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

K. Point Loads: Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

L. Noise Reduction: To reduce transmission of noise in piping systems, copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.

2.2 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Schedule 40 and Schedule 80 Steel Pipe

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1 - 1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Welded Fabricated Steel Pipe

Maximum Spans for Pipe Supported in Minimum **120 degree** contact saddles (feet)

Nominal Pipe Diameter (inches)	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
24	33	37	41	43	45	47				
26	34	38	41	44	46	48				
28	34	38	41	44	47	49				
30	34	38	42	45	48	49				
32	34	39	42	45	48	50				
34	35	39	42	46	48	50				
36	35	39	43	46	49	51	55			
38	35	39	43	46	49	51	55			
40	35	40	43	47	49	52	56			
42	--	40	43	47	50	52	56			
45	--	40	44	47	50	53	57			
48	--	40	44	47	50	53	58	61		
51	--	41	44	48	51	53	58	62		
54	--	41	44	48	51	54	58	62		
57	--	41	44	48	51	54	59	63		
60	--	41	45	48	52	54	59	63	67	70
63	--	41	45	49	52	55	60	64	67	71
66	--	41	45	49	52	55	60	64	68	71
72	--	41	45	49	52	55	61	65	69	72

78	--	41	45	49	53	56	61	66	69	73
84	--	41	46	50	53	56	62	66	70	74
90	--	41	46	50	53	56	62	67	71	74
96	--	42	46	50	54	57	62	67	71	75

3. For steel pipe sizes not presented in this table, the support spacing shall be designed so that the stress on the pipe does not exceed 5,000 psi. Maximum deflection of pipe shall be limited to 1/360th of the span and shall be calculated by using the formula:

$$L = \sqrt{\frac{7500tD}{32t + D}}$$

Where: t = Thickness (inches)
D = Diameter (inches)
L = Maximum span (feet)

4. Support Spacing for Ductile-Iron Pipe:

Normal Pipe Diameter (inches)	Maximum Span (feet)
All diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

5. Support Spacing for Copper Tubing:

Normal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1 - 1/2	6
2 to 4	10
6 and greater	12

6. Support Spacing for Schedule 80 PVC Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	4
3/4	4.5
1	5
1 - 1/4	5.5
1 - 1/2	5.75
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

7. Support Spacing for Schedule 80 Polypropylene Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	3
3/4	3.5
1	3.75
1 - 1/4	4
1 - 1/2	4.25
2	4.5
3	5.5
4	6
6	7.25
8	8
10	8.75
12	9.5

8. Support Spacing for Fiberglass Reinforced Plastic (FRP) Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
2	8.8
3	10
4	11
6	12.7
8	13.4
10	14
12	15.4
14	16.2
16	17.3
16 and Greater	18

2.3 MANUFACTURED SUPPORTS

A. Stock Parts: Where not specifically indicated, designs which are generally accepted as exemplifying good engineering practice and use stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

B. Manufacturers, or Equal
1. Basic Engineers Inc., Pittsburgh, PA.
2. Bergen-Paterson Pipesupport Corp., Woburn, MA.
3. Grinnell Corp. (Supply Sales Company), Cranston, RI
4. NPS Products, Inc., Westborough, MA.
5. Power Piping Company, Pittsburgh, PA.

2.4 COATING

A. Galvanizing: Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. Other Coatings: Other than stainless steel or non-ferrous supports, all supports shall receive protective coatings in accordance with the requirements of Section 09 90 00 - Protective Coatings and Linings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Pipe supports, seismic restraints, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ASME B31.1 - Power Piping. Concrete inserts for pipe hangers and supports shall be coordinated with the form work.

B. Appearance: Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. Hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.

3.2 FABRICATION

A. Quality Control: Pipe hangers, supports, and seismic restraints shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

END OF SECTION

SECTION 40 05 10
MILL PIPING – EXPOSED AND BURIED

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install all exposed and buried mill piping (pipe diameter 6 inches and less) as shown and in accordance with Contract Documents. This section applies to all mechanical Work and associated piping systems. Work related specifically to plumbing piping systems shall be performed in accordance with Section 22 00 00 – Plumbing.

B. All work shall be in strict accordance with the International Plumbing Code, and codes of the State of Utah, City of Riverton, and any other authorities having jurisdiction. The Contractor shall have required certifications and be thoroughly familiar with the local codes. The Contractor shall obtain and pay for all necessary permits.

C. This section outlines requirements the following small (pipe diameter 6 inches and less) mechanical piping and associated accessories:
1. Small steel pipe
2. Solvent welded PVC pipe and Valves
3. CPVC pipe and Valves
4. PVDF pipe

D. The Contractor shall furnish hoses, hose racks and signage where indicated on the Drawings and as indicated herein.

1.2 REFERENCE STANDARDS

A. Commercial Standards

ANSI/ASME B16.3	Malleable Iron Threaded Fittings
ANSI/ASME B16.4	Gray Iron Threaded Fittings,
ASMEB16.5	Pipe Flanges and Flanged Fittings,
ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ANSI B16.12	Cast-Iron Threaded Drainage Fittings
ANSI/ASME B16.15	Cast Bronze Threaded Fittings, Classes 125 and 250
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASTM A 53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 74	Specification for Cast Iron Soil Pipe and Fittings
ASTM A 105	Specification for Carbon Steel, Forgings for Piping Applications
ASTM A 106	Specification for Seamless Carbon Steel Pipe for High Temperature Service
ASTM A 312	Specification for Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A 518	Specification for Corrosion-Resistant High-Silicon Iron Castings
ASTM B 43	Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B 62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B 88	Specifications for Seamless Copper Water Tube
ASTM C 599	Specification for Conical Process Glass Pipe and Fittings.
ASTM D 1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2996	Specification for Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D 3222	Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding, Extrusion, and Coating Materials
ASTM D 4101	Specification for Propylene Plastic Injection and Extrusion Materials
ASTM F 441	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

B. Chlorine Institute Pamphlet 6 Piping Systems for Dry Chlorine

1.3 CONTRACTOR SUBMITTALS

A. For the materials and equipment items supplied under the provisions of this Section, submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01 33 00 - Contractor Submittals.

B. Product information for all valves shall be submitted in accordance with Section 40 05 51 – Valves, General.

PART 2 - PRODUCTS

2.1 SMALL STEEL PIPE (SYSTEMS 1, 2, 3 AND 6)

A. Unless otherwise indicated, galvanized steel pipe and black steel pipe in sizes 6 inches in diameter and smaller shall conform to the requirements of ASTM A 53 or ASTM A 106, as called out in the piping schedule and shall be Schedule 40 or 80 as indicated. Galvanized steel pipe shall not be cement mortar lined unless otherwise indicated. Fittings for galvanized steel pipe shall be of galvanized malleable iron, with NPT or grooved ends. Black pipe may have welded joints, with standard or extra strong welding fittings, or fittings indicated. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1. Unions shall be as manufactured by Henry Valve Company; Vogt Valve Co.; or equal.
5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.2 COPPER TUBING (SYSTEM 24)

A. Hard Copper Tube and Fittings: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
5. Copper Pressure-Seal-Joint Fittings:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Elkhart Products Corporation; Industrial Division; NIBCO INC.; Viega; Plumbing and Heating Systems.
    b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
    c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
6. Copper Push-on-Joint Fittings:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) NVent LLC.
    b. Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.

B. Soft Copper Tube and Fittings: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
   1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   2. Copper Pressure-Seal-Joint Fittings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Elkhart Products Corporation; Industrial Division; NIBCO INC.; Viega; Plumbing and Heating Systems.
      b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      c. NPS 3 and NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.3 CPVC (CHLORINATED POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED (SYSTEM 17)

A. CPVC system and components shall conform to the requirements of Section 33 05 19 – Pressure Piping Tied Joint Restraint System.

B. Solvent Cements for Joining CPVC Piping and Tubing shall conform to ASTM F 493 and the requirements of Section 33 05 19 – Pressure Piping Tied Joint Restraint System.

C. CPVC Ball Valves shall conform to Section 40 05 63 – Ball Valves.

D. CPVC Ball-Check and Swing-Check Valves shall comply with Section 40 05 65 – Valves for Pump Control and Check Service.

2.4 HOSE BIBBS AND HYDRANTS

A. All hose bibbs and hydrants in exposed locations subject to freezing shall be the non-freeze type. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless-steel warning signs "DO NOT DRINK," in clearly legible letters, and permanently attached at the hose bibb. Hose bibbs shall be provided with vacuum breakers as furnished by Crane Co., American Standard, or equal.

B. Manufacturers, or Equal:

Dwg. Callout	Fixture Type	Description
HB-1	Non-freeze Post-type	Exposed bronze hydrant, post-type, depth of bury to suit local conditions; minimum 4 feet. 1. Woodward Mfg. Co., Model Iowa Y1
HB-2	Non-freeze wall-type	Heavy duty bronze hydrant with nickel-bronze face, hinged cover, recessed box, and key. Length to suit wall. 1. Josam Mfg. Co., Series 71000 2. Jay R. Smith Mfg. Co., Fig. 5510/5511 3. Zurn Industries, Inc., Fig. Z-1300

HB-3	Hose valves	Heavy duty bronze hydrant, with composition disc, handwheel, cap and chain. Sizes 1 1/2-inch and 2 1/2 inch: 1. Fire-End and Croker Corp, Model 180 2. James Jones (Watts Regulator Co., Nos. J-383 and J-344, respectively Size 1-inch, without cap and chain: 1. Apollo (Conbraco Industries, Inc.), Model 70-805 2. Fire-End and Croker Corp, Model 180 Size 3/4-inch, without cap and chain: 1. Apollo (Conbraco Industries, Inc.) Model 70-804, or 78-104 2. Chicago Faucet No.7T 3. Ford Meter Box Co., Model B8H-233HB2 4. Woodford Manufacturing Co., Model Y24 or 24P
HB-4	Wall box type	Recessed, with nickel-bronze box, hinged cover, and key. 1. Josam Mfg. Co., Series 71020 2. Jay R. Smith Mfg. Co., Series 5710 3. Zurn Industries, Inc., Fig. Z-1345

2.5 SHOCK ABSORBERS

A. Install shock absorbers in accordance with Section 22 00 00 – Plumbing.

2.6 ACCESS DOORS AND COVERS

A. Install access doors and covers in accordance with Section 22 00 00 – Plumbing.

2.7 WALL-MOUNTED HOSE RACKS

A. The Contractor shall provide wall-mounted hose racks at locations indicated. Racks shall be all welded steel construction, of minimum 8-gage sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100 feet of 3/4-inch or 1-1/2-inch hose. Where racks are located in the open, they shall be supported from two 2- by 2- by 1/4-inch galvanized steel angle posts set in a concrete base or as indicated.

2.8 HOSES AND NOZZLES

A. The Contractor shall furnish the following lengths of hose:
   1. 1 - 50 ft lengths of 3/4-inch diameter hose
   2. 1 - 75 ft lengths of 1-inch diameter hose

B. Each length of hose shall be provided with male and female connectors and nozzle. Hoses shall be seamless extruded rubber with dacron cotton exterior designed for a working pressure of at least 200 psi.

C. Nozzles shall be capable of complete shut-off and shall produce a solid straight stream and up to a 90-degree conical fog. Nozzle material shall be polished brass. Nozzles shall have rubber bumpers.

D. Nozzle Manufacturers, or Equal:
   1. W.D. Allen Mfg. Co., Illinois
   2. Fire-End and Crocker Corp., New York
   3. Halprin Supply Co., Illinois
   4. Western Fire Equipment Co., California

2.9 GASKETS AND BOLTS

A. Except as otherwise indicated, gaskets for flanged joints shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

B. Except as otherwise indicated, bolts shall conform to the requirements of Section 05 50 00 – Metal Fabrications.

2.10 INSULATING CONNECTIONS

A. Insulating bushings, unions, couplings or flanges, as appropriate, shall be used for joining pipes of dissimilar metals, and for piping systems where corrosion control and cathodic protection are involved, in accordance with the requirements of Section 22 00 00 –Plumbing Piping and Fittings.

2.11 PIPE INSULATION

A. Hot and cold liquid piping shall be installed in accordance with Section 22 00 00 – Plumbing.

2.12 PIPE SUPPORTS

A. Pipe Supports, hangers, anchors, seismic restraints, and guides shall be in accordance with the requirements of Section 40 05 07 - Pipe Supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Small Steel Pipe: Buried galvanized or black steel pipe shall be coated as specified in Section 09 90 00 – Protective Coatings and Linings or provided with an extruded high density polyethylene coating with minimum thickness of 35 mils.

B. Plastic Pipe: PVC, CPVC, and FRP pipe joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F, unless otherwise indicated. Care shall

be taken to provide sufficient supports, anchors, and guides, to avoid stress on the piping. Obtain the services of the pipe manufacturer, to instruct the pipe fitters in the correct way of making solvent welded and threaded joints. Only clean, fresh primer and solvent shall be used at all times at the recommended temperatures.

C. Drain Traps: Drain traps shall be installed at low points in air and gas lines or elsewhere where indicated. Liquid outlets shall be piped to the nearest floor drain or open sump.

D. Couplings: Pipe couplings shall be installed in strict accordance with the manufacturer's printed recommendations, using the correct style coupling and gasket for any given application.

E. Gaskets for Flanged Joints: Gaskets shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

F. Insulating Connections: All insulating connections shall be installed in accordance with manufacturer's printed instructions. Care shall be exercised to prevent damage to insulating fittings, while making up the joints.

3.2 CONTINUITY BONDS

A. Where required by the Contract Documents, all metallic pipe joints, except field-welded joints and insulating joints, shall be continuity bonded in accordance with the requirements of Section 40 05 00 - Piping, General.

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SECTION 40 05 50
MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51.

PART 2 - PRODUCTS

2.1 AIR-VACUUM AND AIR-RELEASE VALVES

A. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.

B. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.

C. Combination Air Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.

D. Manufacturers
   1. APCO (Valve and Primer Corporation)
   2. Crispin - Multiplex Manufacturing Company
   3. GA Industries
   4. Val-Matic (Valve and Manufacturing Corporation)
   5. Engineer approved equal.

2.2 AIR AND VACUUM VALVES FOR VERTICAL TURBINE AND SUBMERSIBLE TURBINE PUMPS

A. An air and vacuum valve for the vertical turbine pump shall be installed on the pump discharge pipe indicated. The valve shall vent large quantities of air out through the orifice when pump starts, close tight when liquid enters, and permit large quantities of air to re-enter through orifice when pump stops, to prevent vacuum forming in the pump column. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. The discharge orifice shall be fitted with a double-acting throttling device to regulate and restrict air venting, which shall establish a pressure loading on the rising column of water and eliminate damaging shock to the pump, controls, and valves during pump start. On pump stop, a double-acting throttling device shall automatically open, allowing full line unrestricted air re-entry to prevent any vacuum from forming in the pump column. The valve shall be designed for minimum 150 psig water-working pressure.

B. Manufacturer
1. APCO (Valve and Primer Corporation)
2. Val-Matic (Valve and Manufacturing Corporation)
3. Engineer approved equal.

2.3 VACUUM RELIEF/AIR INLET VALVE FOR SURGE TANK

A. A vacuum relief/air inlet valve shall be installed on the surge tank. The vacuum relief/air inlet valve shall be normally closed, capable of admitting large quantities of air into the system immediately should the system pressure become negative and preventing a vacuum from forming during draining, pipeline rupture, or water column separation. The valve shall be of the size indicated, with flanged ends to match piping connections. Bodies shall be of high-strength cast iron with a steel hood. The float, seat, spring, and moving parts shall be constructed of Type 316 stainless steel. The internal valve-plug and seat shall be heavy cast brass. The plug shall be normally closed by means of a stainless steel spring and shall open when a vacuum/pressure differential exceeds 0.25 psig or less. Seat seal shall be of Buna-N providing a drip-tight seal. Valves shall be designed for minimum 150 psig water-working pressure, unless otherwise indicated.

B. Manufacturers
1. APCO (Valve and Primer Corporation)
2. Val-Matic (Valve and Manufacturing Corporation)
3. Engineer approved equal.

2.4 BACKFLOW PREVENTER VALVES

A. General: Backflow preventers shall work on the reduced pressure principle. They shall consist of 2 spring-loaded check valves, automatic differential pressure relief valve, drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 psi, with bronze or stainless steel trim. Drain lines with air gaps shall be provided. The backflow preventer valves shall be in accordance with AWWA C511 standard.

B. The number and sizes of backflow preventors required are given on the Contract Drawing P&IDs.

C. Manufacturers
1. Cla-Val Company
2. Febco (CMB Industries)
3. Hersey Products
4. Watts, ACV
5. Wilkins Regulator Division (Zurn Industries)
6. Engineer approved equal.

2.5 CORPORATION STOPS

A. Unless otherwise indicated, corporation stops shall be made of solid brass for key operation, with screwed ends with corporation thread or iron pipe thread, as required. Note that corporation stops on special chemical diffuser ports shall be 316 stainless steel – unless indicated otherwise.

B. Manufacturer
1. Ford Meter Box Company, Inc.
2. James Jones Company (Watts, ACV)
3. Mueller Company
4. Engineer approved equal.

2.6 MUD VALVES

A. Mud valves shall be flanged, non-rising stem type, with threaded stem, seat ring, and gate ring of bronze. Valves shall be provided with coupling nut, extension stem, stem guides, and operating stand, and wheel or wrench nut as indicated. Mud valve shall be installed with valve seats level.

B. Manufacturers
1. Clow
2. Mueller
3. Engineer approved equal.

2.7 PRESSURE RELIEF VALVES FOR TANKS

A. Materials:
1. Cover: Ductile iron, bronze, or Stainless Steel.
2. Body and strainer: Ductile iron or Stainless Steel.
3. Seal ring: Neoprene rubber

B. Size
1. Valve Body: Minimum 4-inch diameter, length sufficient to penetrate the granular material under the slab by at least 2 inches.

C. Manufacturers
1. Neenah Foundry; R-5000, Type C
2. Penn-Troy Manufacturing, Inc.; Troy Valve

3. Trumbull Industries, Inc.
4. Engineer approved equal.

2.8 SOLENOID VALVES

A. Solenoid valves shall be of the size, type, and class indicated and shall be designed for not less than 150 psi water-working pressure. Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon or other resilient seals with material best suited for the temperature and fluid handled. Unless otherwise indicated, for chemicals and corrosive fluids, solenoid valves with PVC, polyvinylidene fluoride (PVDF), or Teflon (PTFE) materials of construction, suitable for the specific application shall be provided. Enclosures shall be NEMA rated in accordance with the area designations of Section 26 00 00 – Electrical General Provisions. Coil ratings shall be for continuous duty. For electrical characteristics see the electrical Drawings or Specifications.

B. Manufacturers
1. For general duty
   a. Automatic Switch Co. (ASCO), Model RED HAT
   b. Skinner Valve (Parker Hannifin Corporation)
   c. Magnatrol Valve Corporation
   d. J. D. Gould Co.
   e. Engineer approved equal.
2. Metallic valves for corrosive fluids
   a. Valcor Engineering Corporation
   b. Engineer approved equal.
3. Plastic valves for corrosive fluids
   a. +GF+ Plastic Systems, Inc.
   b. Spears Mfg. Co.
   c. Engineer approved equal.

2.9 FLANGED PRESSURE RELIEF VALVES, SIZES 1-1/2 INCHES THROUGH 42 INCHES

A. Valve Characteristics: The pressure relief valve shall open when the inlet pressure exceeds a set maximum level. It shall maintain that level and gradually close as the inlet pressure drops below the maximum pressure. The valve shall be a hydraulically operated, adjustable, pilot controlled, diaphragm type globe or angle valve as indicated. All necessary repairs shall be possible without removing the valve from the pipeline.

B. Valve Body: The valve body shall be of cast iron, ASTM A 48 – Gray Iron Castings, or ASTM A 126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 125 lb or 250 lb flanged ends to ANSI/ASME B 16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or the body shall be of ductile iron to ASTM A 536 – Ductile Iron Castings, with 150 lb or 300 lb flanged ends to ANSI/ASME B 16.42 - Ductile Iron Pipe Flanges and Flanged Fittings. The valve cover shall be flanged and be of the same material as the body. Contractor is to select the appropriate valve pressure class as listed in the valve schedule and as recommended by the valve manufacturer to provide suitable operating service.

C. Valve Trim: The valve stems, springs, body seat rings, and all bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom guides.

All rubber parts shall be of Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover. The valve pistons and piston liners shall be bronze to ASTM B 62- Composition Bronze or Ounce Metal Castings.

D. Valve Controls: The valve shall be furnished with a complete, externally mounted control system, including adjustable speed control needle valves, strainer, and all necessary [copper or stainless steel] connecting tubing and fittings. The controls shall be capable of achieving all the flow and speed adjustment indicated.

E. Features: Where indicated in the Drawings, the relief valves shall be equipped with a limit switch to remotely detect valve position.

F. Factory Tests and Warranty: Valves shall be factory tested with a hydrostatic test and a functional test and a test certificate shall be submitted to the Engineer prior to delivery of valves. Valves shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

G. Spare Parts: The following spare parts shall be furnished in accordance with Section 40 05 51 (for each valve size):
   1. 1 set of all resilient seals, and discs
   2. 1 diaphragm (for diaphragm valves, only)

H. Manufacturers
   1. Singer Valve, Inc.
   2. Cla-Val Company
   3. Watts, ACV.
   4. Engineer approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Backflow preventers shall be installed in utility water lines where required by applicable codes or regulations, and where indicated on Contract Drawings.

B. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with Section 40 05 51.

C. Backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

END OF SECTION

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SECTION 40 05 51
VALVES, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11 00 00 - Equipment General Provisions, apply to the Work of this Section.

C. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.

D. Where a valve is to be supported by means other than the piping to which it is attached, the Contractor shall obtain from the valve manufacturer a design for support and foundation that satisfies the criteria in Section 11 00 00. The design, including drawings and calculations sealed by an engineer, shall be submitted with the Shop Drawings. When the design is approved, the support shall be provided.

E. Unit Responsibility: A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.

F. Single Manufacturer: Where two or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals

B. Shop Drawings: Shop Drawings shall contain the following information:
   1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.
   2. Complete information on valve actuator, including size, manufacturer, model number, limit switches, and mounting.
   3. Cavitation limits for control valves.
   4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.
   5. Data in accordance with Section 26 20 00 – Low-Voltage Induction Motors for electric motor-actuated valves.
   6. Complete wiring diagrams and control system schematics.
   7. Valve Labeling: A schedule of valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

C. Technical Manual: The Technical Manual shall contain the required information for each valve.

D. Spare Parts List: A Spare Parts List shall contain the required information for each valve assembly, where indicated.

E. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. General: Valves and gates shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Gate valves 18-inches and larger or where chain wheel is required, shall be furnished with spur gear and hand wheel. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.

B. Valve Actuators: Unless otherwise indicated, valve actuators shall be in accordance with Section 40 05 52 - Valve and Gate Actuators.

C. Protective Coating: The exterior surfaces of all valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated in accordance with Section 09 90 00 – Protective Coatings and Linings. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.

D. Valve Labeling: Except when such requirement is waived by the construction manager in writing, a label shall be provided on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2-inches by 4-inches in size and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the construction manager.

E. Valve Testing: As a minimum, unless otherwise indicated or recommended by the reference Standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:

1. Hydrostatic Testing: Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valves rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.
2. Seat Testing: Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The

duration of test shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.

3. Performance Testing: Valves shall be shop operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.

F. Certification: Prior to shipment, the Contractor shall submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

G. Valve Marking: Valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. General: Materials shall be suitable for the intended application. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:

1. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
3. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.
4. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications.
5. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.
6. PVC: Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.
7. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.
8. NSF Standard 14: Materials shall be listed for use in contact with potable water.

2.3 VALVE CONSTRUCTION

A. Bodies: Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.

B. Valve End Connections: Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.

C. Bonnets: Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.

D. Stems: Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Bronze valve stems shall conform to ASTM B 584, except that zinc content shall not exceed 16 percent.

E. Stem Guides: Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 304 stainless steel.

F. Internal Parts: Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.

G. Nuts and Bolts: Nuts and bolts on valve flanges and supports shall be in accordance with Section 05 50 00 – Metal Fabrications.

2.4 VALVE ACCESSORIES

A. Valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

A. The Contractor shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the Owner, after expiration of the correction of defects period.

2.6 MANUFACTURERS

A. Manufacturer's Qualifications: Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the valves indicated.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. General: Valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as indicated. Gates

shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.

B. Access: Valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.

C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are indicated, the Contractor shall properly assemble and install such items so that systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop Drawing submittals.

END OF SECTION

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SECTION 40 05 52
VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the Contractor shall be responsible to the Owner for compliance of the valves, gates, and actuators with the Contract Documents.

D. Single Manufacturer: Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Section 26 00 00 - Electrical General Provisions apply to the Work of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals and Section 40 05 51 - Valves, General.

B. Shop Drawings: Shop Drawing information for actuators shall be submitted together with the valve and gate submittals as a complete package.

C. Calculations: Selection calculations showing dynamic seating and unseating torques versus output torque of actuator.

D. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, butterfly valve manual actuators, and butterfly valve electric motor actuators under one cover and in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, shut-off and throttling valves and externally actuated valves and gates shall be provided with manual or power actuators. The Contractor shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall have the torque ratings equal to or greater than required for valve seating and dynamic torques,

whichever is greater, and shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves. Wires of motor-driven actuators shall be identified by unique numbers.

B. Manufacturers: Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are furnished by different manufacturers, the Contractor shall coordinate selection to have the fewest number of manufacturers possible.

C. Materials: Actuators shall be current models of the best commercial quality materials and be liberally-sized for the required torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.

D. Actuator Mounting and Position Indicators: Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48- and 60-inches above the floor or the permanent working platform.

E. Standard: Unless otherwise indicated and where applicable, actuators shall be in accordance with AWWA C 540 - Power-Actuating Devices for Valves and Slide Gates.

F. Functionality: Electric, pneumatic, and hydraulic actuators shall be coordinated with the power requirements of Division 26 and instrumentation equipment.

G. Fasteners: Fasteners shall be in accordance with Section 05 50 00 - Miscellaneous Metalwork.

H. Protective Coatings: Protective coatings shall be in accordance with Section 09 90 00 – Protective Coatings and Linings.

2.2 MANUAL ACTUATORS

A. General: Unless otherwise indicated, valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4-inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. Buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psi, valves 30-inches in diameter and larger, and where so indicated, shall have worm gear actuators, hermetically-sealed water-tight and grease-packed. Other valves 6-inches to 24-inches in diameter may have traveling nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves: Unless otherwise indicated, buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as required by the local

Utility Company or the Engineer. Wrench nuts shall comply with AWWA C 500 - Metal - Seated Gate Valves for Water Supply Service.

C. Chain Actuator: Manually-activated valves with the stem located more than 7-feet above the floor or operating level shall be provided with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains provided by the valve manufacturer. The wheel and guide shall be of ductile iron, cast iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5-feet 6-inches above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.

D. Floor Stands: Valve actuator floor stands shall be cast iron or fabricated steel pedestals. The centerline of the actuator shall be approximately 42 to 48 inches above the base of the pedestal.

E. Floor Boxes: Hot dip galvanized cast iron or steel floor boxes and covers to fit the slab thickness shall be provided for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

F. Tee Wrenches: Buried valves with floor boxes shall be furnished with 2 operating keys or 1 key per 10 valves, whichever is greater. Tee wrenches sized so that the tee handle will be 2 to 4 feet above ground, shall fit the operating nuts.

G. Manual Worm Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90 degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears or worm gearing. The gear ratio shall be self-locking to prevent "back-driving." The spur or helical gears shall be of hardened alloy steel and the worm gear shall be alloy bronze. The worm gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. Gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Output shaft end shall be provided with spline to allow adjustable alignment. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. Gearing shall be designed for a 100 percent overload. The entire gear assembly shall be sealed weatherproof. Manual worm gear actuators shall be Auma GS Series, Limitorque HBC Series, no “Or-Equals”.

H. Traveling-Nut Actuator: The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weatherproof cast iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of nipples. Gearing shall be designed for a 100 percent overload.

I. Schedule for Manual Actuator Types: For a complete schedule of manual actuators required on project valves (4” diameter and larger), see Contract Drawing GM-10 and GM-11.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adapter piece.
2. Gearing: The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm gearing. The spur or helical gears shall be of hardened alloy steel, and the worm gear shall be alloy bronze. Gearing shall be accurately cut with hobbing machines. Power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.
3. Starting Device: Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.
4. Switches
    a. Electronic Type Switches: Limit switches or valve position shall be sensed by a 15 bit, optical, absolute position encoder. The open and closed positions shall be stored in a permanent, non-volatile memory. The encoder shall measure valve position continuously, including both motor and hand wheel operation, with or without use of battery. An electronic torque sensor shall be furnished. The torque limit may be adjusted from 40 to 100 percent of rating in 1 percent increments. The motor shall be de-energized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating, and a “jammed valve” protection feature with automatic retry sequence shall be incorporated to de-energize the motor if no movement occurs. Valve actuators with electronic type switches shall be as manufactured by Limitorque or Auma Actuators, Inc.
    b. The actuator shall be wired in accordance with the schematic diagram. Wiring for external connections shall be connected to marked terminals. One of 1-inch and one of 1.25-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Switches shall not be subject to breakage or slippages due to over-travel. Traveling-nuts, cams, or micro switch tripping mechanisms shall not be used. Limit switches shall be of the heavy-duty open contact type with rotary wiping action.
5. Handwheel Operation: A permanently attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb.ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel. A clutch lever shall be provided to put actuator into handwheel operation. Valves with electric motor actuators having stems more than

7-feet above the floor shall be provided with chain activator handwheels. The clutch lever shall be provided with a cable secured to the chain to allow disengagement for manual operation.

6. Motor: The motor shall be of the totally enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 480 volt, 3-phase 60 Hz current, and have Class F insulation and a motor frame with dimensions in accordance with the latest revised NEMA MG Standards. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. Bearings shall be of the ball type, and thrust bearings shall be provided where necessary. Bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. . Two Class B thermal contacts or solid state thermistors imbedded within the motor windings shall be provided to protect against over-temperature damage. The motor shall be provided with a space heater suitable for operation on 120 volt, single phase, 60 Hz circuit unless the entire actuator is a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion. Each electric motor actuator shall be provided with a local disconnect switch or circuit breaker to isolate power from the motor and controller during maintenance activities.
7. Open/Close Operating Speed: Unless otherwise indicated, electric actuators shall provide a full close to full open or full open to full close operating time range from [30 to 60 seconds].
8. Schedule for Electric AC Actuator Type: For a complete schedule of electric actuators required on project valves (4" diameter and larger), see Contract Drawing GM-10 and GM-11.
    a. All electric actuators identified as "OPEN/CLOSE ELECTRIC" on GM-10 and GM-11, shall have AC Reversing type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
    b. All electric actuators identified as "MODULATING ELECTRIC" on GM-10 and GM-11, shall have AC Modulating type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
9. Remote Actuator Control Station. Valves with electric motor actuators where the valve centerline is located at a height greater than 6.5-feet above the floor shall provide a remote actuator control station at a location no higher than 4-feet above the floor. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications. The actuator controls shall be wall-mounted beneath the valve at a location approved by the Design Engineer.

B. Electric Motor Actuators (AC Reversing (Open / Close) Control Type)
1. General: Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with open / stop / close and local/off/remote selector switches on the actuator local control station.

2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at floor elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Starter: The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 480 volt, 3-phase, 60 Hz current. A control power transformer shall be included to provide a 120 volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The integral weatherproof compartment shall contain a suitably sized 120 volt ac, single phase, 60 Hz space heater to prevent moisture condensation on electrical components. A local power disconnect switch shall be provided with each actuator. A close-coupled, padlockable switch shall be provided with each actuator.
4. Local Control Station: Each actuator shall be provided with a local control station with the valve actuator assembly. The station shall include open, close, and stop push buttons, and a local/remote selector switch.
5. Manufacturers:
    a. Auma, SA Series (for valves 12 inches and smaller) or SA with GS worm gear (for valves 14 inches and larger).
    b. Limitorque, LY Series (for valves 12 inches and smaller) or L-120 with HBC worm gear (for valves 14 inches and larger)
    c. No “Or-Equals” allowed.

C. Electric Motor Actuators (AC Modulating Control Type)
1. General: Where indicated, modulating electric motor actuators shall be the ac modulating type complete with a local control station with power disconnect switch or circuit breaker, provided with open/stop/close and local/off/remote selector switches on the actuator local control station, and open/close status lights.
2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at floor elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Control Module: The control module shall be of the electronic solid-state ac type with control outputs for positioning the valve via 4 - 20 ma input signals.
4. Starter: The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes. The solid-state starter and control module shall be rated for continuous modulating applications. Power supply shall be 480 volt, 3 phase, 60 Hz. A disconnect switch shall be included with each actuator.

5. Construction: The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters and pushbutton calibration elements for field setup. Potentiometer adjustments shall contain a PID control function internally. In addition, the controller shall contain as standard feature a loss of command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4 - 20 ma. As an alternative to the construction requirement, the motor shall be capable of modulating at a rate of 600 starts per hour at the 50 percent to 85 percent travel range of the valve. The system shall allow control of the open, close, or percent open function when the local/off/remote switch is in the remote position. Each actuator shall have a frequency shut down system which when pre-programmed, shall function as directed upon receipt of an ESD signal.
6. Manufacturers:
    a. Auma, SA Series (for valves 12 inches and smaller) or SA with GS worm gear (for valves 14 inches and larger).
    b. Limitorque, LY Series (for valves 12 inches and smaller) or L-120 with HBC worm gear (for valves 14 inches and larger)
    c. No "Or-Equals" allowed.

D. 120 VAC Quarter-Turn and Multiturn Electric Valve Operators on Isolation Valves 3-Inch Dia. and Smaller. Where indicated on Contract Drawings, and primarily on vendor supplied equipment skids and control packages, 120 VAC electric actuators may be supplied on smaller valves of 3-inch diameter and smaller, as follows:
1. Provide 120 VAC, 1-phase motor-operated valve operator suitable for use with quarter-turn ball valves, multiturn diaphragm valves, and multiturn globe valves. Operator shall have the following characteristics and features:
    a. Reversing capacitor-start motor rated for operation on 120 V ac, 60 Hz, single phase. Output torque as required for valve application and pressure differential.
    b. Integral motor overload protection, with auto reset
    c. Permanently-lubricated gear train
    d. For open/close control, provide four single pole, double throw cam actuated limit switches (2 OPEN, 2 CLOSED). One set of limit switches shall be used for both motor control and local indication. The other set shall be available for connection to remote monitoring. Limit switch contacts shall be adjustable and shall be rated for not less than 5 amps at 120 V ac.
    e. Local Control Station: Open/Close: Corrosion-resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection and 2 pushbuttons, OPEN and CLOSE. In addition, provide OPEN and CLOSE indicating lights operating at 120 V ac for connection to valve control limit switches.
    f. For modulating control, provide an electronic positioner and feedback potentiometer. The positioner shall utilize a 4 - 20 ma signal to adjust the valve opening. Feedback potentiometer shall be 0 - 1000 ohms.
    g. Local Control Station Modulating: Corrosion resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection, one OPEN and one CLOSE push buttons, a resistance to

current converter with 4 - 20 ma output, and a 0 to 100 percent electronic valve position indicator.

h. Local power disconnect switch (NEMA 4X) for disconnecting 120 V ac power to valve. Disconnect shall be installed in the field within sight of the valve actuator, in accordance with the requirements of NPFA 70.

2. See Drawings for control diagram wiring interface.
3. Two wire control systems are not required for this actuator.
4. Operators shall be RCS, Asahi/America Quarter Master or equal.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments: Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.2 INSTALLATION

A. Valve and gate actuators and accessories shall be installed in accordance with Section 40 05 51 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

B. Inspection, Startup, and Field Adjustment: An authorized representative of the manufacturer shall visit the Site and witness the following:
1. Installation of the equipment for not less than two (2) Work Days
2. Inspection, checking, and adjusting the equipment for not less two (2) Work Days.
3. Startup and field-testing for proper operation for not less than two (2) Work Days.

C. Instruction of Owner's Personnel: The authorized service representative shall visit the Site for not less than 2 Days to instruct the Owner's personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment.

END OF SECTION

SECTION 40 05 61
GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide gate valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

C. The requirements of Section 40 05 52 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51.

PART 2 - PRODUCTS

2.1 GENERAL

A. Buried valves shall be of the inside screw, non-rising stem type. The valve actuators shall be as indicated, with counter-clockwise opening stems, in accordance with Section 40 05 57.

B. Gate valves 18-inches and larger shall be provided with a bypass line and isolation valve.

2.2 METAL-SEATED GATE VALVES (3-INCHES AND LARGER)

A. Construction: Metal-seated gate valves for water and sewage service shall conform to AWWA C 500 - Metal-Seated Gate Valves for Water Supply Service. The valve bodies shall be of cast iron conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, or ductile iron conforming either to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures, or to ASTM A 536 - Ductile Iron Castings, with flanged, bell and spigot, or mechanical joint-ends as indicated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 2 of AWWA C500. The design working water pressure shall be 200 psig for valves 12-inches and smaller and 150 psig for larger valves. The valves may be of the double-disc type for tighter shut-off, or of the solid-wedge type, with rising or non-rising stem. For sewage or fluids containing solids, an outside thread shall be used. Valves 14-inches and larger installed in vertical pipes shall be fitted with bronze slides, tracks, rollers, and scrapers to assist the travel of the gate assembly. Gate valves 14-inches and larger shall be furnished with bypass assemblies.

B. Actuators: Unless otherwise indicated, gate valves shall have manual actuators in accordance with Section 40 05 52.

C. Manufacturers, or Equal

1. Clow Valve Co.
2. Kennedy Valve
3. M & H Valve Company
4. Milwaukee Valve Company, Inc.

2.3 KNIFE-GATE VALVES (2- TO 96-INCH)

A. Construction: Knife-gate valves shall be of the flanged or wafer design, with raised face and resilient seats for positive seating. Wetted parts shall be constructed of Type 316 stainless steel, and the gates shall be finish-ground on both sides to prevent packing or seat damage. Valves 2- to 12-inches in size shall be furnished with cast stainless steel bodies; valves 14-inches and larger shall have semi-steel bodies with stainless steel linings. The valve stem shall be of stainless steel with a long life packing. The valves shall be rated for tight shut-off at the following pressures:
1. Valve sizes 4- to 12-inches 150 psi (bi-directional)
2. Valve sizes larger than 12-inches 50 psi

B. Actuators: Knife-gates shall have outside-screw and yoke-rising stems with manual handwheel actuators, unless otherwise indicated, in accordance with Section 40 05 52.

C. Manufacturers, or Equal
1. DeZURIK Water Controls Corporation
2. Fabri-Valves
3. Rovang, Inc.

2.4 RESILIENT-SEATED GATE VALVES

A. General: Resilient-seated gate valves may be provided in lieu of metal-seated double-disc or solid-disc gate valves, at the discretion of the Engineer.

B. Construction: Resilient-seated gate valves shall conform to AWWA C509 - Resilient-Seated Gate Valves for Water and Sewerage Systems AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service. The valves shall be suitable for a minimum design working water pressure of 150 psig see NTS, above, with flanged, bell and spigot, or mechanical joint ends. The valve body, bonnet, and disc shall be of cast iron or ductile iron and the disc or body shall be rubber-coated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 1 of AWWA C509 AWWA C515. The stem, stem nuts, glands, and bushings shall be bronze, with the stem seal per AWWA C509 AWWA C515.

C. Pressure Ratings:
1. AWWA C509 valves that are 3, 4, 6, 8, and 12 inches in size shall be rated for 200 psig minimum design working water pressure, and 16-, 20-, 24-, and 30-inch valves shall be rated for 150 psig minimum design working water pressure.
2. AWWA C515 valves 3- through 36-inch with outside screw-and-yoke (OS&Y) rising stem and 3- through 16-inch for non-rising-stem (NRS), shall be rated for 200 psig minimum design working water pressure.

D. Protective Coating: Valves shall be factory coated in accordance with Section 09 90 00 - Protective Coating. The Contractor shall submit a test report from a coating inspector that

the coating is holiday-free. The Contractor shall be aware that it may retain the services of a third party coating applicator to achieve the holiday-free requirement.

E. Actuators: Unless otherwise indicated, resilient-seated gate valves shall have manual actuators in accordance with Section 40 05 52.

F. Manufacturers, or Equal
1. Mueller Company
2. M & H
3. Clow

2.5 GATE VALVES (SMALLER THAN 3-INCHES)

A. Construction: Gate valves smaller than 3-inches, for general purpose use, shall be non-rising stem, heavy-duty type for industrial service, with screwed or soldered ends to match the piping. The bodies shall have union bonnets of bronze conforming to ASTM B 62 - Composition Bronze or Ounce Metal Castings. The stems shall be of bronze conforming to ASTM B 62, or ASTM B 371 - Copper-Zinc-Silicon Alloy Rod. The solid wedges shall be of bronze conforming to ASTM B 62. The valves shall have malleable iron handwheels unless otherwise indicated, and stem seals shall be of Teflon-impregnated or other acceptable non-asbestos packing. Valves shall have a pressure rating of minimum 125 psi steam and 200 psi coldwater, unless otherwise indicated.

B. Manufacturers, or Equal
1. Crane Company
2. Milwaukee Valve Company
3. Wm. Powell Company
4. Stockham Valves and Fittings
5. Walworth Company

2.6 HIGH-PRESSURE GATE VALVES (2- TO 12-INCHES)

A. Construction: High-pressure gate valves, except for buried valves, shall have cast iron bodies and flanged bonnets with outside screw & yoke rising stems conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 250 psi flanged ends. The valves shall be rated for 250 psig steam and 500 psig cold water working pressure. The solid wedges shall be of bronze or cast iron, bronze-fitted, and the stem shall be of bronze with non-asbestos fiber packing.

B. Actuators: Unless otherwise indicated, high-pressure gate valves shall have cast iron or ductile iron handwheels with 2-inch square operating nuts, in accordance with Section 40 05 52.

C. Manufacturers, or Equal
1. Crane Company
2. Milwaukee Valve Company
3. Wm. Powell Company
4. Stockham Valves and Fittings
5. Walworth Company

2.7 PLASTIC GATE VALVES (1-1/2 TO 14-INCHES)

A. Construction: Plastic gate valves shall have PVC bodies with ANSI 150 lb. flanged ends, and polypropylene or CPVC-SBR-lined wedges for tight shut-off. The non-rising stem shall be of PVC or Type 304 stainless steel construction, with O-ring seal. The valves shall have a coldwater pressure rating of 150 psig for sizes 1-1/2 through 8-inches, 110 psig for size 10-inches, and 70 psig for sizes 12- and 14-inches.

B. Actuators: Unless otherwise indicated, PVC gate valves shall have manual handwheel actuators with position indicators, in accordance with Section 40 05 57.

C. Manufacturers, or Equal
   1. ASAHI/America
   2. Spears Mfg. Co.

PART 3 - EXECUTION

3.1 GENERAL

A. Gate valves shall be installed in accordance with the provisions of Section 40 05 51. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

SECTION 40 05 63
BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

C. The requirements of Section 40 05 52 - Valve and Gate Actuators apply to this Section.

D. [The requirements of Section 46 33 00 - Chemical Feeding Equipment, General apply to this Section.]

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures and 40 05 51 - Valves, General.

PART 2 - PRODUCTS

2.1 METAL BALL VALVES (3-INCHES AND SMALLER)

A. General: Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inches shall have actuators in accordance with Section 40 05 52 - Valve and Gate Actuators.

B. Body: Ball valves up to and including 1.5-inches in size shall have bronze or carbon steel 2 or 3 piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inches to 3-inches in size shall have bronze or carbon steel 2 or 3 piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.

C. Balls: The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.

D. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced teflon seal.

E. Seats: The valve seats shall be of teflon or Buna-N, for bi-directional service and easy replacement.

F. Manufacturers, or Equal
   1. Conbraco Industries, Inc. (Apollo)
   2. ITT Engineered Valves
   3. Neles-Jamesbury, Inc.
   4. Watts Regulator

5. Worcester Controls

2.2 PLASTIC BALL VALVES (1.5-INCHES AND SMALLER)

A. General: Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the specific fluid application. Valves shall have manual actuators in accordance with Section 40 05 52 - Valve and Gate Actuators, unless otherwise indicated.

B. Construction: Plastic ball valves shall have true-union ends or flanged ends to mate with ANSI B 16.5, class 150 flanges for easy removal. The balls shall have full size ports and teflon seats. Body seals, union O-ring seals, and stem seals shall be in accordance with the corrosion resistance requirements of [Section 46 33 00]. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. Ball valves for sodium hypochlorite solution service shall be drilled through the ball or body per valve manufacturer recommendation to relieve offgas and equalize pressure across the valve. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.

C. Manufacturers, or Equal
1. ASAHI-America
2. George Fischer, Inc.
3. NIBCO Inc., (Chemtrol)
4. Plast-O-Matic Valves, Inc.
5. Spears Mfg. Co.
6. Watts Regulator

PART 3 - EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with Section 40 05 51 – Valves, General. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

SECTION 40 05 64
BUTTERFLY VALVES

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11 00 00 – Equipment General Provisions apply to this Section.

C. The requirements of Section 40 05 51 - Valves, General apply to this Section.

D. The requirements of Section 40 05 52 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

E. Furnish submittals in accordance with Section 40 05 51 – Valves, General.

F. Shop Drawings

1. Complete Shop Drawings of butterfly valves and actuators.
2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.
3. Certification of proof-of-design test from the valve manufacturer.
4. Certification: The Contractor shall obtain written certification from the butterfly valve manufacturer, addressed to the Owner, stating that the butterfly valves and the valve operators will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the manufacturer accepts joint responsibility with the Contractor for coordination of all butterfly valves and valve operators, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed units. The Contractor shall submit all such certificates to the construction manager.
5. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, manual operators, and electric motor valve operators under one cover and in accordance with the requirements of Section 01 33 00 – Submittal Procedures.
6. Valve Labeling: The Contractor shall submit a schedule of butterfly valves to be labeled indicating in each case the valve location and the proposed wording for the label.
7. Field Procedures: Written instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to delivery of the butterfly valves and valve operators.

1.3 QUALITY ASSURANCE

G. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

PART 2 - PRODUCTS

2.1 RUBBER SEATED BUTTERFLY VALVES (AWWA)

A. General: Butterfly valves for water working pressures up to 250 psi shall conform to ANSI/AWWA C504 - Rubber Seated Butterfly Valves, subject to the following requirements. Valves shall be of the size and class indicated. Flanged valves shall have Class 150 or Class 250 flanges conforming to ANSI B16-1.

B. Manual Actuators: Actuators shall conform to Section 40 05 52 - Valve and Gate Actuators and to ANSI/AWWA C540 - Power Actuating Devices for Valves and Sluice Gates, subject to the following requirements. Unless otherwise indicated, all manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30 inches in diameter and larger.

C. Worm Gear Actuators: Valves, 30 inches and larger, as well as all submerged and buried valves, shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

D. Manufacturers, or Equal
1. De Zurik Corporation.
2. Kennedy Valve.
3. Mueller

2.2 DOUBLE ECCENTRIC BUTTERFLY VALVES 4-INCH AND LARGER – CLASS 150B AND 250B

A. General: The butterfly valve shall be designed expressly for waterworks applications and shall be of the double offset design whereby the elastomeric seal is not compressed with the valve in the open position. Zero, single and API based triple offset butterfly valve designs are not acceptable. Butterfly valves for water working pressures up to 150 psi shall conform to ANSI/AWWA C504 Class 150B. Butterfly valves for water working pressures greater than 150 psi shall conform to the design requirements of ANSI/AWWA C-504, Class 250B. Valves shall be of the size and class indicated in the valve schedule or in the plans. All valves unless noted otherwise, shall be sized for bi-directional water service, full rated pressure and a line velocity of 16 feet per second and suitable for higher linebreak velocities of 50 fps. Lifting lugs will be provided for all valves 24" and larger.

B. Flanges: Class 150B flanged valves shall have ANSI B16.1 Class 125-pound flanges. Class 250B flanged valves shall comply with ANSI B16.1 Class 250 up through 48-inch unless otherwise noted or if mating to ductile iron pipe. Above 48-inch, flange

outside diameter, number of bolts, diameter of bolt circle, and diameter of bolts shall comply with ANSI/AWWA C 207 Class E.

C. Body: Valve bodies shall be ductile iron, ASTM A536 65-45-12 or A536 60-40-18. Cast gray iron is not allowed due to near zero elongation and as it vulnerable to shear stress. The valve body shall include integrally cast support feet top and bottom. It shall be mechanically equipped with a fastened stainless steel stamped or engraved tag indicating manufacturer and reference build data. Valves 54 inch and larger shall include two tags diametrically opposed. The valve build data shall be made available upon request by the customer and shall be retained by the manufacturer for no less than 70 years unless noted longer. The entire valve body and flanges shall be epoxy corrosion coat protected except for the valve shaft bores.

D. Disc: The disc shall be ductile iron ASTM A536 65-45-12 or ASTM A536 60-40-18. The entire disc and all its wetted surfaces shall be coated without exception. The disc's elastomeric seal retainer shall be type 304, duplex 2205 or 316 stainless steel. Neither bronze nor carbon steel is acceptable. Both the disc and elastomeric seal retainer shall have recesses designed to retain a dual shouldered seal under extreme localized velocities, at full differential opening and/or linebreak closing. The disc shall be mechanically fastened to the valve shaft by using Polygon "no fail" connection or equivalent stainless steel key connection or the disc shall be mechanically fastened to the valve shaft using tangential stainless steel shaft pins of type 316 or higher alloy. Disc pins shall extend completely through the valve and shall be mechanically fastened. The disc shall be completely coated except for the disc shaft bores.

E. Shaft: Valve shafts shall be dual stub shafts of stainless steel ASTM A276 Type 316, 304, 431, duplex 2205,or 420. The valve shaft material and thickness shall be suitable for the applications pressure and velocity without the use of its safety factors. Shafts may not be turned down to fit drive splines without accompanying torsional strength reduction calculations and its effect on the safety factor.

F. Elastomeric Seal and Seal Ring: Valve seals shall be EPDM, secured to a completely coated valve disc by a duplex 2205, 304 or 316 stainless steel, continuous non-segmented seal ring and secured by 316 stainless steel fasteners. The seal shall not scallop, cold flow or tear at localized velocities less than 300 fps. The elastomeric seal shall not be penetrated by fasteners. The valve shall be bi-directionally leak free. The elastomeric seal shall be double shouldered and extend no greater than 0.25 inches past the disc edge to seat the valve. The seal shall be designed to flex in either flow direction. There shall be a small gap on both sides of seal which will allow for pipeline pressurized media to further expand the seal against the metallic seat- the higher the differential pressure or velocity. The elastomeric seal shall be field replaceable and adjustable in line. It shall not require special skills or tools to replace the seat. With access to the seat retaining bolts, the seat removal, replacement and readiness for service must be able to be accomplished in a maximum of 3 hours for all size valves. Seat methods which do not comply or use either irreplaceable vulcanized seals or which use hardened epoxy or grout in a dovetailed groove are not acceptable.

G. Metallic Seat: The metallic valve seat shall be located in the valve body. It shall be a

highly wear resistant stainless steel alloy. There shall be no gap between the valve body and metallic body seat and consequently no potential for corrosion or lifting of the seat. The seat shall be applied through a high alloy weld overlay process. Metallic seats shall not be mechanically retained by fasteners.

H. Shaft Seals: Shaft seals shall not need periodic manual adjustment. They shall be multi-O-ring seals protecting both the OD and ID of the shaft bearings. They shall prevent pressurized system water from entering the uncoated valve disc hub and valve body shaft bore. The valve shaft shall remain non-wetted and unpressurized. The non-wetted shaft shall allow the actuator to be removed without dewatering the pipeline. It shall prevent debris and system pressurized water from entering into the uncoated valve body shaft bore. It shall prevent waters or contaminated media, external to the valve, from entering through the valve shaft under vacuum/ negative pressure conditions in the pipeline, or hydrostatic pressure conditions external to the valve. Neither manual pulldown packing glands nor braided packing are allowed. The outer shaft seals shall be a replaceable cartridge type, bolted to the valve body. Packing shall not be held in place with an adapter plate or by the valve actuator.

I. Shaft Bearings: Valve shaft bearings shall be corrosion resistant, self-lubricating sleeve type made of bronze, stainless steel or stainless steel backed PTFE. Bearing choice and consequent bearing friction shall be correctly added to valve input torque requirements.

J. Strength: The proportion and dimensions of all parts of the valve and actuator shall be designed to withstand, without failure, the stresses occurring under the testing and operating conditions. The maximum allowable stress in any material shall not exceed 1/5 of the ultimate tensile strength or 1/3 of the minimum yield strength. Class 150B valves shall be rated to and shall receive a pressure test of 150 psi and Class 250B valves shall be rated to and shall receive a pressure test of 250 psi applied to one side of the disc with zero pressure applied to the other side of the disc while in the closed position, without damage or permanent deformation to any part of the valve, seat, disc or shaft. The valve shall be capable of withstanding such pressures in both directions.

K. Manual Actuators: Actuators shall conform to Section 40 05 57 – Valve and Gate Actuators and to ANSI/AWWA C 540, subject to the following requirements. All actuators shall be self-locking and shall hold the valve disc in the closed, open and any intermediate position without creeping or fluttering. All actuators shall incorporate a mechanical stop-limiting device to prevent over travel of the disc. Unless direct buried or otherwise indicated, all manually actuated butterfly valves shall be equipped with a handwheel and external position indicator. The number of turns for direct buried valves shall be a minimum of 1.4 times the nominal valve size with no fewer than 25 turns. The valve manufacturer shall be responsible for mounting and testing the actuator. Screw-type (traveling nut) actuators are not permitted due to their inconsistent output torques through the 90-degree stroke. All manual direct buried service actuators shall be designed for a 300 foot-pound input torque against the closed and open travel stops. The Owner reserves the right to field verify.

L. Worm-Gear Actuators: All valves including submerged and buried valves, shall be equipped with top tier AWWA worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing. Buried service valves shall be 90% or greater, grease packed. Submerged service valves in potable water applications shall be 100% grease filled with FDA approved food grade grease. Documentation for the selected grease for submerged service valves shall accompany submittals. The Owner reserves the right to field verify grease levels. Non-complying gears shall be remedied by the factory, verified by the customer and signed off by both parties. No name or unbranded actuators will not be accepted.

M. Hardware: All fasteners and hardware shall be type 316 Stainless Steel.

N. Paint and coatings: The manufacturer is required to have and follow a system of valve preparation and coating which assures a quality holiday free application and which maximizes the available multi-decade protection the coating offers. Manufacturers that do not properly prepare or coat their valves properly will not be accepted.

The manufacturer must provide their written system of valve preparation and coating. This document shall include the methodologies used (quality compliance) as well as post application review (quality assurance). It will be based on a professional system of coating and grading such as NACE, SSPC, GSK, ISO or DIN and will include both text and color photo-documentation. The manufacturers coating system must be documented as well as implemented with a quality assurance program to prevent unacceptable deviation. This coating system shall be submitted for approval. It shall be titled, signed and dated by the manufacturers Coating Department Head, its' Compliance Officer or an equal ranking staff.

1. Valves 48-inch and smaller: All external and internal surfaces except for the seating surface shall be 400-degree F plus, heat bonded fusion coated. Coating damaged in shipping or installation shall be noted and properly repaired to the satisfaction of the utility or its authorized agent.

O. Limit Switch. Where indicated on plans, valve shall be equipped with an on/off limit switch to communicate position to pump station PLC/RTU.

P. Manufacturers, No Equal (**Contractor shall confirm valve delivery date and ability to meet NSF Standard 61 requirements)

1. Av-Tek Inc., High Performance DEX Double Eccentric Butterfly Valve

It shall be Contractor's responsibility to confirm that valve supplier provides a guaranteed delivery date that meets the project schedule, and certifies that all materials meet NSF Standard 61 requirements for potable water service.

Failure to meet these requirements will be cause for rejection of valve supplier, and Contractor's substitution of an alternate supplier at no additional cost to the Owner. Contractor shall note that the naming of manufacturer's above does not guarantee that these specific requirements can be met by each of them.

PART 3 EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 40 05 51 – Valves, General.

B. Contractor shall use the provided lifting lugs to move all project valve(s). The use of chains, lifting straps, rope or any type other strapping through the valve body is strictly prohibited. Correct lifting procedures shall be the Contractor's responsibility. As necessary, consultation with the valve manufacturer is recommended. The contractor shall be responsible for all damage and project delays resulting from improper lifting and moving procedures, these shall include but shall not be limited to: pulling the valve body out of round, gouges, scratches, displacing the gear box etc.

C. Strict care shall be taken to assure valves are not installed under stress. In no instance shall adjacent mating flanges be forced into position. A progressive and proper star cross pattern shall be used to tighten valve flange mating bolts.

END OF SECTION

SECTION 40 05 65
VALVES FOR PUMP CONTROL AND CHECK SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Valves, General.

PART 2 - PRODUCTS

2.1 SWING CHECK VALVES (3-INCHES AND LARGER)

A. General: Swing check valves for water and general service shall be of the outside lever and spring or weight type, in accordance with AWWA C 508 - Swing-Check Valves for Waterworks Service, 2-in. through 24-in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. Units shall have a flanged cover piece to provide access to the disc. Where indicated, swing check valves shall be provided with position indicators.

B. Body: The valve body and cover shall be of cast iron conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or be mechanical joint ends, as indicated.

C. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B 584 - Copper Alloy Sand Castings for General Applications.

D. Seat and Rings: The valve seat and rings shall be of bronze conforming to ASTM B 584 or B 148 - Aluminum-Bronze Castings or of Buna-N.

E. Hinge Pin: The hinge pin shall be of bronze or stainless steel.

F. Dashpot: A bottom-mounted or side-mounted hydraulic dashpot shall be provided to prevent reverse flow and to alleviate water hammer during the closing cycle of the valve. The dashpot shall have 2 or 3 stage closing rates, depending on manufacturer's recommendation for intended service: For the 2 stage closing rate, the first stage shall be adjustable from 100 to 10 percent. The second stage shall be adjustable from 10 to zero percent. For the 3 stage closing rate, the first stage shall be adjustable from 100 to 50 percent. The second stage shall be adjustable from 50 to 10 percent. The third stage shall be adjustable from 10 to zero percent. Each rate shall be infinitely and independently field adjustable depending on the

system requirement. The dashpot shall be a self-contained oil system separate and independent from the pipeline fluid. The oil reservoir for the closing cycle shall be stainless steel, open to the atmosphere with an air breather cap to allow oil level changes in the reservoir and also to prevent contamination of the oil from any outside source. The oil reservoir for the opening cycle shall be stainless steel, be hermetically sealed to contain pressure (air over oil), and shall be equipped with a 3-inch diameter pressure gauge and pneumatic fill valve. There shall be a provision for disconnecting the each dashpot from the valve for servicing, without removal of the valve.

G. Manufacturers, or Equal
   1. APCO (Valve and Primer Corp.)
   2. Kennedy Valve
   3. Mueller Company
   4. Stockham Valves and Fittings
   5. Golden Anderson
   6. VAL-MATIC (Valve and Manufacturing Corporation)

2.2 SWING CHECK VALVES (2-1/2 INCHES AND SMALLER)

A. General: Swing check valves for steam, water, oil, or gas in sizes 2-1/2 inches and smaller shall be suitable for a steam pressure of 150 psi and a cold water pressure of 300 psi. Units shall have screwed ends unless otherwise indicated, and screwed caps.

B. Body: The valve body and cap shall be of bronze conforming to ASTM B 763 - Copper Alloy Sand Castings for Valve Application, or ASTM B 584 with threaded ends conforming to ASME B1.20.1 - Pipe Threads, General Purpose (inch).

C. Disc: Valves for steam service shall have bronze or brass discs conforming to ASTM B 16 - Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines, and for cold water, oil, and gas service replaceable composition discs.

D. Hinge Pin: The hinge pins shall be of bronze or stainless steel.

E. Manufacturers, or Equal
   1. Crane Company
   2. Milwaukee Valve Company
   3. Stockham Valves and Fittings
   4. Wm. Powell Company

2.3 INTERNAL SPRING-LOADED CHECK VALVES (GLOBE STYLE – SILENT CHECKS)

A. General: Internal spring-loaded check valves for water pumps compressors, gas, air, and steam shall be of the full-flow internal spring-loaded poppet type. The valves shall be designed for a water-working pressure of not less than 150 psi unless otherwise indicated.

B. Body: The bodies of valves 3-inches and larger shall be of cast iron conforming to ASTM A 126 with 125 lb flanged ends conforming to ASME B 16.1 unless otherwise indicated. Where necessary, there shall be a positive, watertight seal between the removable seat and the valve body. The stem guide shall be integrally cast with the body or screwed into the body.

C. Valves smaller than 3-inches shall have bronze bodies with screwed ends conforming to ASME B 1.201, suitable for a minimum working pressure of 200 psi, and a temperature of 250 degrees F, unless otherwise indicated. The type of bronze shall be suitable for the intended service.

D. Disc and Stem: The disc and stem of all valves in sizes 3-inches and larger shall be of bronze conforming to ASTM B 584 - Copper Alloy Sand Castings for General Applications, or stainless steel. The stem shall have 2 point bearings. The downstream bearing shall have a bronze or other suitable bushing, to provide a smooth operation.

E. Valves smaller than 3-inches shall have discs and retaining rings of Teflon, nylon, or other suitable material, and stems of bronze, brass, or stainless steel, suitable for the intended service.

F. Stem Guide: The stem guide shall be either firmly fixed in the valve body to prevent it from sliding into the adjacent pipe and damaging the pipe lining, or the valve manufacturer shall provide each valve with one matching flange compatible with the adjacent pipe and its lining to prevent damage to the lining. The compatible flange shall be part of the Shop Drawing submittal.

G. Seat**:** Valves for general service at temperatures up to 250 degrees F shall have bubble-tight shut-off with resilient seats of Buna-N, Teflon, or other suitable material. Valves for steam service and temperatures over 250 degrees F shall have metal-to-metal seating of bronze or stainless steel, as recommended by the manufacturer for the specific service condition. Resilient seats shall be firmly attached to the seating ring by compression molding or other acceptable method.

H. Spring: Valves in sizes 3-inches and larger shall have Type 316 stainless steel springs, and valves smaller than 3-inches shall have stainless steel or beryllium copper springs, as suitable for the service. The spring tension of the valves shall be designed for the individual pressure condition of each valve.

I. Manufacturers, or Equal
   1. APCO (Valve and Primer Corp.)
   2. CPV (Combination Pump Valve Company)
   3. Miller Valve Co., Inc.
   4. VAL-MATIC (Valve and Manufacturing Corporation)

2.4 TILTED DISC CHECK VALVES (3 – 48 INCH)

A. General: This specification covers the design, manufacture, and testing of Tilted Disc Check Valves suitable for pressures up to 400 psig (2750 kPa) (3"-12") and 350 psig (2,070 kPa) (14"+) water service. The Check valves shall be of the Tilted Disc metal seated, full body type capable of accepting optional bottom or top mounted oil dashpots.

B. Standards: The valves shall be certified to NSF/ANSI 61 Drinking Water System Components - Health Effects and certified to be Lead-Free in accordance with NSF/ANSI 372. A 20 in. (500mm) valve or larger shall be proof of design cycle tested through 250,000 cycles in the horizontal position and leak tested at the rated pressure. The leakage rate shall be less than 1 fluid ounce per hour per inch of valve size after the test.

C. Connection: The valves shall be provided with drilled flanges in accordance with ANSI B16.42 Class 300 iron flanges. Ductile iron flanges shall be flat faced. Flanged inspection ports shall be provided upstream and downstream of the valve disc for inspection or use with optional dashpots on 6 in. and larger valves.

D. Design: The valve body shall consist of two sections bolted together as a central diagonal flange inclined at an angle of 55 degrees. The inlet body section shall contain a seat ring positioned and captured by the diagonal flange. The outlet body section shall accept eccentrically located pivot pin trunnions with sealed covers and lubrication grease fittings. The eccentric pivot trunnions shall be located to divide the disc into approximately 1/3 and 2/3 proportions and also allow the seating surface of the disc to rotate away from the seating surface of the seat ring without contact. Clearance shall be provided between the pivot pin and bushing when the disc is seated to prevent binding and to ensure a tight seal. The minimum pivot pin diameter shall be as shown below.

Valve Size (in)	3	4	6	8	10	12	14	16
Pin Diameter (in)	9/16	5/8	1-1/8	1-3/8	1-5/8	1-7/8	2-1/8	2-3/8

E. Materials: The valve body shall be constructed of ASTM A126 Class B cast iron for Class 250 valves up to 10 in. (250mm). 12 in. (300mm) and larger Class 250 valves shall be constructed of ductile iron ASTM A536 Grade 65-45-12. The disc in sizes up to 10 in. (250mm) shall be one-piece construction with integral seat and constructed of ASTM B148 Alloy C95400 aluminum bronze. 12 in. (300mm) and larger discs shall be ASTM A536 Grade 65-45-12 ductile iron. The disc seating ring shall be ASTM B271 Alloy C95500 centrifugally cast aluminum bronze. The mating seat ring located in the body shall be ASTM B271 Alloy C95400 centrifugally cast aluminum bronze. The pivot pins shall be ASTM B505 Alloy C95500 aluminum bronze and shall be guided by a bushing constructed of ASTM B505 Alloy C95400 aluminum bronze (12 in./300mm and larger valves).

F. Testing: The valves shall be hydrostatically tested at 1.5 times their rated cold working pressure. Additional tests shall be conducted per AWWA, ANSI, MSS or API standards when specified. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.

G. Coatings: The exterior of the valve shall be coated with a universal alkyd primer. The valve interior shall be coated with an epoxy coating approved for potable water.

H. Manufacturers, or Equal
1. Val-Matic Valve & Mfg. Corporation

2.5 PLASTIC BALL CHECK VALVES

A. General: Plastic ball check valves for corrosive fluids, in sizes up to 4-inches, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions.

B. Construction: The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections or flanged ends conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. Seals shall have Viton O-rings, and valve design shall minimize possibility of the balls sticking or chattering. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

C. Manufacturers, or Equal
   1. ASAHI-AMERICA
   2. George Fischer, Inc.
   3. NIBCO Inc. (Chemtrol Division)
   4. Spears Mfg. Co. (PVC, CPVC, AND PP only)

2.6 METAL BALL AND LIFT CHECK VALVES

A. General: Metal ball check valves for saturated steam, oil, water, and gas in sizes 1/2- up to 1-inch shall be used for horizontal installation only. Lift check valves for LP gas in sizes 1/4 up to 2-inches shall be used for horizontal installation only.

B. Construction: The ball check valve body and cap shall be bronze ASTM B 584. Ball disc shall be stainless steel construction, as best suited for each individual service condition. The union cap shall provide a tight joint and be easily dismantled when necessary. They shall have screwed connections. The valves shall be suitable for a maximum working non-shock pressure of 150 psi saturated steam or non-shock cold water, oil, and gas rating of 300 psi.

C. The lift check valve body, and cap shall be leaded bronze ASTM B 763. Disc shall be special composition, as best suited for petroleum service condition. The disc shall be secured to the disc by means of a disc retaining nut. To protect against leakage on light oils and gases, the disc shall be sealed into the holder. The union cap shall provide a tight joint, easily dismantled when necessary. They shall have screwed connections. The valves shall be suitable for a maximum working non-shock pressure of 400 psi cold water, oil, gas, LP gases, and volatile fluids.

D. Manufacturers, or Equal
   1. Crane

2.7 PLASTIC SWING OR WYE-CHECK VALVES

A. General: Plastic swing or wye-check valves for corrosive fluids, in sizes up to 8-inches or as available, may be used for horizontal or vertical up-flow conditions.

B. Construction: The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction as best suited for each individual service condition. They shall have flanged ends conforming to ASME B16.5 Class 150, and flanged top access covers and shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inches and smaller. For larger sizes and other materials and temperatures the pressure rating may be lower.

C. Manufacturers, or Equal
   1. ASAHI-AMERICA
   2. George Fischer, Inc.
   3. Spears Mfg. Co. (Plastic Swing Check only)

PART 3 - EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 40 05 51 - Valves, General.

END OF SECTION

SECTION 40 05 69
PRESSURE REDUCING VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide pressure reducing valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures and 40 05 51 – Valves, General, including a cavitation study from the valve manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL

A. Function: Pressure reducing valves shall reduce an upstream pressure to a pre-set constant lower pressure, regardless of fluctuations in the upstream pressure.

B. Operation: The valves shall be hydraulically-operated, with diaphragm or piston direct action, pilot-controlled, per paragraph 2.2, and shall be of the globe or angle pattern as indicated. Necessary repairs shall be possible without removing the valves from the pipeline. The smaller direct-acting valves with threaded ends per paragraph 2.3, shall be suitable for water or air service and shall be of the globe pattern.

2.2 FLANGED VALVES, SIZES 1-1/2 INCHES THROUGH 42-INCHES

A. Valve Body: The valve body shall be of cast iron to ASTM A 48 - Gray Iron Castings, or ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 125 lb flanged ends to ANSI/ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800. The valve cover shall be flanged and be the same material as the body.

B. Valve Trim: The valve stems with position indication, springs, body seat rings, and bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom guides. Rubber parts shall be Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover. The valve pistons and piston liners shall be bronze to ASTM B 62 - Composition Bronze or Ounce Metal Castings.

C. Valve Controls: The valve shall be provided with a complete, externally mounted control system, including speed control needle valves, strainers, check valve, isolation valves, and necessary copper or stainless steel connecting tubing and fittings. The controls shall be capable of achieving the flow and speed adjustment indicated.

D. Factory Tests and Warranty: Valves shall be factory tested with a hydrostatic test and a functional test and a test certificate shall be submitted to the Engineer prior to delivery of the valve. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

E. Operating Conditions: The valves shall be designed to operate under the conditions as specified in the specific equipment specification or as identified in the Contract P&ID drawings.

F. Spare Parts: The following spare parts shall be furnished in accordance with Section 40 05 51 – Valves, General:
   1. One set of all resilient seals and discs
   2. One diaphragm (for diaphragm valves, only)

G. Manufacturers, or equal
   1. Cla-Val Company
   2. GA Industries
   3. OCV Control Valves
   4. Ross Valve Mfg. Co., Inc.
   5. Singer Valve, Inc.
   6. Watts, ACV

2.3 THREADED VALVES, SIZES 1/2 TO 2-1/2 INCHES

A. Valve Body: The valve body shall be bronze to ASTM B 62 or cast steel, with a minimum pressure rating of 300 psi, and with threaded ends. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm or piston.

B. Valve Trim: The valve stems, springs, body seats, and washers shall be of Series 300 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B 62.

C. Operating Conditions: The valves shall be designed to operate under the conditions as specified in the specific Division 11 equipment specification or as identified in the Contract P&ID drawings.

D. Spare Parts: The following spare parts shall be furnished in accordance with Section 40 05 51 – Valves, General:
   1. One complete set of resilient seals and discs
   2. One diaphragm (for diaphragm valves, only)

E. Manufacturers, or equal
   1. Cla-Val Company
   2. Fisher Controls
   3. GA Industries
   4. Watts, ACV
   5. Wilkins Regulator Div. (Zurn Industries)

2.4 PLASTIC VALVES, SIZES 1/4 TO 2 INCHES

A. Plastic pressure reducing valves shall be designed for not less than 150 psi water working pressure and shall be suitable for the fluid service. For chemicals and corrosive fluids, solenoid valves shall be PVC, CPVC, polypropylene (PP), polyvinylidene fluoride (PVDF), or teflon materials of construction as recommended by the manufacturer for the specific application.

B. Characteristics: Valves shall open when the outlet pressure drops below a set minimum value, and maintain the pressure and open wide as flow requirements dictate. Valves shall be spring- or hydraulically-operated, direct acting, adjustable, diaphragm or piston type as indicated.

C. Manufacturers, or equal
   1. Corrosive Fluids
   2. Plast-O-Matic Valves, Inc.
   3. George Fisher

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with provisions of Section 40 05 51 – Valves, General.

3.2 SERVICES OF MANUFACTURERS

A. Inspection, Startup, and Field Adjustment: The service representative of the valve manufacturer shall be present at the Site for 1-Day, to assist the Contractor in the installation and adjustment of the valve(s).

B. Instruction of Owner's Personnel: The training representative of the valve manufacturer shall be present at the Site for 1-Day to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

C. For the purpose of this paragraph, a Day is defined as an 8 hour period, excluding travel time.

END OF SECTION

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SECTION 40 61 00
INSTRUMENTATION SYSTEMS GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. General requirements applicable to all process control and instrumentation systems (PCIS) work.
   2. The requirements of this section apply to all components of the PCIS unless indicated otherwise.
   3. General requirements for process control and instrumentation (PCI) submittals.

B. Related sections:
   1. The contract documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the contractor and its subcontractors to review all sections to ensure a complete and coordinated project:
      a. Items involving electrical, control, and instrumentation construction may be shown on drawings or referred to in specifications that do not apply specifically to electrical, control and instrumentation systems.

C. PCIS work and responsibility shall be as follows:
   1. Contractor – The Contractor is responsible for the overall plant PCIS, including but not limited to all instrumentation. The Contractor shall coordinate the procurement and installation of all PCIS equipment per the Contract Documents.
   2. Integrator – The Owner has pre-selected APCO, Inc. as the Integrator. The Integrator is responsible for providing RTU hardware, software, and RTU programming. The Integrator shall be responsible for providing all PLC hardware, I/O, HMI, networking hardware, and software as indicated in the Drawings and Specifications. The Integrator will also be responsible for all SCADA integration, including all hardware and software. The Contractor is responsible for the installation of all control panels provided by the Integrator.

D. Interfaces to Equipment, Instruments, and Other Components:
   1. The drawings, specifications and overall design are based on preliminary information furnished by various equipment manufacturers which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
   2. Provide all material and labor needed to install the actual equipment furnished, include all costs to add any additional instruments, wiring, control system inputs/outputs, controls, interlocks, electrical hardware etc., which may be necessary to make a complete, functional installation based on the actual equipment furnished. Make all changes necessary to meet the manufacturer's wiring requirements.
   3. Submit all such changes and additions to the Engineer for acceptance in accordance with the General Conditions.

4. Review the complete set of drawings and specifications to ensure that all items related to the instrumentation and control systems are completely accounted for. Include any items that appear on drawings or in specifications from another discipline in the scope of work. If a conflict between drawings and specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
5. Provide complete loop drawings for all systems, including packaged equipment furnished as part of a vendor furnished package, and for all pre-purchased equipment.

E. All instrumentation, control equipment and systems for the entire project is to comply with the requirements of Division 40, whether referenced in the individual equipment specifications or not:
1. The requirements of Division 40 apply to all instrumentation and control work specified in other Specifications, including HVAC controls, packaged mechanical systems, LCPs, VCPs, etc.
2. Inform all vendors supplying instrumentation, control systems, panels, and/or equipment of the requirements of Division 40.
3. The Owner is not responsible for any additional costs due to the failure of the contractor to notify all subcontractors and suppliers of the Division 40 requirements.

F. Contract Documents:
1. General: Contract documents consist of drawings, specifications, and other documents issued by the Engineer. The drawings and specifications are complementary and are to be used together to fully describe the work and requirements shown written or reasonably inferred on one form is considered as written, shown or implied in all. In the event work is called for in more than one place and there are conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.
2. Specifications:
   a. The General and Supplementary Conditions of the contract documents govern the work.
   b. These requirements are in addition to all General Requirements.
3. Contract Drawings:
   a. The instrumentation and control drawings show in a diagrammatic manner the desired locations, and arrangements of the components of the instrumentation work. Follow the drawings as closely as possible, use professional judgment and coordinate with the other trades to secure the best possible installation, use the entire drawing set for construction purposes. The contractor is to verify all dimensions given on the drawings, and to report any discrepancy or inconsistency to the Engineer before commencing with the work.
   b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximations only. Exercise professional judgment in executing the work to ensure the best possible installation:
      1) The equipment locations and dimensions shown on the plans and elevations are approximations. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors and all disciplines to ensure that all instrumentation and control equipment is compatible with other equipment and space requirements. Make and workout

changes required to accommodate differences in equipment dimensions.

2) The contractor has the freedom to select from among the named manufacturers of equipment as identified in the individual specification sections. However, the Engineer has typically designed the spatial equipment layout based upon one manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the contractor's responsibility to ensure that the equipment being furnished fits within the defined space and works with the provided infrastructure.

c. Installation Details:

1) The contract drawings include installation details indicating means and methods the contractor is to use to install instrumentation and control equipment. For cases where a typical detail does not apply, develop installation details that are necessary for completing the work, and submit these details for discussion with, review and approval by the Engineer.

d. Schematic Diagrams:

1) All controls are shown in the de-energized state unless otherwise noted.

a) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.

b) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination or control system voltage drop considerations.

c) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure unless otherwise noted or indicated.

d) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences found in the drawings and/or specifications. Combine all information and furnish a coordinated and fully functional control system.

4. Alternates/Alternatives: Refer to the General Conditions for substitute item provisions.

5. Changes and Change Orders: Refer to the General Conditions.

1.2 REFERENCES

A. Code Compliance:

1. As specified

a. The publications are referred to in the text by basic designation only. The latest edition accepted by the authority having jurisdiction of referenced publications in effect at the time of bid governs.

2. The following codes and standards are hereby incorporated into these specifications:

a. National Fire Protection Association (NFPA):

1) NFPA 70 - National Electric Code (NEC).

2) NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
3) NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment, where applicable.
4) NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

b. Underwriters Laboratories, Inc. (UL):
1) UL 508A - Industrial Control Equipment.
2) UL 698A – Industrial Control Equipment in hazardous locations.

c. American National Standards Institute (ANSI):
1) ANSI B16.5 - Pipe Flanges and Flanged Fittings.

d. American Petroleum Institute (API):
1) API RP551 - Process Measurement Instrumentation.
2) API RP552 - Transmission Systems.
3) API RP553 - Refinery Control Valves.
4) API RP554 - Process Instrumentation and Control.
5) API RP555 - Process Analyzers.
6) API RP556 - Fired Heaters & Steam Generators.
7) API RP557 - Guide to Advanced Control Systems.

e. American Society of Testing and Materials (ASTM):
1) ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

f. Instrumentation, Systems, and Automation Society (ISA):
1) ISA-5.1 - Instrumentation Symbols and Identification.
2) ISA-5.2 - Binary Logic Diagrams for Process Operations.
3) ISA-5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
4) ISA-5.4 - Instrument Loop Diagrams.
5) ISA-5.5 - Graphic Symbols for Process Displays.
6) ANSI/ISA-7.00.01 - Quality Standard for Instrument Air.
7) ISA-RP - 12.4 - Pressurized Enclosures.
8) ANSI/ISA-18.1 - Annunciator Sequences and Specifications.
9) ISA-20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
10) ISA-TR20.00.01 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.
11) ANSI/ISA-50.00.01 - Compatibility of Analog Signals for Electric Industrial Process Instruments.
12) ISA-51.1 - Process Instrumentation Terminology.
13) ISA-RP60.3 - Human Engineering for Control Centers.
14) ISA-71.01 - Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity.
15) ISA-71.02 - Environmental Conditions for Process Measurement and Control Systems: Power.
16) ISA-71.03 - Environmental Conditions for Process Measurement and Control Systems: Mechanical Influences.
17) ISA-71.04 - Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

B. Compliance with Laws and Regulations:
   1. Refer to the General Conditions.

C. Project or Site Conditions:
   1. Refer to site conditions Section 26 00 00 to ensure all equipment and instrumentation provided meets site conditions.

1.3 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation, Systems, and Automation Society.
   4. NFPA: National Fire Protection Association.
   5. NETA: National Electrical Testing Association.

B. Specific Definitions:
   1. Control Circuit: Any circuit operating at 120VAC/VDC or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
   2. Panel: An instrument support system that may be either a flat surface, a partial enclosure or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term "panel" in these contract documents is interpreted as a general term, which includes flat surfaces, enclosures, cabinets and consoles.
   3. Power Circuit: Any circuit operating at 90 Volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
   4. Signal Circuit: Any circuit operating at less than 50 Volts (AC or DC) which conveys analog information or digital communications information.
   5. Digital Bus: A communication network, such as Ethernet, Ethernet/IP, Modbus, Profibus, Foundation Fieldbus, ControlNet or DeviceNet, allowing instruments and devices to transmit data, control functions and diagnostic information.
   6. 2-Wire Transmitter (loop-powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this specification, two-wire transmitter refers to a transmitter that provides 4-20mA current regulation of a signal in a series circuit with an external 24VDC driving potential.
      a. Can be Field-bus communications signal, 4-20mA signal or both.
   7. Powered Transmitters: A transmitter that requires a separate power source (120VAC, 240VAC, 24VDC etc.) in order for the transmitter to develop its signal. As used in this Specification, the produced signal may either be a 4-20mA current signal, a digital bus communications signal or both.
   8. Modifications: Changing, extending, interfacing to, removing or altering an existing circuit.

C. Acronym Definitions:

1. ES: Enterprise System; PC-based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
2. FAT: Factory Acceptance Test.
3. HOA: Hand-Off-Auto; control function that is totally PLC-based. In the Hand mode of control equipment is manually started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode of control equipment is started or stopped, valves are opened or closed through a control program or algorithm within the PLC software. In the Off mode the equipment is prohibited from responding from the PLC control.
4. HMI: Human Machine Interface; operator interface device consisting of an alphanumeric display and operator input devices. The HMI is typically a flat panel type of display with either a touch screen or tactile button interface.
5. HVAC: Heating, Ventilation, & Air Conditioning.
6. ICSC: Instrumentation and Control System Contractor; subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
7. IJB: Instrument Junction boxes; a panel designed with cord sets to easily remove, replace, or relocate instrument signals.
8. I/O: Input/Output.
9. LCP: Local Control Panel; operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and may or may not contain a PLC or RIO.
10. LAN: Local Area Network; a control or communications network that is limited to the physical boundaries of the facility.
11. LOR: Local-Off-Remote; control function that usually allows for locally/manually control of the attached equipment. In the Remote mode equipment is started or stopped, valves are opened or closed through the PLC-based upon the selection of the HOA. In Local control, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
12. OIT: Operator Interface Terminal; PC-based interface device used for operator interface with the controls network and/or SCADA system.
13. P&ID: Process and Instrumentation Diagram.
14. PC: Personal Computer.
15. PCIS: Process Control and Instrumentation System; includes the entire instrumentation system, the entire control system and all the work specified in Division 40 and depicted on the P&IDs.
16. PCM: Process Control Module; an enclosure containing any of the following devices: PLC, RIO, or network devices.
17. PJB: Power Junction Box; an enclosure with terminal blocks that distribute power to multiple instruments or controls devices.
18. PLC: Programmable Logic Controller.
19. RIO: Remote I/O; devices for connection to the PLC consisting of remote I/O racks or remote I/O blocks.

20. RTU: Remote Telemetry Unit; a controller typically consisting of a self-contained controller (CPU) and has means for remote communications. The remote communications devices typically are radios, modems, communication networks etc.
21. SCADA:Supervisory Control and Data Acquisition; a system or network that consists of the computer-based software package that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reporting, trending, and other higher level control system software.
22. UPS Uninterruptible Power Supply.
23. VCP: Vendor Control Panel; a control panel that is/are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
24. WAN: Wide Area Network; a control or communications network that extends beyond the physical boundaries of the facility usually by means of radios, modems, and other communication equipment.

1.4 SYSTEM DESCRIPTION

A. General Requirements:
1. The work includes everything necessary for executing and completing the general requirements for the instrumentation and control system work described in the contract drawings and specifications and reasonably inferable there from including but not limited to:
a. Preparing hardware submittals for field instrumentation.
b. Design, develop, control panel designs, and all other drawing submittals specified in Division 40.
c. Prepare the test plan, the training plan, and the spare parts submittals.
d. Procure all hardware.
e. Provide PCIS system hardware and software.
f. Fabricate panels.
g. Perform bench calibration and verify calibration after installation.
h. Oversee and certify installation of the PCIS system.
i. Oversee, document, and certify loop testing.
j. Oversee, document, and certify system pre-commissioning.
k. Conduct the required performance tests.
l. Prepare Operation and Maintenance Manuals (O&MMs).
m. Conduct training classes.
n. Prepare record drawing packages.
o. Integrate the PCIS with instrumentation and control devices provided under other sections as specified.
p. Develop all requisite loop drawings and record drawings associated with equipment provided under other divisions of these specifications and (as specified) owner furnished and existing equipment.
q. Resolve signal, power, or functional incompatibilities between the PCIS and interfacing devices.
r. Perform all required corrective and preventative maintenance.
2. It is the intent of these specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of all equipment furnished by others as

well as equipment furnished by the contractor, as specifically mentioned and which are necessary for complete and successful operation.

3. Provide the complete operating PCIS to perform the specified monitoring, communications, alarm, control, display, and reporting functions in accordance with the requirements of the contract documents.
4. Coordinate all aspects of the work with the ICSC before bidding to ensure that all costs associated with a complete installation are included. The owner is not responsible for any change orders due to lack of coordination of the work between the contractor, the ICSC, and the other subcontractors and/or suppliers.
5. Furnish detailed, complete, and thorough operations and maintenance documentation; including, but not limited to operations manuals, maintenance manuals, as-built wiring drawings, training manuals, as-built software documentation, vendor-supplied software documentation, final as-installed software configurations and all other documentation required to operate, modify and maintain all parts of the PCIS.
6. Where demolition is shown on any drawing, the electrical subcontractor is responsible for disconnecting equipment electrical connections and rendering the equipment safe. The ICSC is responsible for physically removing all instrumentation to be demolished and return it either to the Owner or dispose of it as directed by the owner's representative. The ICSC shall be responsible for any program modifications required based on the demolition of the equipment; both for the loops directly and indirectly affected.
7. Portions of this project may involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
   a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before performing any work.
   b. Provide and document any interface with, modifications to, upgrade to or replacement of existing circuits, power systems, controls, and equipment.
8. Revise in a manner as directed by the Engineer all I/O and addressing that the Engineer determines to be unacceptable as a result of a lack of contractor coordination between contract documents and all subcontractors and/or suppliers.
9. Defective Work:
   a. Refer to the General Conditions.

B. System Overview: The new PCIS shall include but not be limited to the following:
   1. Control Panels to be furnished for the PCIS shall include, but may not be limited to:

Facility	Panel tag	Description	Supplied by	Installed by	Reference Specification	PLC/HMI Programming By
PUMP STATION	RTU	PLC BASED CONTROL PANEL AND SCADA INTERFACE	INTEGRATOR	CONTRACTOR	40 63 43, 40 78 00	INTEGRATOR

   2. All required SCADA hardware, software, and programming by Integrator.

C. General:
   1. Furnish submittals that are fully developed for a given section of the work and fully indexed with a tabbed divider for every element and component.

2. Sequentially number the pages within the tabbed sections. Submittals and Operation and Maintenance Manuals (O&MMs) that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
3. Edit all submittals and O&MMs so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished so that the information remaining is only applicable to the equipment being furnished.
4. Instruct all equipment suppliers of submittal and O&MMs in the requirements of Section 40 61 00 - Process Control and Instrumentation Systems, General.
5. Submittal Requirements:
    a. Submit copies of shop drawings, and product data, in accordance with Division 1 requirements in addition to the requirements of this section. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
    b. Where submittals are required, provide a separate submittal for each specification section. To expedite construction, the contractor may make more than one submittal per specification section, but a single submittal may not cover more than one specification section. The only exception to this requirement is when one specification section covers the requirements for a component of equipment specified in another section.
6. Exceptions to specifications and drawings:
    a. Include a list of proposed exceptions to the specifications and drawings along with a detailed explanation of each.
    b. Any exceptions to the specification and drawings must be noted and the reason for the exception explained.
    c. If there is insufficient explanation for the deviation, the submittal will be returned requiring revision and re-submittal.
    d. Acceptance of any exception is at the sole discretion of the Engineer. Furnish all items (materials, features, functions, performance, etc.) that are not listed as exceptions strictly in accordance with the specifications and drawings.
    e. Replace all items that do not strictly meet the requirements of the specifications, which were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.
7. Submittal Organization:
    a. First page:
        1) Specification Section reference.
        2) Name and telephone number of individual who reviewed submittal before delivery to Engineer.
        3) Name and telephone number of individual who is primarily responsible for the development of the submittal.
        4) Place for contractor's review stamp and comments.
    b. Next pages:
        1) Provide confirmation of specification compliance in a tabular form that individually lists each specification section, paragraph, and sub-paragraphs and unequivocally states compliance with said requirement or takes exception to the requirement and lists the reason for said exception and offers alternative means for compliance.

2) Include a response in writing to each of the Engineer's comments or questions for submittal packages which are re-submitted:
   a) In the order that the comments or questions were presented throughout the submittal.
   b) Referenced by index section and page number on which the comment appeared.
   c) Acceptable responses to Engineer's comments are either:
   d) Engineer's comment or change is accepted and appropriate changes are made.
   e) Explain why comment is not accepted or requested change is not made.
   f) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
   g) Any re-submittal, which does not contain responses to the Engineer's previous comments, shall be returned for revision and re-submittal.
   h) No further review by the Engineer will be performed until a response for previous comments has been received.

c. Remaining pages:
   1) Actual submittal data:
      a) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
      b) For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is intended to be used.

d. Specific submittal requirements:
   1) Furnish the submittals required by each section or Division 27:
      a) Product Data.
      b) Shop Drawings.
   2) Use equipment and instrument tags as depicted on the P&IDs for all submittals.
   3) Adhere to wiring numbering scheme outlined in Division 26 throughout the project:
      a) Uniquely number each wire per the specifications.
   4) Wire numbers must appear on all equipment drawings.

e. In these contract documents, some items of work are represented schematically, and are designated for the most part by numbers, as derived from criteria in ANSI/ISA S5.1:
   1) Employ the nomenclature and numbers designated herein and on the drawings exclusively throughout shop drawings, data sheets, and similar submittals.
   2) Replace any other symbols, designations, and nomenclature unique to a manufacturer's, suppliers, or subcontractor's standard methods with those identified herein and on the drawings.

f. Furnish submittals in the following general order, each in a separate bound set:
   1) Product Data.

2) After approval of the Product Data, submit the Project Shop Drawing submittals
3) Testing, Calibration and Start-up procedures.
4) Operation and Maintenance Data.
5) Training Submittals.
6) Record Documents.

D. Product Data:
1. General:
a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these specifications.
c. Include:
1) Catalog cuts.
2) Bulletins.
3) Brochures.
4) Quality photocopies of applicable pages from these documents.
5) Identify on the data sheets the project name, applicable specification section, and paragraph.
6) Identify model number and options for the actual equipment being furnished.
d. Neatly cross out options that do not apply or equipment not intended to be supplied.
2. Material and Equipment Schedules:
a. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and instruments that are proposed:
b. Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
3. Instrument Data Sheets and Cut Sheets:
a. Provide fully completed data sheets, both electronically in Microsoft Word or Excel and in hardcopy, for each instrument and component according to ISA S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. Include the following information on the data sheet:
1) Component functional description used herein and on the drawings.
2) Manufacturers model number or other product designation.
3) Tag number used herein and on the drawings.
4) System or loop of which the component is a part.
5) Location or assembly at which the component is to be installed.
6) Input and output characteristics.
7) Scale range and units and multiplier.
8) Requirements for electric supply.
9) Requirements for air supply.
10) Materials of construction and of component parts that are in contact with, or otherwise exposed to, process media, and or corrosive ambient air.

11) Special requirements or features, such as specifications for ambient operating conditions.
12) Features and options that are furnished.

b. Provide a technical brochure or bulletin ("cut sheet") for each instrument on the project. Submit with the corresponding data sheets:
1) Where the same make and model of instrument is used in two or more applications on the project, and the process applications are nearly identical, and the materials, features and options are identical submit one brochure or bulletin for the set of identical instruments.
2) Include a list of tag numbers for which it applies with each brochure or bulletin.
3) Furnish technical product brochures that are complete enough to verify conformance with all contract document requirements, and to reflect only those features supplied with the device.
4) Cross out models, features, options, or accessories that are not being provided.
5) Clearly mark and identify special options and features.

c. Organization: Index the data sheets and brochures in the submittal by systems or loops.

4. Control Panel Hardware Submittal:
a. Submit the following in one submittal package.
b. Complete and detailed bills of materials:
1) Including quantity, description, manufacturer and part number for each assembly or component for each control panel.
2) Include all items within an enclosure.

c. Complete grounding requirements for each system component including any requirements for PLCs, process LANs and SCADA equipment.
d. Requirements for physical separation between control system components and 120VAC, 480VAC and medium voltage power cables.
e. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.
f. Heat Dissipation in Enclosures calculations with proposed equipment to dissipate and resolve heat rise issues within each panel.
g. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:
1) The manufacturer's model number or other identifying product designation.
2) Tag and loop number.
3) System of which it is a part of.
4) Site to which it applies.
5) Input and output characteristics.
6) Requirements for electric power.
7) Device ambient operating requirements.
8) Materials of construction.

E. Shop Drawings:
1. General:

a. Coordinate all aspects of the work so that a complete, instrumentation, computer, and control system for the facility is supported by accurate shop and record drawings:
    1) Clearly show every wire, circuit, and terminal provided under this contract on one or more submitted wiring diagrams.
b. Show all interfaces between any of the following: instruments, vendor control panels, motor control centers, motor starters, variable speed drives, control valves, flow meters, chemical feeders and other equipment related to the PCIS.
c. Organize the shop drawing submittals for inclusion in the O&MMs:
    1) Furnish the initial shop drawing submittal bound in one or more standard size, 3-ring, D-ring, loose leaf, vinyl plastic, hard cover binders suitable for bookshelf storage.
    2) Binder ring size: 2 inches.
d. Include the letterhead and/or title block of the firm responsible for the preparation of all shop drawings. Include the following information in the title block, as a minimum:
    1) The firm's registered business name.
    2) Firm's physical address, email address, and phone number.
    3) Owner's name.
    4) Project name and location.
    5) Drawing name.
    6) Revision level.
    7) Personnel responsible for the content of the drawing.
    8) Date.
e. The work includes modifications to existing circuits:
    1) Clearly show all modifications to existing circuits.
    2) In addition, show all existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
f. All drawings that show a modification of an existing circuit must include the name and signature of the individual who performed the field verification work, along with a statement that the individual personally performed the field verification and that the information shown is correct.

2. Shop drawing requirements:
    a. Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
    b. Locations of conduit entrances and access plates.
    c. Component layout and identification.
    d. Schematic and wiring diagrams with wire numbers and terminal identification.
    e. Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
    f. Anchoring method and leveling criteria, including manufacturer's recommendations for the seismic and wind conditions.
    g. Weight.
    h. Finish.
    i. Nameplates.
    j. Temperature limitations, as applicable.

3. Control Panel Drawings:
    a. Layout Drawings:
        1) Submit panel, enclosure, console, furniture and cabinet layout drawings for all items provided.
        2) As a minimum, include the following information:
            a) To scale front, side and plan views.
            b) All dimensions.
            c) Heat dissipation in electrical enclosure calculations to include surface area, heat input, enclosure temperature rise, safety margins, outdoor applications and resolutions and equipment to be used to help dissipate heat rise for each enclosure.
            d) Interior and exterior arrangements.
            e) Mounting information, including conduit entrance location.
            f) Finish data.
            g) Tag number and functional name of items mounted in/on each panel, console and cabinet.
            h) Nameplate legend including text, letter size and colors.
    b. Wiring and Piping Diagrams:
        1) Submit panel wiring and piping diagrams for every panel that contains wiring and/or piping.
        2) Include the following information:
            a) Name of panel.
            b) Wiring and piping sizes and types.
            c) Terminal strip numbers.
            d) Wire tags and labels.
            e) Functional name and manufacturer's designation for items to which wiring and piping are connected.
            f) Electrical control schematics in accordance with ANSI standards.
    c. Installation drawings:
        1) Provide site-specific installation drawings for all control equipment panels; including dimensions.
        2) Provide scaled drawings and show the position of the equipment at its intended installation location.
        3) Show the placement of all equipment being provided under this contract and its spatial relationship to all other equipment located in the abutting and adjoining areas.
        4) Show all required access and clearances associated with the equipment with a statement of compliance to manufacturer's recommendations, NEC requirements and other applicable codes.
4. Schematic Diagrams:
    a. Submit schematic diagrams for all electrical equipment in ladder diagram format.
    b. Include device and field connection terminal numbers on all schematic diagrams.
    c. Incorporate equipment manufacturer's shop drawing information into the schematic diagrams in order to document the entire control system.

F. Testing, Calibration, and Start-up Submittal:

1. General testing submittal requirements are specified in this section.
2. Test Procedure Submittals:
    a. Submit the proposed procedures to be followed during tests of the PCIS and its components in two parts:
        1) Preliminary Submittal: Outline of the specific proposed tests and examples of proposed forms and checklists.
        2) Detailed Submittal: After successful review of the preliminary submittal, submit the proposed detailed test procedures, forms and checklists. Include a statement of test objectives with the test procedures.
3. Provide certified and witnessed test and calibration checklists for each of the following tests:
    a. Calibration, adjustment and test details for all components and systems.
    b. Factory Acceptance Tests.
    c. Loop Validation Tests.
        1) Loop Validation Certifications:
            a) After the field device loop tests have been successfully completed for all individual instruments, all separate analog control networks, all valves, all VCPs, all motors, all local operator interface panels, all motor control centers, etc., submit a certified copy of all test forms signed by the contractor, Integrator and the owner's representative, with test data entered, together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected and tested.
    d. Pre-commissioning Test.
    e. Performance Test.
4. Factory Acceptance Test:
    a. Include complete test procedures and forms to be used during the test.

G. Operation and Maintenance Manuals:
1. Furnish the Engineer with a complete preliminary set of written O&MMs eight (8) weeks before calibration, start-up and/or testing.
2. Furnish in accordance with the following additional requirements.
3. Submit preliminary sets of these manuals to the Engineer for review of format and content:
    a. Engineer will return one (1) set with comments.
    b. Revise and/or amend as required and submit the requisite number of copies to the Engineer fifteen (15) days before pre-commissioning of the systems.
4. Incorporate changes that occur during startup and submit as part of the final manuals.
5. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
6. Include record documents and the approved shop drawing submittals modified for conditions encountered in the field during the work.
7. Include signed results from Calibration, Loop Validation Tests, Pre-commissioning, and Performance Testing.
8. Provide installation, connection, operating, calibration, setpoints (e.g., pressure, pump control, time delays, etc.), adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.

9. Provide exploded or other detailed views of all instruments, assemblies and accessory components together with complete parts lists and ordering instructions.
10. Spare Parts List:
    a. Include a priced list of recommended spare parts for all the equipment furnished under this contract. Include recommended quantities sufficient to maintain the furnished system for a period of five (5) years.
    b. Annotate the list to indicate which items, if any, and quantities are furnished as part of this contract.
    c. Provide the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts.
11. Organize the O&MMs for each process in the following manner:
    a. Section A - Process and Instrumentation Diagrams.
    b. Section B- Loop Drawings.
    c. Section C- Instrument Data Sheets and Brochures.
    d. Section D- Sizing Calculations.
    e. Section E- Instrumentation Installation Details.
    f. Section F- Test Results.
    g. Section G- Operational Manual.
    h. Section H- Spare Parts List.
12. Training Submittals:
    a. Develop and submit for review a General Training Plan. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).
    b. The Engineer will review the General Training Plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the Engineer, the proposed instructor(s) are not sufficiently qualified to conduct the specified training courses or lack experience on the specific configuration of the system, additional training must be provided by more qualified instructors.
    c. Training Course Plan submittals:
        1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson.
        2) Describe any student pre-requisites for the course or training activity.
        3) Provide an updated schedule for all sessions of the course; including dates, times, durations and locations.
        4) Submit training materials.
    d. Incorporate all submittal review comments into the course.
    e. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.

H. Record Documents:
1. Provide record documents of all instrumentation drawings.
2. Record Drawing requirements:
    a. Update record drawings regularly throughout the project (monthly as a minimum).

b. Record drawings must be fully updated as a condition of the monthly progress payments.
c. Submit final fully updated record drawings upon completion of the work for final review.
d. Clearly and neatly show all changes in accordance with all existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.

3. Shop Drawings:
   a. Upon completion of the work, update all shop drawings to indicate the final as-built configuration of the systems:
      1) Should an error be found in a shop drawing during installation or startup of equipment, note the correction, including any field changes found necessary on the drawing and submit the corrections in the record documents.
      2) Update, check, and revise all wiring drawings and other submitted drawings and documents to show final installed conditions.
   b. Provide "As-Built" shop drawings for all instrumentation equipment on 11x17 inch using bond paper.
   c. Provide electronic copies of these documents on CD-ROM disks in AutoCad Version 2014, or later, by Autodesk. Size all drawings to be readable and legible on 11x17 inch media.
4. Submittal Documents:
   a. Provide an interim submittal of record documents after the PCIS system pre-commissioning but before performance testing.
   b. Submit final record documents before substantial completion or earlier if so specified.
5. Review and Corrections:
   a. Correct any record documents or other documents found to be incomplete, not accurate, of poor quality or containing errors.
   b. Promptly correct and re-submit record documents returned for correction.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Perform all instrumentation and control work, whether needed for the power, control system, process, HVAC, telephone, security, etc. in accordance with all codes and standards.

B. Unless otherwise specified, each individual instrument shall have a minimum accuracy of ±0.5 percent of full scale and a maximum repeatability of ±0.25 percent of full scale.

C. Conduct Factory Acceptance Tests in accordance with paragraph 2.09 of this section.

D. Installation supervision in accordance with paragraph 3.04 of this section.
   1. Calibration: The Contractor shall furnish the services of trained technicians to perform a complete calibration of each instrument and device, as specified in this specification.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Store all equipment and materials delivered to the job site in a location that will not interfere with the construction or the owner's operations.

B. Shipping Precautions:
   1. After completion of shop assembly, successful factory acceptance test, pack all equipment, cabinets, panels, and consoles in protective crates and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust and moisture.
   2. Place dehumidifiers, when required, inside the polyethylene coverings.
   3. Skid-mount the equipment for final transport.
   4. Provide lifting rings for moving without removing protective covering.
   5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing and handling at the job site.

C. Special Instructions:
   1. Securely attach special instructions for proper field handling, storage and installation to each piece of equipment before packaging and shipment.

D. Tagging:
   1. Tag each component and/or instrument to identify its location, instrument tag number and function in the system.
   2. Firmly attach a permanent tag, indelibly machine marked with the instrument tag number as given in the tabulation, on each piece of equipment constituting the PCIS.
   3. Tag instruments immediately upon receipt in the field.
   4. Prominently display identification on the outside of the package.
   5. Utilize the tag and loop number identifications shown of the P&IDs.

E. Delivery and Inspection:
   1. Deliver products in undamaged condition, in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label.
   2. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record the receipt of products at the site. Inspect for completeness and evidence of damage during shipment.
   3. Remove damaged products from the site and expedite delivery of identical new undamaged products, augment incomplete shipments or replace lost products in order not to delay the progress of the work.

F. Storage and Protection:
   1. Provide for the safe storage and delivery of materials; whether furnished by the contractor or by others.
   2. Meet all storage requirements of the manufacturer and provide for the safe storage of all materials and equipment as recommended by the manufacturer.
   3. Store all equipment in dry permanent shelters:
      a. Provide adequate protection for stored equipment against mechanical injury.
      b. Provide space conditioning to meet the manufacturer's recommendations.

4. Protect instrumentation and control work at all times from damage, defacement or deterioration from any cause whatever.

1.7 PROJECT OR SITE CONDITIONS

A. Site Conditions:
   1. Provide a PCIS, including all equipment, raceways and any other components required for a complete installation that meets the environmental conditions for the site as specified in the general requirements and below.
   2. Area Classifications:
      a. Furnish enclosures that match the area classifications.
   3. Site Security:
      a. Abide by all security and safety rules concerning the work on the site.

1.8 SEQUENCING

A. General:
   1. General scheduling requirements as specified.
   2. Testing requirements.
   3. Work restrictions and other scheduling requirements.

B. Loop Validation Test:
   1. Notify the Engineer of scheduled tests a minimum of thirty (30) days before the estimated completion date of installation and wiring of the PCIS.
   2. Complete testing a minimum of five (5) days before the pre-commissioning phase of the project.

C. Training:
   1. Complete all training before the pre-commissioning phase of the project may start.
   2. Schedule the training sessions a minimum of fifteen (15) days prior to the start date of the courses.
   3. Submit training manuals to the Engineer a minimum of ten (10) days before starting the training session.
   4. Within ten (10) days after the completion of each session, submit the following:
      a. A list of all owner personnel that attended the session.
      b. A copy of the training materials utilized during the lesson with all notes, diagrams and comments.

D. Pre-Commissioning Test:
   1. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests and all inspections have demonstrated that the PCIS complies with all Contract requirements.
   2. Acceptance of the PCIS pre-commissioning testing must be provided in writing by the Engineer before the performance testing may begin.

E. Provide all special tools and spare parts, refer to Paragraph 1.15 of this Section, before performance testing commences, suitably wrapped and identified.

F. Performance Testing:

1. Complete Pre-commissioning test a minimum of five (5) days before the Performance Test.
2. Conduct a 14-day Performance Test.

G. Substantial Completion: The following conditions shall be fulfilled before the PCIS is considered complete:
1. All submittals have been completed and approved.
2. The PCIS has been calibrated, loop tested and pre-commissioned.
3. The owner training has been performed.
4. All required spare parts, expendable supplies and test equipment have been delivered to the owner.
5. The performance test has been successfully completed.
6. All debris associated with installation of instrumentation has been removed.
7. All probes, elements, sample lines, transmitters, tubing and enclosures have been cleaned and are in like-new condition.

1.9 WARRANTY

A. Warrant the PCIS in accordance with the General Conditions:
1. Provide additional warranty as specified in the individual specifications.

1.10 SYSTEM STARTUP

A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

1.11 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As called out on Drawings and specified in individual instrument and equipment specifications in other sections of Division 40.

2.2 MATERIALS

A. Furnish all materials under this contract that are new, free from defects and standard products produced by manufacturers regularly engaged in the production of these devices and that bear all approvals and labels as required by the specifications.

B. Provide materials complying with the applicable industrial standards in accordance with the General Conditions.

2.3 COMPONENTS

A. Furnish all meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings; unless otherwise specified to match existing equipment.

B. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of ±0.5 percent of full scale and a minimum repeatability of ±0.25 percent of full scale.

C. Signal Transmission:
   1. Analog Signals:
      a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable; unless otherwise indicated.
      b. Furnish electrical analog signals outside control panels that are 4-20mA /24VDC; except as indicated.
      c. Analog signals within enclosures may be 1-5VDC.
      d. Electrically or optically isolate all analog signals from other signals.
      e. All pneumatic signals shall be controlled by a 3-15psig span.
      f. Discrete input signal: as indicated in the controller hardware specification.
      g. Discrete output signals:
         1) Dry contacts or TRIAC outputs (with express written approval by the Engineer) as needed to coordinate with the field device.
         2) Interposing Relays:
            a) Provide interposing relays for all discrete outputs connected to the PLC; unless relay output PLC cards are provided as part of the PLC system.
      h. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
      i. Maintain the total loop impedance of 10% below the published total loop impedance for 4-20mA signals at the rated value for the regulating device at the loop operating voltage.
      j. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.

D. Discrete Circuit Configuration:
   1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
   2. Alarm contacts: Fail to the alarm condition.
   3. Control contacts fail to the inoperative condition unless otherwise indicated on the drawings.

E. Grounding:
   1. Provide control panels with a signal ground bus isolated from the power ground bus:
      a. Provide multiple panels in one location with a common point for signal ground bus connection to ground.
   2. Single-point ground shields and measurement loops at the source panel external terminals, unless otherwise noted, by bonding to the control panel signal ground bus.

3. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output; except when the panel circuit is galvanically isolated.

2.4 ACCESSORIES

A. Provide flow conditioning devices or other required accessories if necessary to meet the accuracy requirements in the contract documents.

2.5 SOURCE QUALITY CONTROL

A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products that bear all approvals and labels as required by the specifications.

B. Arrange with all manufacturers of the equipment and fabricators of panels and cabinets, to allow the owner and Engineer to inspect and witness the testing of the equipment at the site of fabrication:
   1. Equipment includes the cabinets, special control systems, flow measuring devices and other pertinent systems and devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Review the existing site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

B. Provide a complete instrumentation and control system:
   1. Install all extra conduits, cables and interfaces as may be necessary to provide a complete and operating electrical and process control and instrumentation system.

3.2 INSTALLATION

A. The construction and installation of all instrumentation, control equipment and materials must comply with all applicable provisions of:
   1. National Electrical Code.
   2. Applicable local codes and regulations.

B. Equipment locations shown on the drawings may change due to variations in equipment size or minor changes made by others during construction:
   1. Verify all dimensions as indicated on the drawings. Actual field conditions govern all final installed locations, distances and levels.
   2. Review all information shown on the drawings, including architectural, structural, mechanical, instrumentation and electrical to coordinate work as necessary to adjust to all conditions that arise due to such changes.
   3. Make minor changes in location of equipment before rough-in; upon approval and as directed by the owner and/or Engineer.

C. Perform all related electrical work in accordance with the applicable Sections of Division 26.

D. The PCIS configurations are diagrammatic:
   1. The locations of equipment are approximate unless dimensioned.
   2. Where project conditions require, make reasonable changes in locations and arrangements; upon approval by owner and/or Engineer.

E. Field Instruments Installation:
   1. Install field instruments in accordance with the contract documents, ANSI/API 550 and 551 and the manufacturer's instructions.
   2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
      a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the drawings.
      b. Provide sun shields for all field electronic instruments exposed to direct sunlight.
   3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
      a. Type of flexible conduit required for the area classification. Refer to Section 26 00 00 for area classification.
      b. Maximum length of 24 inches or to meet local code.
   4. Connect field instruments with cable as specified in Division 26, except when the manufacturer requires the use of special cable, or otherwise specified herein. Special cable applications shall be in accordance with the NEC.
   5. Verify the correctness of each installation:
      a. Polarity of electric power and signal connections.
      b. Ensure all process connections are free of leaks.

F. Process Sensing Lines and Air Tubing:
   1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
   2. Provide supports for rigid tubing at intervals of not more than 3 feet.
   3. Slope horizontal runs of instrument tubing at a minimum of 1/16th-inch per foot to allow for draining of any condensate.
   4. Bends:
      a. Use proper tool.
      b. Make bends for parallel lines symmetrical.
      c. Make bends without deforming or thinning the walls of the tubing.
   5. Square-cut and clean all ends of tubing before being inserted in the fittings.
   6. Provide bulkhead fittings at all panels requiring pipe and/or tubing entries.
   7. Use stainless steel tubing for all piping that is hard piped from the air header, unless otherwise noted on the drawings or not compatible with the fluids or atmosphere in the area.
   8. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times to maximum travel of the equipment.

G. Conduit, Cables, and Field Wiring:
   1. Provide all PCIS equipment cables and process LAN communication networks under Division 40.

2. Provide terminations and wire identification as specified in Division 26.
3. Protect all wiring from sharp edges and corners.
4. Provide all conduits, fittings, boxes, etc. in accordance with all the requirements of Division 26.

H. Equipment Tie-Downs:
1. Anchor all instruments, control panels and equipment by methods that comply with seismic and wind bracing requirements which apply to the site.
2. All control panels, VCPs, LCPs, RTUs, PCM's, etc., shall be permanently mounted and tied down to structures.

I. Existing Instrumentation:
1. Clean, recondition and re-calibrate each existing instrument to be reused, removed or reinstalled using an authorized service facility of the instrument manufacturer.
2. Provide certification of this work before reinstallation of each instrument.

J. Instrument Tagging:
1. See Drawings.
2. Provide all field-mounted instruments with nameplates:
   a. Nameplates engraved with the instrument's full tag number as indicated on the drawings. Affix tags with stainless steel wire fasteners.
3. Provide all back of panel instruments with nameplates engraved with the instrument's full tag number as indicated on the drawings.
4. Provide all front of panel instruments with a nameplate:
   a. Engravings to include the instrument's full tag number and service description.
   b. Secure nameplates to the panel with stainless steel screws.
   c. Use an approved adhesive if screws would violate the NEMA or other ratings of the enclosure.

K. Cable and Conductor Termination:
1. Terminate all cables and conductors on terminal blocks.
2. Provide terminal block enclosures, where required, suitable for the area classification as specified in Division 26.

L. Surge Protection:
1. Provide outdoor field instrument loops with voltage surge protection units at instruments.
2. Individually fuse each 4-20mA DC loops with a 1/16 ampere slow blow fuse between power supplies and receiver surge protectors.
3. Provide voltage surge protection for 4-wire transmitters and analyzers, protecting both power source and signal loop.

M. FIELD QUALITY CONTROL

N. Inspection:
1. Allow for inspection of PCIS installation.
2. Provide any assistance necessary to support inspection activities.
3. Engineer inspections may include, but are not limited to, the following:

a. Inspect equipment and materials for physical damage.
b. Inspect installation for compliance with drawings and specifications.
c. Inspect installation for obstructions and adequate clearances around equipment.
d. Inspect equipment installation for proper leveling, alignment, anchorage and assembly.
e. Inspect equipment nameplate data to verify compliance with design requirements.
f. Inspect cable terminations.

4. Inspection activities conducted during construction do not satisfy inspection requirements.

O. Field Testing as specified.

P. Installation Supervision:

1. Ensure that the entire PCIS is installed in a proper and satisfactory manner. At a minimum provide the following services:
   a. Installation Resources:
      1) Coordinate with the contractor regarding installation requirements of the contract documents.
      2) Provide technical assistance to installation personnel by telephone or face-to-face.
      3) Furnish installation personnel with at least one copy of the approved submittals.
      4) Provide the instrument installation details specified in Article 1.05 - Submittals.
      5) Provide periodic inspections during the construction period.
      6) Provide a complete check of the completed installation to ensure that it is in conformance with the requirements of the equipment manufacturer and the contract documents.
      7) Field verify accuracy and calibration of all instruments.

3.3 ADJUSTING

A. Control Valves:

1. Stroke all control valves, cylinders, drives and connecting linkages from the OIT and/or HMI, as well as local control devices. Adjust to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions and remote feedback of valve status and position indication.
2. Check control valve actions and positioner settings with the valves in place to ensure that no changes have occurred since the bench calibration.

B. Make all revisions necessary to the control system software, as directed by the Engineer. It is understood that the contractor knows and agrees that changes will be required in the control system software during the Factory Acceptance Tests, the Pre-Commissioning, Performance Testing, Start-up and during the warranty period.

3.4 CLEANING

A. Vacuum clean all control panels and enclosures before start-up and again after final completion of the project.

B. Clean all panel surfaces.

C. Return to new condition any scratches and/or defects received during installation.

D. Wipe all instrument faces and enclosures clean.

E. Leave wiring in panels, manholes, boxes and other locations in a neat, clean and organized manner:
   1. Neatly coil and label all spare wiring lengths with to-from indications for each set.
   2. Shorten, re-terminate and re-label excessive spare wire and cable lengths, as determined by the Engineer.

F. As specified in other sections of the contract documents.

END OF SECTION

SECTION 40 63 43
PLC-BASED CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. PLC-based control systems shall be supplied by the Integrator as specified in 40 61 00 and the Contract Documents. Installation shall be by the Contractor. All requirements for supply shall be in accordance with this Section and all suppliers are referred to as the Contractor for the purpose of supply.

B. The Contractor shall supervise installation, assemble, configure, and place into service the PLC-based control system.

C. Provide a complete and operational system, fully programmed to meet all the requirements of the Proposal Documents. The following work, equipment and services shall be included in this Contract but not be limited to:
   1. Prepare and submit for approval complete control system hardware and software shop drawings.
   2. Furnish complete and operational control systems, including all peripherals and other equipment specified herein.
   3. Perform all control system tests, adjustments, and calibrations.
   4. Furnish qualified labor to perform start-up services.
   5. Furnish qualified instructors to provide complete control system instruction and training.
   6. Furnish all required control system tools, test equipment, spare parts, supplies, technical manuals, reproducible "As-Built" drawings, and program listings as specified herein.

D. All PLCs provided for the control system shall exhibit 100 percent interchangeability of parts.

E. The Proposal Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its sub-contractors to review all sections to insure a complete and coordinated project. In particular, the following sections should be used in conjunction with this section:
   1. Section 40 61 00 – Process Control and Instrumentation Systems General
   2. Section 40 78 00 – Control Panel Instruments

1.2 REFERENCES

A. All PLC-based control systems provided under this contract shall comply with all the commercial standards and codes in accordance with Section 40 61 00 – Process Control and instrumentation Systems General.

1.3 DEFINITIONS

A. Definitions used in this section are in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.4 SUBMITTALS

A. Shop drawing submittals shall be provided in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General and Section 01 33 00 – Submittal Procedures.

1.5 QUALITY ASSURANCE

A. All work shall be performed in accordance with quality assurance and warranty requirements specified in Section 40 61 00 – Process Control and Instrumentation Systems General.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. All equipment and materials delivered to the job site shall be stored in a location which will not interfere with the operations of the Owner's personnel or interfere with construction.

B. Storage and handling will be performed in manners which will afford maximum protection to the equipment and materials.

C. It is the Contractor's responsibility to assure proper handling and on-site storage.

D. Unless otherwise specified, all PLC-based control systems hardware shall be delivered to the project site and stored in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.7 PROJECT / SITE CONDITIONS

A. The project site conditions are defined in Section 40 61 00 – Process Control and Instrumentation Systems General.

1.8 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, work outlined in this section shall be scheduled and sequenced as specified in Section 40 61 00 – Process Control and Instrumentation Systems General.

B. Training shall be conducted in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.
   1. The training as required by paragraph 3.4 of this Section shall be scheduled concurrent with the calibration, equipment testing, and process system testing phases of the project.

1.9 MAINTENANCE

A. Maintenance shall be provided in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and all PLC equipment furnished under this Contract shall be new, free from defects, of first quality, off-the-shelf and produced by manufacturers regularly engaged in the manufacture of these products. No proprietary hardware or software may be used.

B. Hardware Commonality: Where there is more than one item of similar equipment being furnished all such similar equipment shall be the product of a singular manufacturer.

C. All CPEs, I/O modules, power supplies and other accessories required to form a complete system shall be as shown in the drawings but are the responsibility of the Contractor to furnish to provide a complete, operable system.

2.2 EQUIPMENT

A. Provide major equipment as follows:
   1. As shown on attached table following this Section, listed as 40 63 43a PLC-Based Control System List.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The contractor shall utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies which it furnishes.

B. After installation of the entire control is completed, the installation shall be inspected jointly by the supplier, contractor, owner and/or Engineer.
   1. Any problems shall be corrected immediately. When all parties are satisfied with the installation, a written certification of the installation shall be delivered to the Engineer.
   2. The certification shall state that all PLC communications and I/O modules, modems, system grounds, LAN, communication network, workstations, printers, and all other components of the control system have been inspected and are installed in accordance with the manufacturer's guidelines.

C. Unless otherwise specified, the ICSC shall provide field inspection services in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

3.2 FIELD QUALITY CONTROL

A. Testing of all analog inputs and outputs of the control system shall have their calibration checked at a minimum of five points (0%, 25%, 50%, 75% and 100%) to verify consistency with the balance of the analog loop.
   1. This calibration check shall be done in conjunction with the analog loop tests specified in Section 40 61 00.

2. Workstations displays and PLC tag name registers shall both be verified for correctness.

B. After the control system installation has been certified and the analog points have been calibrated, the entire Process Control System shall be tested to verify that all discrete inputs and outputs of all PLCs and any workstations are correct.
   1. As much as possible, points shall be checked "end-to-end". For example, valve status inputs shall be checked by stroking the valve and a pump start output shall be checked by using it to start the pump.
   2. Simulated testing shall be allowed only when no practical alternative exists.
   3. Workstation displays shall be verified for correctness at the same time.
   4. An I/O checklist developed by the ICSC shall be used to record test results and a copy provided to the Engineer upon completion.
   5. The ICSC shall submit to the Engineer a system testing completion report demonstrating Process Control System conforms to requirements of this section.

C. SCADA System Testing: After all system and subsystem installations have been certified and analog loop calibration and discrete I/O testing have been completed, the SCADA system testing shall be performed by the installation contractor.
   1. SCADA system testing shall operate the various process systems of the facility to verify compliance with all functional requirements specified, including the automatic control modes and control system interlocks.
   2. Tests which fail to demonstrate the required operation shall be repeated in their entirety or continued after corrective action has been completed at the discretion of the owner and/or Engineer.
   3. During SCADA system tests, the ICSC shall have a representative on-site continuously who is capable of troubleshooting and modifying the Process Control System configuration programming.

D. Plant Pre-commissioning Start-up Test: The ICSC shall provide start-up support to include the installation contractor's personnel, electrical personnel, chemical feed system personnel and the PLC and SCADA software system manufacturer's representative as required during the testing period to produce a fully operational facility.
   1. This support shall be provided at no additional cost to the owner.
   2. Pre-commissioning and start-up test shall be conducted in accordance with the requirements of Section 40 61 00.

E. Final Acceptance Test: During this test, the entire SCADA control system shall be continuously operated and maintained, 7 days per week, 24 hours per day, during the test period, with zero downtime resulting from system failures. If a system failure occurs, the test shall be considered a failure and not acceptable and the installation contractor shall be required to repeat the test from the beginning. The entire control system shall be acceptable only after all equipment and software has satisfied the performance test requirements. At no additional cost to the owner, the ICSC shall be responsible for any downtime or project delays resulting from system failures related to the Process Control System. Downtime resulting from the following shall be considered system failures:
   1. If a component failure cannot be repaired/replaced within 4 hours.

2. Downtime of any component, exclusive of I/O, whose failure results in the inability of the operator to monitor and manipulate control loops from the associated workstations using standard workstation interface procedures.
3. Downtime resulting from concurrent failure of any CRT, keyboard, or mouse which is associated with the workstation.
4. Downtime in excess of 2 hours resulting from any I/O component failure.
5. Downtime resulting from concurrent failure of 2 or more I/O components in a single PLC.
6. Downtime of any component/peripheral associated with the controls network if the failed component results in a disabling of the historical functions or the failed component is not repaired or replaces within 8 hours.

3.3 DOCUMENTATION SCHEDULE

A. When the installation of the Process Control System is complete, a written certification of the installation shall be delivered to the Engineer. The certification shall state that all PLC communication and I/O modules, modems, system grounds, LAN, communication network, workstations, printers, and all other components of the control system have been inspected and are installed in accordance with the manufacturer's and PCIS guidelines contained in all sections of Section 40 in these specifications.
   1. The contractor, through its ICSC, shall submit to the Engineer a system testing completion report when each process system and all aspects of the configuration software have been successfully tested as described herein.
      a. The report shall note any problems encountered and what action was required to correct them.
      b. It shall include a clear and unequivocal statement that the process systems have been thoroughly tested and are complete and functional in accordance with all specification requirements.
   2. The ICSC through the installation contractor shall submit a final acceptance test completion report which shall state that all contract requirements have been met and which shall include:
      a. A listing of all PLC system equipment maintenance/repair and modification activities conducted during testing.
      b. A listing of all components which were unable to operate successfully and how they were replaced/repaired.
   3. Operator & Maintenance Training: Furnish a completion report which shall include a list of all owner personnel that attended the class, an evaluation of owner personnel that attended the class via written testing or equivalent evaluation and a copy of the hard copy text utilized during the class with all notes, diagrams, and comments.

3.4 TRAINING

A. In addition to the training identified in Section 40 61 00 – Process Instruments and Controls General, the ICSC shall provide training for the purpose of familiarizing the owner's maintenance and operating personnel with the use, maintenance, calibration, and repair of all components of the control system.

END OF SECTION

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40 63 43a			
PLC-Based Control Systems List			
Equipment	**Manufacturer**	**Model No.**	**Description (See note at bottom of document)**
Enclosure	Hoffman	A723618FS	72"x36"x18" Freestanding Steel Enclosure
Back Plane	Hoffman	A72P72F1	72"x36" Steel Back Panel
Power Supply	Phoenix Contact	2904601	Power Supply Unit
UPS	Phoenix Contact	2906994	Uninterruptible Power Supply
Battery	Phoenix Contact	1274118	Battery Module
PLC	Allen Bradley	5069-L320ER	CompactLogix 5380 Controller
AI Modules	Allen Bradley	5069-IF8	Analog Input Module
AO Modules	Allen Bradley	5069-OF4	Analog Output Module
DI Modules	Allen Bradley	5069-IB16	Digital Input Module
DO Modules	Allen Bradley	5069-OB16	Digital Output Module
Network Switch	Phoenix Contact	1085254	Industrial Ethernet Switch
Radio	GE MDS	ECRU91NNNNNS1D1USUNNN	Orbit ECR High Performance Unlicensed 900MHz
OIT	Beijer	X2 Pro 10	X2 Pro Industrial HMI

Notes: Approved substitutions shall be allowed.

SECTION 40 71 13
FLOW-MAGNETIC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments shall be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Section 01 33 00.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. Manufacturer's representative shall be responsible for proving flow meter operation and 4-20 ma loop accuracy.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide a spare pipe spool for each meter size to be used in the event the meter tube must be removed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As identified on the instrument list.

B. Hardware Commonality:
1. All instruments, which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters that monitor hydrostatic head, shall be furnished by a single Manufacturer.
2. All panel-mounted instruments shall have matching style and general appearance.
3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 MANUFACTURED UNITS

A. Flow Meters:
1. Magnetic Flow Meters.
a. General:
1) Magnetic flowmeter systems shall be of the low frequency electromagnetic induction type and produce a DC-pulsed linear signal which is directly proportional to the liquid flow rate.
2) Complete zero stability shall be an inherent characteristic of the flowmeter system.
3) Each magnetic flow metering system shall include:
a) A metering tube.
b) Signal cable.
c) Transmitter.
d) Flow meter grounding rings.
b. Source quality control.
1) Shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
c. Metering tube:
1) Constructed of 316 stainless steel
2) Utilize a minimum of 2 bullet-nosed, self-cleaning electrodes.
3) Liner in conformance with:
a) As identified on the instrument data sheet.
b) Manufacturer's recommendations for the intended service.
c) Whichever is the more stringent.
4) Electrodes in conformance with:
a) As identified on the instrument data sheet.
b) Manufacturer's recommendations for the intended service.
c) Whichever is the more stringent.
5) Meter housing NEMA 4X corrosive conditions.
6) Meter coating consisting of epoxy painted finish.
7) Two grounding rings:

a) Which are in conformance with the Manufacturer's bore and material recommendation for the meter's intended service.
b) Designed to protect and shield from abrasion the liner's edge interface at the meter's end.

d. Transmitter.
1) Microprocessor-based signal converter/transmitter.
2) Utilize DC-pulse technique to drive flux-producing coils.
3) Contain a 6-digit display for flow rate, percent of span, and totalizer.
4) Operator interface consisting of keypads which respond to English text entry.
5) Integral zero return to provide a consistent zero output signal in response to an external dry contact closure.
6) Integral low flow cut-off zero return.
7) Automatic range change.
8) Programmable parameters including:
a) Meter size.
b) Full scale flow rate.
c) Magnetic field frequency.
d) Time constant.
9) Data retention for a minimum of 5 years without auxiliary main or battery power.
10) Self-diagnostics and automatic data checking.
11) Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
12) Ambient operating temperature limits of -29 to 60 °C (-20 to 140 °F).

e. Performance requirements:
1) Time constant:
a) 0.5 to 1,000 seconds.
2) Accuracy:
a) 0.25 percent of flow rate from 10 to 100 percent of full scale for velocities over 3 ft per second.
3) Repeatability:
a) 0.25 percent of full scale.
4) Isolation:
a) Galvanic or.
b) Optical.
5) Power supply:
a) 120 VAC ± 10%.
b) 60 Hz.
c) 30 Watts Max.
6) Output/Input signal:
a) Output signal: Measured range – Current 0/4 to 20 mA;

f. Factory testing:
1) Each flow metering system shall be hydraulically calibrated at a facility which is traceable to the National Institute of Testing Standards.
2) The calibration procedure shall conform to the requirements of MIL-STD-45662A.

3) A real-time computer generated printout of the actual calibration data indicating apparent and actual flows at 20%, 40%, 60%, 80% and 100% of the calibrated range shall be submitted to the Engineer at least thirty (30) days prior to shipment of the meters to the project site.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated in facilities and with instruments traceable to the National Bureau of Standards.
   1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, flowrates, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances. Weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
   1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
   2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

B. All instrument calibration shall be witnessed by the Owner's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.

B. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

A. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 72 13
LEVEL-ULTRASONIC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions. Follow all installation and material recommendation based on the manufacturers recommendations. Verify with engineer any discrepancies found.

C. Shop Drawings
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, registers, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

B. Manufacturer's representative shall be responsible for proving all 4-20mA output loops.

C. Instruments shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated storage structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials and equipment required for proper calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As identified on the instrument list.

B. Hardware Commonality:
   1. All instruments, which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters that monitor hydrostatic head, shall be furnished by a single Manufacturer.
   2. All panel-mounted instruments shall have matching style and general appearance.
   3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 EQUIPMENT

A. Ultrasonic Level Transmitter
   1. Shall be of the non-contact microprocessor-based type for the continuous measurement of liquid levels.
   2. Components.
      a. A transducer with sufficient cable attached to the transducer for a complete, non-spliced, cable run from the transducer to the transmitter.
      b. A control transmitter unit which can be located up to 1200 feet away from the sensor.
      c. A removable programming unit.
   3. Transmitter
      a. The transmitter shall store the ultrasonic profile in the processor memory and moment by moment, analyze the profile to determine the actual liquid level.
      b. Unit shall alter the ultrasound profile to enhance the echo with every momentary variation in the various level measuring conditions.
      c. All program data shall be safeguarded internally in non-volatile EEPROM memory.
      d. Enclosure NEMA 4X enclosure with an integral front panel mounted meter indicating in scaled engineering units.
      e. 4-20 mA output directly proportional to level.
      f. The unit shall be capable of displaying by software selection either:
         1) Distance to liquid surface from transmitter.
         2) Distance from bottom of tank to liquid surface.
         3) Remaining volume in tank.
      g. Shall contain a minimum of two relays for use as programmable alarm points.
      h. Power requirements shall be specific to site conditions; either 120 VAC, 24 VDC or loop powered.
      i. Shall be short circuit proof with respect to transducer connections.

4. Transducer
    a. Shall be encapsulated.
    b. Operating temperature range -20°C - 60°C with an accuracy of ± 0.25% of range.
    c. Measuring range 45 feet.
    d. Provided for flange mounting.
    e. Integral temperature compensation.
    f. Manufacturer to furnish sufficient cable attached to the transducer for a complete, non-spliced, cable run from the transducer to the transmitter.
5. Programming Unit
    a. Shall be Windows OS compatible software capable of mapping out echoes through the use of a laptop computer (computer furnished by Owner).
6. Performance requirements:
    a. Accuracy: 0.25% or range or 0.24 inches; whichever is greater.
    b. Resolution: 0.1% or range or 0.08 inches; whichever is greater.
    c. Electronics Ambient Temperature: -5°F to 122 °F (-20°C to 50 °C).
    d. Transducer Process Temperature: -40°F to 300 °F (-40°C to 150 °C).
7. As manufactured by:
    a. Endress+Hauser Prosonic FMU Series w/ FDU Sensor.
    b. Or, Engineer Approved Equal.

2.3 ACCESSORIES

A. Furnish two copies (licensed to the Owner) of the configuration and mapping software ("Time-of-Flight") tools. In addition to the software, furnish two tool cables/adapters, which allow the software to function correctly without the HART interface.

2.4 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated in facilities and with instruments traceable to the National Bureau of Standards.
    1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
   1. It is the ICSC's responsibility to install all instruments in conformance with manufacturer's recommendations.
   2. It is the ICSC's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

B. All instrument calibration shall be witnessed by the Owner's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
   1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

A. The ICSC shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with Paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

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SECTION 40 73 13
PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated storage structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ashcroft 1279 w/ Performance Plus.

B. NoShok 600/700 Series.

C. Dwyer Series 765 or Series 7000B.

D. Wika USA XSEL Series.

E. Or, Engineer Approved Equals.

2.2 MANUFACTURED UNITS

A. Pressure, Vacuum, Compound Gauges.
   1. General.
      a. Furnish and install pressure and vacuum gauges as specified, complete, including all fittings, snubbers, connections, gaskets, supports, and accessories in the locations shown or specified, in accordance with the Contract Documents.
      b. Pressure gauges shall be provided whether or not shown on the plans:
         1) On suction and discharge connection to all pumps.
         2) On discharge connection from blowers and compressors.
         3) On each side of pressure reducing valves.
         4) In other locations as shown on the P&IDs and/or mechanical plans.
      c. Vacuum gauges shall be provided whether or not shown on the plans:
         1) On all supply side educator-type chemical feeders.
         2) In other locations as shown on the P&IDs and/or mechanical plans.
      d. Sleeve pressure gauges.
         1) Shall be provided where shown on the plans.
         2) Pressure shall be sensed by a flexible sleeve contained in a flanged cast iron or steel spool or wafer body, and transmitted to the gauge through a captive fluid.
         3) Sleeve shall be of BUNA-A and fabricated so as to isolate the body from the process liquid.
         4) Gauges shall be calibrated to read in applicable units.
         5) Accuracy of ±1% - 150% of the working pressure of the system to which they are connected.
   2. Construction:
      a. Gauges shall be industrial quality type with Type 316 stainless steel movement.
      b. Phenolic case.
      c. Liquid filled.
      d. Unless otherwise shown or specified, gauges shall have:
         1) A 4-1/2-inch dial.
         2) 1/2-inch threaded connection.
         3) Type pulsation dampener adapter.

a) Pulsation Dampener as manufactured by:
b) Cajon Co.
c) Weksler Instruments, Corp.
d) Ashcroft.
e) Or, Engineered Approved Equal.

4) A block and bleed valve - 1/2 inch national pipe thread process connection and bleed/calibrate valve between block valve and outlet port.

e. Gages shall be calibrated to read in applicable engineering units.
f. Accuracy of ± 0.5% - 150 % of the working pressure or vacuum of the pipe or vessel to which they are connected.
g. All gauges shall be vibration and shock resistant.

3. Diaphragm seals:
   a. Gauges attached to system involving chemical solutions, corrosive fluids, sludge, sewage, or other liquids containing solids shall be equipped with diaphragm seals.
   b. In addition, diaphragm seals shall be provided and included at the locations shown.
   c. Seals shall have clamped housings.
   d. All seals shall have 1/2 inch NPT flushing connection and fluid fill connection.
   e. Diaphragm Seals as manufactured by:
      1) Ashcroft Type 101.
      2) Ametek Type S Series.
      3) NoShok Type 10/10H.
      4) Or, Engineer Approved Equal.
4. Gauges general as manufactured by:
   a. Ashcroft Type 1279 w/ Plus Performance.
   b. Dwyer Series 7000B.
   c. Wika XSEL Model 212.34 (213.34 as required).
   d. Ametek Model 1929.
   e. NoShok 700 Series.
   f. Or, Engineer Approved Equal.
5. Gauges sleeve pressure as manufactured by:
   a. Red Valve Co., Inc.
   b. Onyx.
   c. NoShok Type 40.
   d. Or, Engineer Approved Equal.
6. Snubbers as manufactured by:
   a. Ashcroft, Model 311.
   b. Dwyer, Series PS.
   c. NoShok, Model 5025/5050
   d. Or, Engineer Approved Equal.
7. Pulsation dampeners as manufactured by:
   a. Cajon Co.
   b. Weksler Instruments, Corp.
   c. Ashcroft.
   d. Or, Engineer Approved Equal.

2.3 ACCESSORIES

A. Gauges shall be liquid filled or have some equivalent anti-vibration/-bounce technology.

2.4 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
   1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances. Weld-o-lets, valves, orientation, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
   1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
   2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations.
   3. Install two 2-valve instrument manifolds for each gauge pressure transmitter.
   4. Bolt 3-valve manifolds at non-flange diaphragm type differential pressure transmitters in place of standard flange adapters.
   5. Install root valves at process taps except insertion elements.
   6. Install gauge valves on process connections to instruments where multiple instruments are connected to one tap or where root valves are not readily accessible.
   7. All gauges shall be installed with the face in the vertical position.
   8. In strict accordance with the manufacturers printed instructions.
   9. At the locations shown on the drawings, when so shown.
   10. Care shall be taken to minimize the effect of water hammer or vibrations on the gauges.
   11. In extreme cases, and with the approval of the Engineer, gauges may be mounted independently, with flexible connectors.

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests.

3.5 ADJUSTING

A. All instruments shall be field verified.

3.6 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

3.7 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
   1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.8 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The Contractor shall provide documented evidence for a differential plus or minus that results from these changes.

B. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with Paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 73 37
PRESSURE-SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated storage structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the OWNER.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - – PRODUCTS

2.1 MANUFACTURERS

A. SOR Series V1.

B. Mercoid Series CS.

C. United Electric Series 400.

D. Or, Engineer Approved Equal.

2.2 MANUFACTURED UNITS

A. Pressure Switches.
   1. General:
      a. Enclosure NEMA 4X.
      b. Manual Reset trip on increasing pressure.
      c. Relay Switches shall be DPDT.
      d. Actuator Seal: Teflon (verify with manufacturer for each and every installation)
      e. Each pressure switch shall have visible scale and contact operation.
   2. Pressure switches shall have a contact rating of 10 Amps at 125 VAC.
   3. Pressure switches shall be snap-action switches and shall be in general-purpose enclosures at indoor installations, or weatherproof enclosures at outdoor installations.
   4. Diaphragm seals shall be provided and included at the locations indicated in the drawings.
   5. Any pressure switch used to detect high pump discharge shall be equipped with a manual reset.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
   1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - – EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
   1. It is the CONTRACTOR's responsibility to install all instruments in conformance with manufacturer's recommendations.
   2. It is the CONTRACTOR's responsibility to notify the ENGINEER of any installation conditions that may be shown at variance with the manufacturer's recommendation.

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the ENGINEER prior to commissioning.

B. All instrument calibration shall be witnessed by the OWNER's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the OWNER's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The CONTRACTOR shall replace any instruments damaged prior to commissioning at no additional cost to the OWNER.
   1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

A. The CONTRACTOR shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

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SECTION 40 75 01
INSTRUMENT LIST

PART 1 - GENERAL

1.1 INSTRUMENT LIST

A. Instrument list is shown in the attached table following this section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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Zone 2 & 3 Pump Station Instrument List			
Tag	**Location**	**Device**	**Description**
FE/FIT-201	Chemical Room/ Electrical Room	Flow Meter and Transmitter	Rosemount 8750W or Endress Hauser Promag 400.
FE/FIT-301			
AE/AIT-190	Chemical Room	Colorimetric Chlorine Analyzer	Hach CL 17SC or Approved Equal, to include controller for local readout and SCADA connection.
LE/LIT-102	Chemical Room	Level Sensor	Endress+Hauser Prosonic FMU Series w/ FDU Sensor, or Engineer-Approved Equal.
PE/PIT-101	Valve Vault	Pressure Indicating Transmitter	Instrument to be provided by Herriman City.
NA-101	Pump Room	Intrusion Switch	Door: Magnetic Entry Switch Ademco 960, Sentrol 2505A, GRI4400, NASCOM 505A or Equivalent.
NA-102	Electrical Room		
NA-103	Pump Room		Overhead Door: Floor Mounted Switch George Risk Industries, Inc., Model 220-36 or Equal.
NA-104	Chemical Room		
LSH-101	Pump Room	Flood Switch	Gem Sensor (series LS270) Single Point Level Switch
LSH-102	Chemical Room		
LSH-103	Sewer Manhole w/ Sump		
TT-01	Pump Room	Temperature Transmitter	Dwyer BTT-N00-3, Omega EWS-TX, or Engineer-Approved Equal.
ZS-201	Pump Room	Limit Switch	Provided with valve by valve supplier.
ZS-202			
ZS-203			
ZS-301			
ZS-302			
ZS-303			
ZS-103	Valve Vault		
XS-3202	Zone 1 East Tank	Intrusion Switch	Existing.
XS-3203			
LT-01	Zone 1 East Tank	Level Sensor	Dwyer SBLT2. Range 0 to 50 feet, with sufficient length of manufactuer's cable.

Notes: Substitutions allowed with written approval of Owner and Engineer only.

SECTION 40 78 00
CONTROL PANEL INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. General: This section sets forth the general specification and requirements for the devices that shall be located within and on control panels to form a complete and operable system.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 DEFINITIONS

A. In accordance with Section 40 61 00 -- Process Control and Instrumentation Systems General.

1.3 SYSTEM DESCRIPTION

A. In accordance with Section 40 61 00.

B. Analog measurements and control signals shall:
   1. Be electrical as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted.
   2. Electrical signals outside control panels shall be 4-20 mA DC, except as noted.
   3. Signals within enclosures may be 4-20 mA DC, except as noted.
   4. Dropping resistors shall be installed at all field side terminations in the control panels to ensure loop integrity, as required.

C. All control panels shall each be provided with power supplies which are configured to match the voltage and current requirements of the load.

D. Each 120 VAC control loop and instrument shall have an individual fuse or circuit breaker within its respective control panel and clearly identified for function.

E. Each 120 VAC and 24 VDC PLC output shall have its own individual fuse external of the I/O card, with blown fused indication.
   1. Size external fuse to open before any I/O card mounted fuses.

F. Signal Isolators, Signal Converters, and Power Supplies:
   1. Signal isolators shall be furnished and installed in each measurement and control loop, wherever required:
      a. To ensure adjacent component impedance match.
      b. Where feedback paths may be generated.
      c. To maintain loop integrity when the removal of a component of a loop is required.

2. Signal converters shall be included where required to resolve any signal level incompatibilities.

G. Separate signal power supplies shall be included, as required by the manufacturer's instrument load characteristics, to ensure sufficient power to each loop component.

1.4 SUBMITTALS

A. In accordance with:
1. Section 40 61 00, "Process Control and Instrumentation Systems General."
2. Refer to individual instrument and device specifications for additional submittal requirements.

B. Additional submittal requirements.
1. Circuit Breakers.
a. Provide a complete schedule showing load and rating of circuit breakers.
2. Control Fuses.
a. Provide a complete schedule and fuse coordination study.
3. Control Power Transformers.
a. Provide complete sizing calculations in accordance with the requirements of Control Power Section of this Specification Section.

1.5 ASSURANCE

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

1.6 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

1.7 PROJECT / SITE CONDITIONS

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

1.8 SEQUENCING AND SCHEDULING

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

B. All control panel testing shall be performed prior to shipping.

1.9 WARRANTY

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

1.10 MAINTENANCE

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

B. Spares

1. All unused inputs and outputs from the PLC/PAC shall be wired to field terminal blocks and identified.
2. Furnish one spare normally open and one spare normally closed dry contact for each push-button, selector switch, relay, etc.
3. Furnish five spare fuses for each and every fuse type in the panel.
4. Furnish 15 spare terminal blocks or 25%, whichever is greater.
5. All spare contacts of relays, switches, etc., shall be internally wired to terminal blocks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All panel-mounted instruments shall have matching style and general appearance.

B. Instruments performing similar functions shall be of the same type, model, or class, and shall be of one manufacturer.

2.2 COMPONENTS

A. Signal Isolators, Converters, and Power Supplies
1. Signal isolators shall be furnished and installed in each measurement and control loop, wherever required, to ensure adjacent component impedance match, or where feedback paths may be generated.
2. Signal converters shall be included where required to resolve any signal level incompatibilities.
3. Signal power supplies shall be included, as required by the manufacturer's instrument load characteristics, to ensure sufficient power to each loop component.
4. Signal isolators shall have complete isolation of input, output and power input.
    a. Signal input shall be 4-20 mA into 50 Ω, maximum.
    b. Signal output shall be 4-20 mA into 1000 Ω, minimum.
    c. Power input shall be 120 VAC, 60 Hz.
    d. Span and zero shall be adjustable.
    e. Accuracy shall be ±1 percent of span.
    f. Units shall be surface, DIN-rail, or rack mounted.
5. Acceptable manufacturers:
    a. Acromag.
    b. AGM Electronics Model TA-4000.
    c. Turck
    d. Or, Engineer Approved Equal.

B. Relays
1. General Purpose Relays:
    a. General purpose relays shall be plug-in type
    b. Contacts rated 10 Amps at 120 VAC
    c. With LED indication for energization
    d. With push-to-test button
    e. Quantity and type of contacts shall be as shown on the Drawings or as needed for system compatibility.

f. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover.
g. Sockets for relays shall have screw-type terminals.
h. Provide transient surge protection across the coil of each relay.
i. Relays shall be:
1) Potter and Brumfield Type KRP or KUP.
2) IDEC.
3) Square D Type K.
4) Allen Bradley.
5) Or, Engineer Approved Equal.

2. Slave Interposing Relays:
a. Additional slave relays shall be provided when the number or type of contacts shown exceed the contact capacity of the specified relays and timers.
b. Additional relays shall be provided when higher contact rating is required to interface with starter circuits or other equipment.
c. Shall be provided to compensate for voltage drop due to long wire runs.
d. The slave and interposing relays shall be as the general-purpose relays.
e. Provide transient surge protection across the coil of each relay.

3. Control Relays
a. Including all electrically held relays, pneumatic time delay relays, mechanically latch relays, solid state time relays where the number of contacts exceed those available with the general-purpose relays.
b. Convertible contact cartridges to convert any contact from a normally open to a normally closed configuration.
c. Contact material shall be fine grade silver.
d. Contact cartridges to be enclosed having a clear cover to allow for inspection of the contacts.
e. Contact rating NEMA A600.
f. Control Voltage 120 VAC.
g. Provide transient surge protectors across the coil of each control relay.
h. As manufactured by:
1) Allen Bradley 700P.
2) Square D850 Type X.
3) Cutler Hammer AR.
4) IDEC.
5) SquareD.
6) Or, Engineer Approved Equal.

4. Time Delay Relays
a. Time delay relays shall be pneumatic on-delay or off-delay type.
b. Contacts shall be rated 10 Amps at 120 VAC.
c. Units shall include adjustable dial with graduated scale covering the time range in each case.
d. Provide transient surge protection across the coil of each relay.
e. As manufactured by:
1) Agastat Series 7000.
2) Allen-Bradley.
3) IDEC.
4) SquareD.
5) Or, Engineer Approved Equal.

C. Digital Process Indicator
1. Digital process indicators shall be self-contained instruments that display process signals directly in engineering units.
2. The unit shall be suitable for panel mounting and shall utilize a seven segment LED display of not less than 0.56-inch height.
3. Features.
a. Multi-range capabilities.
b. Integral provisions for scaling.
c. Switch programmable decimal points.
4. NEMA 4 / IP65 sealed front metal bezel.
5. Current and Voltage loop indicators.
a. Current-loop indicators as shown on the drawings or as required by the instrumentation.
b. Voltage-loop indicators as shown on the drawings or as required by the instrumentation.
c. 3 ½ - digit.
d. Accuracy shall meet or exceed the following requirements.
1) DC Volts : ±0.1% of reading + 1 digit.
2) AC Volts : ±0.1% of reading + 2 digits (45-500 Hz).
3) DC Current :
a) 199.9µA : ±0.1% of reading + 1 digit.
b) 1.999mA : ±0.1% of reading + 1 digit.
c) 19.99mA : ±0.1% of reading + 1 digit.
d) 199.9mA : ±0.15% of reading + 1 digit.
e) 1.999A : ±0.5% of reading + 1 digit.
4) AC Current (45-500 Hz) :
a) 199.9µA : ±0.1% of reading + 2 digits.
b) 1.999mA : ±0.1% of reading + 2 digits.
c) 19.99mA : ±0.1% of reading + 2 digits.
d) 199.9mA : ±0.15% of reading + 2 digits.
e) 1.999A : ±0.5% of reading + 2 digits.
e. Ratings, protection, and indication:
1) Maximum voltage on terminal blocks 300 VAC or VDC.
2) Maximum voltage on basic range inputs 75 VAC ro VDC.
3) Maximum shunt current
a) For 199.9µA : 2 Ma.
b) For 1.999mA : 20 mA.
c) For 19.99mA : 200 mA.
d) For 199.9mA : 1 A.
e) For 1.999A : 3 A.
f. Power supply as indicated on the drawings or required by the system:
1) 120 VAC.
2) 230 VAC.
g. Operating Temperature
1) 32°F – 140°F (0° C to 60°C).

D. Manual Operator Interface Devices.
1. Control Components - Oil Tight

a. All operators, pushbutton, selector switches, and pilot lights are to be of the same manufacturer.
b. NEMA Type 13 oil-tight.
c. With synthetic rubber gasket.
d. Heavy duty.
e. Industrial grade full size 1-3/16" (30 mm) diameter.
f. Pushbutton units:
    1) Contacts rated
        a) NEMA A600
        b) 600 VAC maximum
        c) Make = 7,200 VA
        d) Break = 720 VA
    2) Color Code
        a) Red: Stop
        b) Green: Start
        c) Orange: Open
        d) Blue: Closed
    3) As manufactured by
        a) Allen Bradley 800T Series.
        b) SquareD Harmony 9001SK Series.
        c) IDEC TWTD Series.
        d) Cutler Hammer 10250T Series.
        e) Or, Engineer Approved Equal.
    4) Furnish one spare normally open and normally closed contact with each switch.
g. Selector switches
    1) Contacts rated
        a) NEMA A600
        b) 600 VAC maximum
        c) Make = 7,200 VA
        d) Break = 720 VA
    2) As manufactured by
        a) Allen Bradley 800T Series.
        b) SquareD Harmony 9001SK Series.
        c) IDEC CS Series.
        d) Cutler Hammer 10250T Series.
        e) Or, Engineer Approved Equal.
    3) Furnish one spare normally open contact and normally closed contact with each switch.
h. Pilot lights
    1) Transformer type pilot lights
    2) 120 VAC
    3) Push-to-Test
    4) Provide indicating light colors as follows:
        a) White: Power On
        b) Green: On / Running
        c) Red: Off
        d) Amber: Abnormal / Alarm Condition / Failure
        e) Blue: Closed

5) As manufactured by
   a) Allen Bradley 800T Series.
   b) SquareD Harmony 9001SK Series.
   c) IDEC TWTD Series.
   d) Cutler Hammer 10250T Series.
   e) Or, Engineer Approved Equal.

2. Control Components Corrosive Areas
   a. All operators, pushbuttons, selector switches, pilot lights are to be of the same manufacturer.
   b. NEMA 4X corrosion resistant.
   c. Exterior parts to be made of high impact strength fiberglass reinforced polyester.
   d. Incorporating an internal neoprene boot which completely encloses all internal parts.
   e. Industrial grade full size 1-3/16" (30mm) diameter.
   f. Pushbutton:
      1) Having an integral wiping gasket around the pushbutton that cleans the wall of the pushbutton guard of any foreign material accumulation as the button is operated.
      2) Contacts rated:
         a) NEMA A600.
         b) 600 VAC maximum.
         c) Make = 7,200 VA.
         d) Break = 720 VA.
      3) Color code:
         a) Red: Stop / Off
         b) Green: Start / On
         c) Orange: Alarm / Failure
         d) Blue: Open
      4) As manufactured by:
         a) Cutler Hammer 10250T Series.
         b) SquareD Harmony 9001SK Series.
         c) Allen Bradley 800H Series.
         d) Or, Engineer Approved Equal.
   g. Selector switches:
      1) Contacts rated:
         a) NEMA A600.
         b) 600 VAC minimum.
         c) Make = 7,200 VA.
         d) Break = 720 VA.
      2) As manufactured by:
         a) Cutler Hammer 10250T Series.
         b) SquareD Harmony 9001SK Series.
         c) Allen Bradley 800H Series.
         d) Or, Engineer Approved Equal.
   h. Pilot lights:
      1) Transformer type pilot lights.
      2) 120 VAC.
      3) Corrosion resistant.

4) Push-to-Test.
5) With LED type lamps
6) Provide indicating light colors as follows:
   a) White: Power On / Normal Condition
   b) Green: On / Running
   c) Red: Off / Stopped
   d) Amber: Abnormal / Alarm Condition / Failure
   e) Blue: Closed
7) As manufactured by:
   a) Cutler Hammer 10250T Series.
   b) SquareD Harmony 9001SK Series.
   c) Allen Bradley 800H Series.
   d) Or, Engineer Approved Equal.

E. Terminal Blocks
1. Field terminal or inter-cabinet wiring blocks.
   a. DIN-Rail Mounted.
   b. Terminal to be screw type.
   c. Recessed terminal hardware to minimize the possibility of contact with current carrying parts.
   d. Molded of high dielectric material.
   e. Minimum rating 600 VAC.
   f. All external connections to and from all control panels must be via terminal blocks including control circuits and solenoid circuits.
   g. All individual terminals and terminal blocks shall be marked in a permanent manner with printed identification.
   h. Grounding Terminals blocks shall be Green/Yellow
   i. As manufactured by:
      1) Allen Bradley
      2) Phoenix Contact.
      3) Wago.
      4) ABB/Entrelec.
      5) Or, Engineer Approved Equal.

F. Conductors Within Control Panel
1. Wire markers:
   a. All conductors within the control panel are to be permanently marked with wire numbers at each end.
   b. Wire numbers are to correspond to the wire numbers on the control drawings and as detailed in Section 26 05 53.
   c. Wire numbers are to correspond to the terminal block number to which they are attached in the control panel.
   d. Markers shall comply with the requirements of Section 26 05 53.

G. Nameplates
1. In conformance and full compliance with Section 26 05 53.
   a. All control components within the control panel shall have engraved laminated plastic nameplates secured with stainless steel screws or epoxy

cemented in place. Nameplates cannot be attached to the covers of the panel channel.

2. All components on the front cover shall be identified by nameplates.
   a. Use standard manufacturer engraved nameplates for all pushbuttons, and selector switches only if color matches that specified for engraved nameplates.
      1) If not then furnish nameplates to match colors as specified in Section 26 05 53.
   b. Use engraved plastic laminated nameplates for all other devices, keyboards, and annunciator LED's.
   c. All control panels shall have an engraved, plastic, laminated nameplate identifying the control panel, voltage, and feeder breaker and panel.
   d. On NEMA 4X enclosures use an epoxy based adhesive to affix nameplates to panel.
3. Shall be provided for instruments, function titles for each group of instruments, and other components mounted on the front of panel.
4. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, each electronic trip, and the like, mounted inside the panel. These shall be descriptive, to define the function and system of such element.
5. Lettering, styles, abbreviations and sizes shall be in conformance with ISA-RP-60.6 (1984) with an intended viewing distance of 3 to 6-feet as shown or as selected by the Engineer.

H. Control Circuit Breakers.
1. Each 120 VAC control circuit, instrument, or loop shall be powered from an individual control circuit breaker or fused terminal block.
2. DIN-Rail mounted using the same DIN-Rail as used for the terminal blocks.
3. Manual ON-OFF Switch
4. Rated 240 VAC.
5. Rated 2000 AIC.
6. Current Ratings as required.
7. Provide complete nameplate identifying each circuit.
   a. In conformance with Section 26 05 53.
8. As manufactured by:
   a. ABB S200 Series.
   b. Siemens 5S Series.
   c. Allen-Bradley 1489/1492 Series.
   d. Schneider Electric Multi 9 Series.
   e. SquareD QYU Series.
   f. Or, Engineer Approved Equal.

I. Fuses
1. Isolate Group of PLC/PAC with fuses as detailed in the Contract Drawings.
2. Isolate Group of PLC/PAC Digital Inputs with fuses as detailed in the Contract Drawings.
3. Isolate all PLC/PAC Analog inputs with fuses as detailed in the Contract Drawings.
4. Coordinate fuse size below internal output protection of the PLC/PAC output cards.
5. Fuses to be terminal block mounted.
   a. With Lighted Fuse Puller.

6. Furnish Nameplate identifying each fuse.
    a. Section 26 05 53.
7. Spare Fuses in conformance with paragraph 1.11 of this Section.
8. As manufactured by:
    a. Allen-Bradley.
    b. ABB/Entrelec.
    c. Phoenix Contact.
    d. Wago.
    e. Or, Engineer Approved Equal.

J. Field/Remote Connections
1. All field/remote connections shall be made via terminal blocks.
2. Furnish an individual terminal block space for each wire.
    a. Two wires on one terminal block shall be not be allowed.
3. Furnish an empty wire channel on the panel adjacent to the field/remote terminal block strip to be used to route the field/remote wires prior to connection to the terminal blocks.
4. Spare terminal blocks in conformance with paragraph 1.11 of this Section.

K. Control Voltage.
1. Control voltage shall be supplied via control circuit breakers in the control panel.
2. Control power shall be sourced from the 120 VAC power within the control panel, unless otherwise noted in the plans.
3. Control voltage shall be supplied via a control circuit in the control panel.

L. Transient / Surge Protection
1. Control Panel Power System Level Protection; if not powered by an internally installed uninterruptable power supply (UPS).
    a. The control system manufacturer shall provide protection against voltage surges for all instrumentation furnished under this contract.
        1) Protection shall protect all instrumentation assemblies, components and board mounted electronic devices from damages in the event of direct hit by lightning onto any power line.
        2) Instrumentation line or disturbances device within the facility.
        3) Voltage surges from other sources.
    b. Provide protection against the full spectrum of voltage transients including the relatively rare high energy transients as well as the much more frequent low energy and high frequency noise.
    c. Provide fill in for short term notches up to 50 microseconds. and ANSI C62.41 Category A attenuation.
    d. Provide normal mode noise protection (noise between current carrying conductors).
    e. Shall consist of a system that includes transient voltage surge suppression and an active tracking filter.
    f. Meeting the following requirements:
        1) Response time:
            a) Normal Mode - Less than 1 nanosecond.
            b) Common Mode - Less than 5 nanoseconds.
        2) Safety approvals:

a) UL 1233 (EMI/RFI Filter).
b) UL 1449.

3) Mean-time between failures:
a) Greater than 100,000 hours.

4) Frequency response EMI/RFI small signal RFI or large signal transients.

5) Surge energy capacity:
a) 120 VAC: Line-Neutral, Line-Ground, Neutral-Ground = 160 Joules, Total 480 Joules.
b) 240 VAC: Line 1 - Line 2, Line 1 - Ground, Line 2 - Ground = 280 Joules. Total 340 Joules.

6) Peak surge current capacity (8 x 20 μsec):
a) 6,500 Amperes.
b) 39,900 Amperes total.

g. As manufactured by:
1) Accuvar by Control Concepts a subsidiary of Liebert Corporation.
2) ASCO Model 252 (formerly Liebert Emerson/Edco HSP121BT01RU).
3) Schneider Electric Surgelogic LC/XR/XW Series.
4) Thomas&Betts Joslyn TransEnd Series.
5) Or, Engineer Approved Equal.

2. Data and Signal Line Protectors to be used on each and every signal line:
a. Provide electronic circuits and components from damaging surge voltages and currents.
b. Provide protection of signal and data lines associated with computer, data communications, instrumentation, broadcasting, and industrial control interfaces.
c. Shall be used directly with EIA standard interfaces:
1) RS-485.
2) Modbus/ModbusTCP
3) 4-20 mA instrumentation loops.
4) ProfiNet
d. Repeatedly provide protection against surge currents in excess of 10,000 Amps.
e. DIN-Rail mounted.
f. Cable shields shall be passed through and may be either grounded or not grounded at the protector.
g. System:
1) Heavy duty multi-staged protectors.
2) Solid state stage intercepts the leading edge of the surge with sub-nanosecond response time.
3) Within micro-seconds, a 3-pole common chambered gas tube capable of handling 20,000 ampere lightning current operates and crowbars the surge to ground.
4) The protector remains in the crowbar state until the surge has passed and line voltages return to safe levels.
h. Location:
1) Place at each end of a signal line, data line, or current loop.
2) In the case of daisy chain configuration, such as RS-485, protectors shall be placed at each node.

i. Electrical Characteristics:
1) Surge Life:
a) Greater than 1000 operations with 200 Amps, 10 x 1000 µsec.
b) Greater than 10 operations with 10,000 Amps, 8 x 20 µsec.
2) Leakage current at rate line to ground voltage < 10 µAmps.
3) Signal/Data attenuation at maximum data rate 3 db with 600 Ω terminations
4) Operating temperature -40°F – +140°F (-40°C – +60°C).
j. As manufactured by:
1) Joslyn:
a) For differential signals, such as RS-422 or RS-485, and current loops - Model 1820.
b) For high frequency differential signals and current loops - Model 1821.
c) For line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector - Model 1810.
2) Interlink BT
a) For Profibus
3) Pepperl+Fuchs
a) For Profibus
3. Protection from inductive spikes within the control panel.
a. Provide surge protection across all inductive coils for control relays, starters, solenoids, etc., as noted.

M. Maintenance Bypass Switch:
1. An external maintenance bypass switch shall be installed in the control panel to provide isolation of the UPS from the power line and loads for maintenance purposes
2. Shall be of the make before break design or have a sufficiently short transfer time so that the UPS can be isolated from the critical loads by placing these loads on commercial power without interruption of operation.
3. This applies to both forward and back transfer of the switch.
4. Shall be rated to carry the full input current of the UPS.
5. Manufacturers:
a. Liebert Micro POD.
b. Or, Engineer Approved Equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

3.2 INSTALLATION

A. Control panel installation shall be provided in accordance with the applicable requirements of Section 40 61 00, "Process Control and Instrumentation Systems General.", and the requirements of Division 26.

3.3 FIELD QUALITY CONTROL

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

3.4 CLEANING

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

3.5 DEMONSTRATION

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

3.6 SCHEDULES

A. All control panel testing shall be performed prior to shipping.

B. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems."

3.7 TRAINING

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems."

END OF SECTION

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DIVISION 43
GAS, LIQUID, AND STORAGE

SECTION 43 20 10
PUMPS, GENERAL

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each pump Section. Unless otherwise indicated, the single Manufacturer shall be the Manufacturer of the pump.

D. Single Manufacturer: Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Shop drawings shall contain the following information:
   1. Pump name, identification number, and specification Section number.
   2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable frequency drive.
   3. The Contractor shall require the Manufacturer to indicate on the performance curves the limits recommended for stable operation without surge, without cavitation, and without vibration (except vibration within specified allowable limits). The stable operating range shall be as wide as possible based on actual hydraulic and mechanical measurements taken during the factory performance tests of the pumps.
   4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
   5. Data, in accordance with Section 26 20 00 Low Voltage AC Induction Motors OR, for the electric motor proposed for each pump.
   6. Elevation of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel,

and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.

7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
8. Complete electrical schematic diagram.

C. Operation and Maintenance Manual: The Manual shall contain the required information for each pump Section.

D. Spare Parts List: A Spare Parts List shall contain the required information for each pump Section.

E. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.

F. Certifications
1. Manufacturer's certification of proper installation.
2. Contractor's certification of satisfactory field testing.

1.3 QUALITY ASSURANCE

A. Factory Testing: The following tests shall be conducted on each indicated pump system:
1. Motors: All motors of sizes 100 hp and larger shall be assembled, tested, and certified at the motor factory and the working clearances checked to ensure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished.
2. Pump Systems: All centrifugal pump systems 100 hp and larger shall be tested at the pump factory in accordance with the Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute, Inc., Performance Acceptance Test Grade 1B. Tests shall be performed using the complete pump system to be furnished, and the Manufacturer’s certified calibrated test motor.
3. For motors smaller than 100 hp, the Manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test data shall be submitted:
    a. Hydrostatic test data
    b. A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.
    c. Pump curves showing head, flow, bhp, efficiency, and NPSH requirements.
    d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve. not change unless the style definition is changed.
4. Factory Witnessed Tests: Witness Tests are not required.

B. Warranty: Unless otherwise specified, each pump shall be supplied with manufacturer’s standard warranty of one (1) year from substantial completion.
    a.

PART 2 - PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the Manufacturer's standard equipment.

B. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine, or encroach on the service factor.

C. No cavitation shall be allowed in pumps operating within the stable operating range for the specified operating conditions. For the purposes of this provision, cavitation shall be recognized and accepted as being present in a pumping unit if cavitation noise can be perceived either by the human ear or by acoustic instruments or devices. The presence or absence of cavitation noise shall be verified by the Owner during both the factory performance tests of the pumps and during operation of the pumps up to the end of the warranty period. To assist in revealing potential cavitation during the factory performance tests, in addition to all other required tests, the Manufacturer shall force the pumps to operate at the specified minimum net positive suction head available for each of the following conditions: minimum flow rate, design flow rate and head, and maximum flow rate.

D. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors, variable frequency controls if required, necessary mountings, and appurtenances.

2.2 MATERIALS OF CONSTRUCTION

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of austenitic ductile iron, conforming to ASTM A 439 - Specification for Austenitic Ductile Iron Castings, or equal.
2. Bronze pump impellers shall conform to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, or B 584 - Specification for Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316.
4. All anchor bolts, nuts, and washers that are not buried or submerged shall be hot-dip galvanized, unless otherwise specified in individual pump Sections. Buried or submerged bolts, nuts, and washers shall be stainless steel in accordance with Section 05 50 00 – Metal Fabrications.

2.3 PUMP COMPONENTS

A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings Dimensions.

B. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed lineshafts. Pumps for other process fluids shall be lubricated as indicated.

C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

D. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.

E. Drains: All gland seals, air valves, cooling water drains, and drains from variable frequency drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

F. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the Contractor shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.

G. Stuffing Boxes: Where stuffing boxes are indicated for the pump seal, they shall be of the best quality, using the Manufacturer's suggested materials best suited for the specific application. For drainage and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.

1. Unless otherwise specified, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
   a. Shaft speeds - up to 2500 rpm
   b. Temperature - up to 500 degrees F
   c. pH range - 0 to 14.
2. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.

H. Mechanical Seals: Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:

Type	Manufacturer
Water Pumps Hot and Cold	Single seals: John Crane, Type I, 21; Borg-Warner Type L; Chesterton

I. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the Manufacturer, in order to maintain reliable seal performance.

J. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.

2.4 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and Manufacturer's name and model number. Dimension and flow information shall be in metric units, followed by English units in parentheses.

B. Solenoid Valves: The pump Manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.

C. Gauges: all pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump discharge lines. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
   1. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
   2. Pressure and compound gauges shall be provided in accordance with Section 17205 – Pressure Gauges.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: Where required by the individual pump Sections, an authorized service representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
   1. Installation of the equipment.
   2. Inspection, checking, and adjusting the equipment.
   3. Startup and field testing for proper operation.
   4. Performing field adjustments to ensure that the equipment installation and operation comply with the specified requirements.

B. Instruction of the Owner’s Personnel
   1. Where required by the individual pump Sections, an authorized training representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to instruct the Owner’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
   2. The representative shall have at least two years’ experience in training. A resume for the representative shall be submitted.

3. Training shall be scheduled a minimum of three weeks in advance of the first session.
4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.
5. The training materials shall remain with the trainees.
6. The Owner may videotape the training for later use with the Owner personnel.

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations.

B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The Contractor shall provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

A. Materials and equipment shall be coated as required in Section 09 90 00 – Painting and Coating.

3.4 FIELD TESTS

A. Where required by the individual pump Sections, each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.

B. The following field testing shall be conducted:
1. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the Engineer.
2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.
4. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is indicated.

C. Field testing will be witnessed by the Engineer. The Contractor shall furnish 5 days advance notice of field testing.

D. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

E. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made.

Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

F. The Contractor shall bear all costs of field tests, including related services of the Manufacturer's representative, except for power and water which the Owner will bear. If available, the Owner's operating personnel will provide assistance in field testing.

END OF SECTION

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SECTION 43 24 03
VERICAL TURBINE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide vertical turbine pumps and drives with associated appurtenances, complete and operable, in accordance with the Contract Documents. The Owner intends on installing pumps in two phases with an initial phase being installed now and pumps replaced as demand increases.

B. The requirements of Section 43 20 10 – Pumps, General apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

1.2 CONTRACTOR SUBMITTALS

A. Shop Drawings: Submittals shall be made in accordance with Section 01 33 00 – Contractor Submittals and Section 43 20 10 – Pumps, General.

B. Spare Parts List: The Contractor shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of manufacturer suggested spare parts for each piece of equipment specified. The Contractor shall also furnish the name, address and telephone number for the nearest distributor for each piece of equipment.

C. Operation and Maintenance Manual: Provide technical operation and maintenance manuals in accordance with Section 01 33 20 – Contractor Submittals.

1.3 QUALITY ASSURANCE

A. All pumps shall be factory tested in accordance with Section 43 20 10 – Pumps, General.

B. Provide pump manufacturer's standard warranty which starts either one (1) year upon substantial completion of the project or eighteen (18) months from date of purchase.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pump Identification:

Pump Name	Utility Water Pump
Equipment Number	PMP-201 PMP-202 PMP-301 PMP-302
Location	Pump Room

2.2 OPERATING CONDITIONS

A. The Work of this Section shall be suitable for long term operation under the following conditions:

Parameter	Units	Value
Duty		Continuous
Drive		Variable speed
Ambient environment		Indoors
Ambient temperature	Deg F	35 to 110
Ambient relative humidity	%	20 to 95
Fluid service		Potable Water
Fluid temperature	Deg F	40 to 75
Fluid pH range		7.0 to 7.5
Fluid specific gravity		1.0
Fluid viscosity	absolute centipoises at 60 deg F	1.14
Project site elevation (finish floor)	ft, msl	4988.50
Minimum water surface in pump barrel	ft, msl	4995.50
Max water level in Zone 1 East Tank	ft, msl	5010.00
Max Pressure in pump barrel above finish floor	psi	9.32
Pump Barrel Diameter	inches	24

2.3 PERFORMANCE REQUIREMENTS

A. Zone 2 Pumps PMP-201, 202 shall meet the following minimum performance requirements:

Parameter	Units	Value
Design flow capacity	gpm	700
Design flow head TDH	ft	163
Design flow minimum efficiency	%	83
Minimum efficiency at maximum flow	%	72
NPSH required	ft	Not to exceed 30 ft of water absolute at any condition from shutoff to minimum pump head.
Maximum pump speed	rpm	1800
Maximum motor speed	rpm	1800
Minimum motor size	HP	50

Parameter	Units	Value

Approximate length from base plate to suction bell, final length determined by manufacturer	inch	109
Minimum column diameter	inch	8
Minimum discharge diameter	inch	12
Minimum inlet diameter	inch	16
Discharge flange rating ANSI	psi	150
Minimum column shaft diameter	inch	1.1875
Maximum bowl diameter	inch	12
Barrel diameter	Inch	24

* Future Zone 2 pumps shall be sized for 1,050 gpm @ 163 ft TDH, 75 HP.

B. Zone 3 Pumps PMP-301, 302 shall meet the following minimum performance requirements:

Parameter	Units	Value
Design flow capacity	gpm	1,467
Design flow head TDH	ft	281
Design flow minimum efficiency	%	83
Minimum efficiency at maximum flow	%	72
NPSH required	ft	Not to exceed 30 ft of water absolute at any condition from shutoff to minimum pump head.
Maximum pump speed	rpm	1800
Maximum motor speed	rpm	1800
Minimum motor size	HP	150

Parameter	Units	Value
Approximate length from base plate to suction bell, final length determined by manufacturer	inch	109
Minimum column diameter	inch	10
Minimum discharge diameter	inch	14
Minimum inlet diameter	inch	20
Discharge flange rating ANSI	psi	150
Minimum column shaft diameter	inch	1.50
Maximum bowl diameter	inch	14.5
Barrel diameter	Inch	24

* Future Zone 3 Pumps shall be sized for 2,200 gpm @ 281 ft TDH, 250 HP.

2.4 MATERIALS OF CONSTRUCTION

A. Each vertical turbine pumps shall conform to the following requirements:

Bowls	Cast-iron, ASTM A 48, Class 30. The bowls shall have vitreous enamel lined waterways to reduce friction losses and provide a maximum efficiency and wear protection. The exterior surfaces of the bowl units shall be coated with 18 mils DFT of epoxy in accordance with Section 09 90 00 – Painting and Coating.
Impeller	Bronze, ASTM B 584 Alloy 903 lead free, statically and dynamically balanced to ISO 1940-1 grade G2.5
Impeller shaft method of connection	Type 316 stainless steel impeller lock collet
Wear rings	Replaceable, Heat Treated 410 stainless steel (or better)– Nongalling with impeller wear rings heat treated to a hardness of at least 50 BHN above the bowl wear rings
Bowl shaft	Stainless steel, Type 416
Suction bell	Cast iron bell, with bottom bearing and streamlined ribs, lining and coating , see bowls
Column	Steel pipe, ASTM A53 Grade B, not less than Schedule 30, epoxy-lined and coated 18 MDFT, in maximum 10-ft lengths, threaded and reinforced to withstand thrust forces, with discharge flange.
Line shaft and couplings	Stainless steel, type 416, turned, ground and polished. Furnished in interchangeable sections not over 10 feet in length to properly match the discharge column. Lineshaft shall be coupled with stainless steel, type 304 couplings.
Shaft lubrication	Product water
Shaft seal	Water-lubricated with packing design. Packing box shall contain no less than 6 graphite fiberglass packing rings and 2 ASTM B584GDC83600 Lantern rings. Sealing between the stuffing box and the discharge head shall be accomplished by means of "O" rings. Headshaft materials, dimensions, configuration, etc. shall be compatible with the recommended packing.
Line shaft bearings	Shaft bearings shall be standard neoprene fluted rubber, or other alloy better suited to the application. The bearings shall be mounted in bronze bearing retainers held in position in the column couplings by means of the butted ends or flanges of the column pipe. Bearings shall be located at intervals of no more than 10 feet.
Discharge head	Fabricated steel Type-T design discharge head, reinforced to withstand pipe thrust, epoxy-lined and coated in accordance with Section 09 90 10 – Pipeline Coating (18 MDFT). With flange(s), base plate, fully machined bottom base. To include side mounted 1/4-inch, 3000 lb forged steel half-couplings for air valve, and drain connections. Flanges to be compatible with type and size of adjacent piping. Head shall be able to accommodate the current and future pump and motor.
Motor shaft coupling	Vertical Hollow Shaft

Bowl and suction	Product lubricated bronze sleeves case bearings
Nameplates	Stainless-steel nameplates giving the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to the pump.
Pump Barrel	Pump Barrel shall be attached to the bowl assembly pump column as designed by manufacturer, and shall provide a true "closed bottom can" type inlet for the pump. The pump barrel and the discharge head shall be water-tight up to a minimum of 10 psi. Dimensions shall meet the requirements shown in the drawings, as required per the pump manufacturer and as required to meet applicable Hydraulic Institute (HI) standards. All flow shall enter the confined inlet structure from above via the T-Head discharged head. Construction shall be welded fabricated steel pipe, ASTM A53, 24" OD, 0.375" Tw. Top flanges shall be AWWA Class E. Barrel thickness, dimensions, fittings and other elements shall be as shown. Barrel flanges shall support the entire weight of the operating pumping equipment, motor and pumped fluid and shall be machined to level according to pump manufacturer tolerances and prepared for installation of the pump base flanges as required. Base plate shall be coated and pump can lined and coated (interior and exterior) with epoxy per Section 09 90 00 – Protective Coatings. Pump can to be concrete encased into place per drawings. Note that a total of six barrels are required, although only four of them will be initially equipped with pumping equipment.

2.5 UTAH DIVISION OF DRINKING WATER COMPLIANCE

A. The pumping equipment shall meet all requirements for NSF 61 certification as required by UDDW.

2.6 ELECTRICAL REQUIREMENTS

Error! Bookmark not defined. Drive: Each pump shall be provided with a vertical, hollow shaft, premium efficiency, high thrust WP1, 480 volt, 3-phase, 60-Hertz heavy duty, electric motor in accordance with Section 26 20 00 – Low-Voltage Induction Motors. Each electric motor shall be designed to accept the total, unbalanced thrust imposed by the pump. Thrust bearings shall be rated for a minimum L-10 life of 20,000 hours.

B. Pumps shall be controlled by an electronic Variable Frequency Drive as noted on the design drawings. See Section 26.

2.7 CONTROLS & INSTRUMENTATION

A. Pumps shall be controlled in accordance with Division 40.

2.8 MANUFACTURER'S, OR EQUAL:

A. National Pump LLC

B. Fairbanks Morse

C. Floway

D. FlowServe

E. Goulds Pumps, Inc.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Factory Testing. Factory tests shall be performed on all full-size pumping equipment as specified in Section 43 20 10.

B. Inspection, Startup, and Field Adjustment: The service representative of the manufacturer shall be present at the Site for 3 working days, to furnish the services required by Section 43 20 10 – Pumps, General.

C. Instruction of Owner's Personnel: The training representative of the manufacturer shall be present at the Site for 1 work day to furnish the services required by Section 43 20 10 – Pumps, General.

D. For the purposes of this paragraph, a work day is defined as an 8 hour period at the Site, excluding travel time. All on-site work hours shall be coordinated with the Owner and/or General Contractor.

E. The Engineer may require that the inspection, startup, and field adjustment services above be furnished in 3 separate trips.

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations.

B. Alignment:

1. All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Equipment shall be secure in position and neat in appearance.

2. Prior to installation, Contractor and Pump Representative shall check if existing cans are plumb. If cans are not plumb, Contractor shall adjust installation of new cans to achieve

a plumb installation. Contractor to provide measurements to verify installation is plumb to the satisfaction of the engineer.

3.4 FIELD TESTS

A. Field tests shall be performed and documented test reports provided according to Section 43 20 10, as suited to the pumps provided under this section. Some of the listed requirements may not be applicable to the particular equipment installed. Provide a written plan identifying the field tests that will be performed, sequencing, etc.

B. Prior to Owner acceptance and formal pump station start-up, all equipment shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a function test in the presence of the Owner and the Engineer. A start up report showing function testing, motor voltages, and running amperages shall be provided to the engineer after pump station start-up. The Contractor and manufacturer shall also sign the certification of proper pump installation attached to this specification.

Certificate of Proper Installation

Project: ZONE 2 & 3 PUMP STATION PROJECT

Contractor: _____

Pump Manufacturer: _____

I hereby certify that:

1. I am an authorized representative of the contractor/manufacturer
2. The pump installation has been made properly in accordance with the manufacturer's recommendations.
3. Field testing as specified in Sections 43 20 10 and 43 24 03 has been completed and the pump has satisfactorily met all performance requirements.

Signatures

Contractor: _____ Date: _____

Manufacturer: _____ Date: _____

END OF SECTION

SECTION 43 41 44
DUAL WALL POLYETHYLENE TANKS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide one dual containment polyethylene tanks and accessories, complete and in place, in accordance with the Contract Documents.

B. Unit Responsibility: The Contractor shall assign responsibility for furnishing the tank system as indicated except for level indication to the tank manufacturer.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASTM D 618	Standard Practice for Conditioning Plastics for Testing
ASTM D 638	Tensile Properties of Plastics
ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D 883	Standard Terminology Relating to Plastics
ASTM D 1505	Standard Test Methods for Density of Plastics by the Density-Gradient Technique
ASTM D 1525	Standard Test Method for Vicat Softening Temperature of Plastics
ASTM D 1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 1998	Polyethylene Upright Storage Tanks
ASTM D 2765	Standard Test Methods for Determination of Gel Content and Swell Ratio of Cross-linked Ethylene Plastics
ASTM D 2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D 3892	Standard Practice for Packaging/Packing of Plastics

ASTM F 412	Standard Terminology Relating to Plastic Piping Systems
ANSI B 16.5	Pipe Flanges and Flanged Fittings
ARM	Low Temperature Impact Resistance (Falling Dart Test Procedure)
NEMA ICS 6	Enclosures for Industrial Control and Systems

1.3 SUBMITTAL PROCEDURES

A. Furnish submittals in accordance with Section 01 33 00 - Submittal Procedures.

B. Shop Drawing Information
   1. Tank Material
      a. Data sheet
      b. Information showing compatibility with chemical to be stored under the concentration and temperature conditions expected
      c. Color sample
      d. Gasket style and material
      e. Bolting material
   2. Dimensioned tank drawings
      a. Location and orientation of openings, fittings, accessories, instrumentation, and anchors and supports
      b. Details of inlet and outlet fittings, manways, flexible connectors, and vents
   3. Tank pad requirements such as blockouts where a full drain fitting is required.
   4. Calculations stamped and signed by a registered Engineer and certified by the tank manufacturer.
      a. Wall thickness. Hoop stress shall be indicated.
      b. Tank restraint system. Show seismic criteria.

C. Proposed Manufacturer Warranty

D. Manufacturer's Unloading Procedure

E. Manufacturer's Installation Instructions

F. Manufacturer’s Written Certification; signed by a senior company officer having authority stating that the tank design, type, and material is compatible with the indicated chemical to be stored in the tank.

G. Manufacturer’s Qualifications: List of installations documenting manufacturer's qualifications. Include names and telephone numbers for tank installations available for the design Engineer to visit.

H. Technical Manual: Include the following in Part 2 - Operational Procedures:
   1. Manufacturer's recommendations for installation.
   2. Installation and adjustment procedures to include foundation bolt and piping connections to the tank.

3. Repair procedures for typical situations, including small holes, pinholes, and minor cracks in the tank.

I. Factory Test Report
1. Tank nominal capacity and diameter, material, hoop stress design
2. Review audit for wall thickness
3. Fitting placement
4. Visual inspection

J. Certification: After inspecting the installed tank, a representative of the manufacturer shall certify in writing that the tank has been installed in accordance with the manufacturer's recommendations. Certification shall be submitted to the Construction Manager.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications
1. The tank manufacturer shall have a record of at least 10 installations during the previous 5 years for the tank sizes and for the chemicals indicated in the Contract Documnets.

1.5 SPECIAL WARRANTY REQUIREMENT

A. The tank shall be warranted for 5 years to be free of defects in material and workmanship.

PART 2 - PRODUCTS

2.1 GENERAL

A. Tanks shall be rotationally-molded high density crosslinked (HDXLPE), one piece seamless construction, cylindrical in cross-section, vertical in axis; complete with piping inlets and outlets, drains, and overflows installed by manufacturer; and anchoring system. Tanks shall be in accordance with ASTM D 1998 unless otherwise indicated. Lined or laminated tanks will not be accepted. Tank outlets shall be either molded on the tank and be the same material or mechanically attached to a chemical compatible insert encapsulated into the tank wall. Covered tanks shall be vented, and where indicated, tanks shall be provided with entrance manways, and level indicators. Tanks shall be marked to identify the manufacturer, date of manufacture, serial number, capacity, and chemical to be stored.

B. Dimensions and tolerances shall be in accordance with ASTM D 1998. Measurements shall be taken with the tank empty, in the vertical position.

2.2 TANKS

A. Service: Chemical storage tanks shall be suitable for the following operating conditions:

Equipment number	TNK-191, 192
Chemical stored	Sodium Hypochlorite
Concentration, percent	0.8 (1)
Unit weight, lb/gal	10.0
Specific gravity	1.2

pH	>10
Maximum chemical temperature, deg. F	80
Minimum chemical temperature, deg. F	40
Minimum indoor air temperature, deg. F	40

B. Materials shall be virgin polyethylene as compounded and certified by the manufacturer, be the type indicated in the tank schedule, and shall meet or exceed the following:

1. Mechanical Properties of HDXLPE Tank Material

Parameter	ASTM Test Method	Value
Density of resin, gm/cc	D 1505	0.938 to 0.946
Tensile strength, psi (2-inches per min)	D 638	2600
Elongation at break, percent (2-inches per min)	D 638	400
ESCR (100 percent lgepal, Condition A, F50), hours	D 1693	>1000
ESCR (10 percent lgepal, Condition A, F50), hours	D 1693	>1000
Vicat softening temperature, deg. F	D 1525	248
Flexural modulus, psi	D 790	100,000

2. Resin used in the tank shall be by Exxon Mobil Chemicals**,** or equal, and shall contain ultraviolet stabilizer as recommended by the manufacturer. Where black or white tanks are indicated, the resin shall be compounded accordingly.

2.3 TANK CONSTRUCTION

A. The minimum wall thickness of the cylindrical portion at any chemical depth shall be determined by ASTM D 1998 as modified by the following equation. Wall thickness shall be tapered, and no wall shall be less than 0.187-inch thick at the top.

a. $T = 0.433 \times ASG \times OD \times H \times OD/2 \times SF \times SD$

b. Where: T = wall thickness at any depth, in

c. ASG = adjusted specific gravity of chemical (See Note A)

d. H = depth of chemical in tank ft

e. OD = outside diameter of tank, ft

f. SF = service factor based on wall thickness

g. SD = hydrostatic design stress, 600 psi (See Note B)

h. Note A: The specific gravity of the fluid shall be multiplied by 1.5 to obtain the adjusted specific gravity, ASG. The maximum ASG value shall be 1.9.

i. Note B: The hydrostatic design stress shall be derated for temperatures above 100 deg F according to ASTM D 1998.

j. The minimum wall thickness shall be sufficient to support its own weight in an upright position without external support. Flat areas shall be provided for attachment of large fittings on the cylindrical portion.

2. The top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall equal the thickness of the top of the wall. The top head of tanks 2000 gal and larger shall provide a minimum of 1300 square inches of flat surface for pipe nozzle locations.

3. The bottom head shall be integrally molded with the cylindrical wall. Knuckle radius shall be in accordance with ASTM D 1998.

4. Tanks with 2000 gal capacity or larger shall have at least 3 lifting lugs molded into the top head. Lugs shall be designed for lifting an empty tank.
5. Tie-down lugs may be molded into the top head.
6. Manways
    a. Unless otherwise indicated, bolted sealed top manway shall be either 18-, 20-, or 24-inches and be in locations easily accessible from the nearest worker access position. The sealed manway shall be constructed of polyethylene material. The bolts shall be compatible with the chemical stored. Gaskets shall be closed cell, cross-linked polyethylene foam and Viton materials.

B. Tank Schedule

Equipment No.	TNK-191
Configuration (see Note 1)	CD
Material Type	HDPE (cross-link)
Insulation	No
Maximum Nominal diameter, in	48
Maximum Nominal Sidewall Height, in (see Note 2)	72
Maximum Overall height, in	96
Minimum Nominal capacity, gallons (see Note 5)	500
Manway (see Notes 3 and 4) Mounting Diameter, inches	 TM 18
Exposure (UV protection required if tank is mounted outdoors)	indoors
Color	natural

Equipment No.	TNK-192
Configuration (see Note 1)	CD
Material Type	HDPE (cross-link)
Insulation	No
Maximum Nominal diameter, in	72
Maximum Nominal Sidewall Height, in (see Note 2)	96
Maximum Overall height, in	120
Minimum Nominal capacity, gallons (see Note 5)	1,500
Manway (see Notes 3 and 4) Mounting Diameter, inches	 TM 18
Exposure (UV protection required if tank is mounted outdoors)	indoors
Color	natural

1. Note 1: CD = closed, domed top
    a. CF = closed, flat top

b. OIF = open, internal flange
c. OEF = open, external flange
d. FLR = flat lid, removable
e. FLH = flat lid, hinged

2. Note 2: Nominal height of domed top tanks is the dimension measured along the straight cylindrical portion of the tank and does not include the rounded top.
3. Note 3: TM = top mount
4. Note 4: Unless otherwise noted, manways shall be integrally molded with the tank.
5. Note 5: Nominal volume shall be calculated based on the straight cylindrical sidewall of the tank, or to the invert of overflow, whichever is lower.

C. Fittings

1. Tank fittings shall be according to the fitting schedule below and oriented as shown on the drawings in the Contract Documents. Gasket material shall be EPDM. Fittings shall be compatible with the chemical stored, be bolted double flanged fittings, Schedule 80, or threaded bulkhead type. Threaded fittings shall use American Standard Pipe Threads. No metals shall be exposed to tank contents. If tanks are insulated, fittings shall be installed at the factory prior to application of the insulation.

	Tanks TNK-191 and TNK-192 Fitting Type (See Note 4) and Size	
Port Description.	Diameter (inches)	Type of Fitting
Fill (top mounted)	4”	TB
Overflow	4”	BF-T
Tank drain (flush with bottom of tank)	2”	IMF
U-Vent (high point of tank)	4”	TB
Outlet to pump (3” above floor)	2”	BF-T
Level indication (top mounted)	2”	BF-T

2. Note 4: Refer to Drawings for fitting sizes, location and orientation. Abbreviations for fittings are:
   a. TB: Threaded bulkhead fitting
   b. BF-H: Bolted flange fitting with Hastelloy-C studs and polyethylene encapsulated heads.
   c. BF-SS: Bolted flange fitting with 316 SS studs and polyethylene encapsulated heads.
   d. BF-T Bolted flange fitting with titanium studs and polyethylene encapsulated heads
   e. DB-SD: Double bolt with siphon drain, 316 SS studs, and polyethylene encapsulated heads.
   f. IMF: Integrally molded flanged.
   g. TST: Threaded siphon tube
   h. SWST: Solvent-welded siphon tube
   i. PVC: Double-nut PVC fitting.
   j. Bulkhead fittings shall be constructed of PVC, PP, or other material compatible with the chemical stored. Gaskets shall be a minimum of 1/4-in thickness and be constructed of 40 to 50 durometer EPDM, 60 to 70 durometer Viton, or material compatible with the chemical in the tank.

3. Bolted flange fittings shall be constructed with two 150 psi flanges, two 150 psi flange gaskets, and the correct number and size of all-thread bolts recommended by the flange manufacturer. Flanges shall be constructed of PVC type 1, grade 1. Gaskets shall be min 1/4-in thick, constructed of 40 to 50 durometer EPDM, 60 to 70 durometer Viton, or material compatible with the chemical in the tank. There shall be minimum 4 full-thread bolts. Bolt heads may be gasket-flanged or may be encapsulated in a type of polyethylene compatible with the chemical stored. If encapsulated, the bolt head shall not contact the fluid in the tank and shall cover the head plus 1/4-in of threads away from the head. Polyethylene shall be color coded to identify the bolt metal underneath. Encapsulated heads shall have a gasket to provide a sealing surface against the inner flange. Bolt holes shall straddle the principal centerline of the tank in accordance with ASME B16.5
4. Integrally Molded Fittings (IMF). These fittings shall be an integral part of the tank and provide complete drainage of liquid through the sidewall of a flat bottom tank. The attachment shall be constructed from a Schedule 80 PVC, stainless steel, or compatible material and be standard at 2-, 3-, 4- or 6-in with inside diameter depending on the tank size.
5. Down Pipes and Fill Pipes: Down pipes and fill pipes shall be supported at 5-ft max intervals with support from standard bulkhead fitting tank attachments or welded PE supports. Down pipes and fill pipes shall be PVC or material compatible with the chemical stored.
6. U-Vents: Each tank must be vented for the material and flow and withdrawal rates expected. U-vents should comply with OSHA 1910.106(F)(iii)(2)(IV)(9) or shall be as large as the filling or withdrawal connection, whichever is larger. The vent shown above has been sized at 1" larger than the fill line. The vent size shall be confirmed by the tank manufacturer and be furnished complete with insect screen. Vents shall be constructed of PVC or material compatible with the chemical stored.
7. Flange Adapters: Adapters may be used to adapt threaded or socket fitting components to 150 psi flange connections. Adapters shall be of material compatible with the chemical stored.
8. Ladders: Ladders shall be constructed of FRP. Ladders must be designed to OSHA standard 2206; 1910.27. Ladders shall be mounted to the tank in such a way that tank expansion and contraction are not restricted. Top ladder mounts shall be connected to the tank as appropriate.
9. Attachments: Pipe attachments at fittings shall be equipped with flexible couplers or other provisions for movement. Piping attachments shall allow for 3 to 4 percent movement.

2.4 LEVEL INDICATON

A. Primary level indication shall be an ultrasonic type device, as specified in Division 40 of the contract documents, provided and installed by the Contractor as part of the plant instrumentation and control system. Contractor shall coordinate with the tank manufacturer the flange interface with the ultrasonic level device.

B. See Through Level Indication: Graduations shall be marked on the tank exterior at every 100 gallon interval with 1,000 gallon intervals clearly labeled for bulk storage tanks. Level indication system shall be compatible with chemical being stored with no glazing, fogging or etching effects.

2.5 TANK STANDS, SEISMIC, AND WIND RESTRAINT SYSTEM

A. The restraint assembly shall be designed and manufactured for IBC per the factors listed in the Contract Documents. No liquid weight may be used to resist seismic uplifting and overturning where tanks are not anchored.

2.6 SAFETY SIGNS

A. Each tank shall be clearly marked with hazardous material warning signs, 10-inches by 14-inches in size. Each sign shall have the word "DANGER" and the name of the chemical stored, printed in large block letters and mounted directly adjacent to the tank outlet and tank inlet. Each entry manway shall be provided with a sign reading "DANGER--CONFINED SPACE--HAZARDOUS ATMOSPHERE". Signs shall comply with the Contract Documents and the requirements herein.

2.7 FACTORY TESTING

A. Material Testing
   1. Low temperature impact test: Condition samples taken from fitting cutouts frozen for 2 hours at minus 40 degrees F. Perform impact tests in accordance with ASTM D 1998. Specimens less than 1/2-in thick shall be tested at 100 ft.-lb. and specimens equal to or thicker than 1/2 -in shall be tested at 200 ft.-lb.
   2. Degree of cross-linking (applicable to cross link material only): Use Method C of ASTM D 2765 to determine the ortho-xylene insoluble fraction of cross-linked polyethylene. Samples from the inside of the tank 1/8-in deep shall test at no less than 65 percent.

B. Tank Testing
   1. Dimensions: Take exterior dimensions with the tank empty, in the vertical position. Outside diameter tolerance, including out-of-roundness, shall be per ASTM D 1998. Fitting placement tolerance shall be 1/2-in vertical and 2 degrees radial.
   2. Visual: Inspect for foreign inclusions, air bubbles, pimples, crazing, cracking, and delamination.
   3. Wall Thickness
      a. Tanks 2000 gal or larger shall be measured for wall thickness by ultrasonic methods at 6-in, 1-ft, 2-ft, and 3-ft up the sidewall at zero and 180 degrees around the circumference from the outlet.
      b. Tanks smaller than 2000 gal may be tested during a production run and the results reported as representative of each tank in the run.
   4. Hydrostatic test: Following fabrication, the tanks, including inlet and outlet fittings, shall be hydraulically tested with water by filling to the brim for a minimum of 4 hours and inspecting for leaks. Following successful testing, the tank shall be emptied and dried prior to shipment.

C. Signed Affidavit. An affidavit signed by the tank manufacturer shall be furnished indicating that the factory tests have been performed and the indicated requirements have been met.

2.8 MANUFACTURERS, OR EQUAL

A. Poly Processing Company

B. Snyder Industries, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

A. After installation of tank and connections, the tank shall be water tested by filling the entire tank with water and monitoring the tank and connections for at least 24 hours. Leaks shall be corrected prior to acceptance. Following successful field testing, the tank shall be completely emptied and dried.

END OF SECTION

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DIVISION 46
WATER AND WASTEWATER EQUIPMENT

SECTION 46 33 00
CHEMICAL FEEDING EQUIPMENT, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide chemical feeding equipment, including tote scales, calibration columns, sight glass, and other appurtenances, complete and operable, in accordance with the Contract Documents.

B. Equipment shall be from manufacturers with several years of experience in the manufacture and assembly of similar products, with a record of successful installations. Such manufacturers shall maintain a well-established, authorized, local service agency with sufficient spare parts and personnel to respond within forty-eight (48) hours to any service calls.

C. The requirements of Section 11 00 00 - Equipment General Provisions apply to the Work of this Section.

D. Unless indicated otherwise, the requirements of this Section apply to all chemical feeding equipment in the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, power drive assemblies, parts, devices, pumps, tanks, mixers, supports, panels, and other accessories forming a part of the equipment, plus schematics, diagrams, and panel layouts.

C. Certification: The Contractor shall obtain written certification from each manufacturer, addressed to the Owner, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and the Drawings, and that the materials are best suited for the chemicals handled.

D. Technical Manuals: Furnish complete operations and maintenance manuals prior to start-up.

E. Spare Parts List: The Contractor shall obtain from the manufacturer a list of suggested spare parts for each piece of equipment subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, etc.

F. Maintenance: Printed instructions relating to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary, shall be furnished in duplicate with each unit or set of identical units.

G. Field Procedures: Instructions for field procedures for erection, adjustments, inspection, and testing shall be furnished prior to installation of the equipment.

H. Calibration Graphs: The manufacturer's representative shall prepare a calibration graph from field tests for each chemical feed unit which does not have a rate set device. Graphs shall read in pounds per hour for dry feeders or in gallons per hour for liquid feeders. The graph shall show the rate setter graduation conversion to pounds per hour or gallons per hour throughout the range of the feed unit. Each graph shall be furnished on hard paper and be sealed in clear plastic.

1.3 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Erection and Startup Assistance: Service and instruction assistance by the manufacturer's engineering representative for each equipment unit shall be furnished by the CONTRACTOR during the following period:

B. One day during erection, unless indicated otherwise in the feed equipment section.

C. One day during startup, unless indicated otherwise in the feed equipment section.

D. Instruction of Owner's Personnel: The Contractor shall furnish the services of a factory service representative to instruct the Owner's personnel in the operation and maintenance of the equipment. This service shall consist of a minimum one day's visit to the plant for each type of similar equipment.

1.4 QUALITY ASSURANCE

A. Warranty: After completion, the Contractor shall furnish to the Owner the manufacturer's written guarantees that the equipment will operate with the published efficiencies, heads, criteria, and flow ranges and meet these specifications. The Contractor shall also furnish the manufacturer's warranties as published in its literature.

PART 2 - PRODUCTS

2.1 GENERAL

A. Wherever it is required that a single manufacturer shall be responsible for the compatible and successful operation of the various components of any equipment unit, it shall be understood to mean that the Contractor shall provide only such equipment as the designated manufacturer will certify is suitable for use with its equipment and with the further understanding that this in no way constitutes a waiver of any indicated requirements.

B. Manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

C. Where two (2) or more units of the same type or size of equipment are required, such units shall be produced by the same manufacturer.

2.2 MATERIALS

A. Materials employed in the equipment shall be suitable for the intended application; materials not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

B. The following table lists the most commonly used chemicals for water and wastewater treatment and some of the suitable materials for the construction of chemical feeding equipment. Unless the manufacturer proposes more suitable materials, the table shall be adhered to:

Chemical	Suitable Handling Material
Polymers (Ionic) (Cationic) (Nonionic) (100% solution)	Type 316 stainless steel PVC FRP (suitable grade, verify compatibility with manufacturer) Teflon Polypropylene
Citric Acid (50% Solution)	Hastelloy C PVDF FRP (suitable grade, verify compatibility with manufacturer) Viton Teflon Vinyl Saran Polypropylene
Sodium Hypochlorite (NaOCl) (0.8 to 15 % solution)	Hastelloy C Titanium PVC FRP (suitable grade, verify compatibility with manufacturer) Viton Penton Hypalon Vinyl Saran Polyethylene Tyril Glass

2.3 APPURTENANCES

A. Nameplate: Each piece of equipment shall be provided with a nameplate (of material compatible with chemical), indicating equipment characteristics, capacity, motor horsepower, speed, electrical characteristics, manufacturer, model number, serial number, etc.

B. Solenoid Valves: The equipment manufacturer shall provide solenoid valves, which are part of the chemical feeding unit. The solenoid valve electrical rating shall be compatible with the equipment voltage and valves shall be complete with the necessary conduit and wiring from the control panel to the solenoids. The valve material shall be suitable for the intended service in accordance with the Section 40 05 50 – Miscellaneous Valves.

C. Pressure Gauges: Where indicated on Contract Drawings, chemical transfer and metering pumps and other equipment shall be equipped with pressure gauges with diaphragm seals in accordance with Section 40 73 13 – Pressure Gauges, except that the size of gauges on small metering pumps may be smaller than indicated in that section.

D. Calibration Columns: Provide Calibration Columns as indicated on the Contract Drawings. Each Calibration Column shall be an acrylic tube with PVC heads. The columns shall be calibrated for 30 second sampling periods and shall have the capacity as indicated in the table below, and shall have a maximum height of 30 inches. Each column shall be securely supported at both top and bottom.

E. Sight Flow Sight Glass: Provide sight flow sight glass as indicated on the Contract Drawings. Each sight flow indicator shall be constructed of a PVC body with 150 # rated flanges. The indicator shall be a flutter type. The flow sight glass shall be manufactured by Jacoby Tarbox style 910-FA-FLTR or Engineer approved equal.

F. Reverse Float Type Sight Gauge: Where indicated on Contract Drawings, chemical storage tanks shall be equipped with a 2-inch PVC float type reverse level sight gauge. The sight gauge shall be manufactured by Poly Processing Co. or equal (stock # 4089 for vertical tanks under 7-feet and stock # 3356 for vertical tanks over 7-feet). An internal Promo type tank pipe support as provided by Poly Processing Co. or equal shall be provided to support the interior tank pipe for all float type sight gauge applications. Calibration tape (stock # 6770) shall also be provided with each unit. The Contractor is responsible to calibrate the tanks and apply the Calibration tape in increments of gallons and over and in increments of 500 gallons for tanks less than 10,000 gallons. Calibration of tanks must be approved by the Engineer.

G. Chemical Tank Discharge Connection Expansion Joints: Provide a custom flexible connection for each chemical tank discharge connection as shown on the contract drawings. The flexible connection shall be manufactured by Harrington Plastics or equal. The flexible connection shall consist of all nonmetallic materials: polypropylene braided overwrap, convoluted PTFE liner, and PVDF flanges. The flexible connection shall be a minimum length of 6-inches and shall allow for minimum horizontal and vertical deflection of 1-inch.

H. Equipment Supports: Chemical feeding equipment and piping shall be firmly supported on concrete equipment pads and anchored down. Supports shall be as shown on the Drawings and in accordance with Sections 40 05 07.

I. Variable Speed Drives: Variable speed drives, drive motors, speed control equipment, and accessories shall be furnished in accordance with Section 26 29 23 - Variable Frequency Drives.

J. Controls: Controls shall be housed in enclosures with NEMA ratings, which comply with the area designations of Section 26 00 00 – Electrical Work, General.

K. Safety Equipment: Where required by Code, chemical unloading, storage, and feeding equipment shall be provided with the necessary safety devices and warning signs, clearly visible.

2.4 TOOLS AND SPARE PARTS

A. Tools: Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for the equipment shall be furnished as a part of the WORK; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts: Furnish spare seals, packing, gaskets, wear rings, and bearings as required by the feed equipment sections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Chemical feeding equipment shall be installed in accordance with governing safety standards, the Shop Drawings, and as indicated.

B. Alignment: Equipment shall be field tested to verify proper alignment, operation as indicated, and freedom from binding, scraping, vibration, shaft runout, leaks, or other defects. Drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The Work shall include furnishing the necessary oil and grease for initial lubrication and testing of all equipment.

END OF SECTION

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SECTION 46 33 42
DIAPHRAGM TYPE METERING PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide diaphragm type metering pumps, together with all drives, motors, valves, supports, controls, accessories, and appurtenances necessary for feeding chemical solutions, complete and operable, including inspection, start-up and field adjustment in accordance with Section 46 33 00 – Chemical Feeding Equipment, General and the Contract Documents.

B. Pumps shall be of corrosion-resistant construction and be of a suitable material for the chemicals indicated at maximum temperature of 40^0 C. Each pump shall have a variable-speed drive (PMS motor) or steeper motor, complete with pump base. Controller for the pump is to be integral with the pump. Size and characteristics of the pumps shall be as indicated herein.

C. The chemical feed system pumps shall be completely assembled, mounted, calibrated, tested and delivered to the site as a single floor mounted skid or unit per chemical system, complete with all of the accessories listed in this section and as shown in the drawings. All metering pumps/skids shall be mounted/located as shown on the drawings.

D. The requirements of Section 11 00 00 - Equipment General Provisions and Section 43 20 10 – Pumps, General apply to this Section.

E. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump, which will satisfy the indicated requirements.

1.2 SUBMITTAL PROCEDURES

A. Shop Drawings: Submittals shall be made in accordance with Section 01 33 20 –Submittal Procedures and Section 43 20 10 – Pumps, General.
   1. Performance data sheets showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump;
   2. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

B. Spare Parts List: The Contractor shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of manufacturer suggested spare parts for each piece of equipment specified. The Contractor shall also furnish the name, address and telephone number for the nearest distributor for each piece of equipment.

C. Operation and Maintenance Manual: Provide technical operation and maintenance manuals in accordance with Section 01 33 20 – Submittal Procedures.

D. Special Tools: provide one (1) set of all special tools required to complete assembly or disassembly of the system components.

1.3 QUALITY ASSURANCE

A. Pump Manufacturer shall issue a certificate of proper installation.

B. The chemical feeding equipment shall be the product of a manufacturer who has designed and manufactured similar equipment and has a record of at least five years of successful operation of this type of process.

C. The drive and pump head warranty shall be two years from date of substantial completion and shall cover the motor and pump head assemblies for manufacturing defects on non-consumable components.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each pumping unit shall be furnished as an integral unit with pump head, motor and all other appurtenances specified and required for proper operation. Each pumping unit shall be self-supporting and shall not require anchoring.

B. Identification:

Pump Name	Equipment Number	Location
Sodium Hypochlorite – Zone 2	PMP 290	Chemical Room – Chlorine
Sodium Hypochlorite – Zone 3	PMP 390	Chemical Room – Chlorine

2.2 OPERATING CONDITIONS

A. The work of this section shall be suitable for long term operation under the following conditions:

B.

Parameter	Units	Value
Duty		Continuous
Drive		Variable
Ambient Environment		Indoors
Ambient Temperature	Deg F	40 to 75
Ambient Relative Humidity	%	20 to 100
Fluid Service	%	-Sodium Hypochlorite (0.8 to 12.5 max)
Fluid Temperature	Deg F	40 to 75
Fluid pH Range		4 - 14
Specific Gravity		1.0 – 1.4
Project Elevation	ft, msl	4,990
Maximum Suction Lift	ft	10

2.3 PERFORMANCE REQUIREMENTS

A. Each pump shall have a control range of 800:1 for pumps up to 52 gph to cover the full range of operations required.

B. Each pump shall satisfy the following minimum performance requirements:

Pump Equipment Number	Design Flow Capacity Range (gph)	Pump Head (psi)	Continuous Operating Pressure (psi)	Service
PMP 290	1.0 – 50	58	As Needed	Sodium Hypochlorite
PMP 390				

C. Each pump shall be capable of self-priming when completely dry with a suction lift capability of up to 10 ft of water. The pump shall be capable of running dry without damaging effects to the pump or internal components.

D. Each pump shall be capable of auto deaeration during pump standby to avoid breakdowns due to air-locking.

E. Each pump shall be capable of anti-cavitation mode of ether 50% or 25% maximum flow to handle higher viscosity liquids or larger air bubbles.

F. Each pump dosing chemical of ≧900 cP viscosity must utilize spring-loaded check valves.

2.4 MATERIALS OF CONSTRUCTION

A. Pump Head Construction: The pump head shall be constructed of PVDF materials with FKM gaskets and Ceramic check balls where in components are in direct contact with the chemical of service. The pump head shall include connections for ¼" minimum poly-ethylene tubing for suction and discharge to be connected. Pump check valves shall utilize ceramic check balls suitable for chemical service.

2.5 MOTOR, DRIVE AND CONTROLS

A. The pump motor and drive shall be rated for a continuous operation for 24 hrs at an ambient temperature of 400C.

B. Power supply shall be 120 Volt, 60-Hz, 1 Phase.

C. The pump controller and motor shall be designed, manufactured and supplied by the metering pump manufacturer and shall be integral to the pump housing. Initial calibration of each pump shall be performed manually. Thereafter, the dosage of each metering pump shall be programmed for remote control through the plant PLC. The pump housing shall be enclosed in a NEMA 4X/IP65 rated enclosure. The controls shall come equipped to perform batching operations or timed interval injection and shall include input connections for low level, empty tank and leak detection capabilities.

D. The controller shall have a backlit LCD interface/display. The interface shall provide a selection of metered output to be displayed in Gal/hr. The interface shall have a lock function to protect against unauthorized changes. Pumps shall have an input for 4-20 mA analogue control, an input for dual level control or external start/stop, pulse output (or run status), and alarm output. The drive speed of each metering pump shall vary automatically in response to a 4-20 mA flow signal input from the plant PLC in order to maintain a pre-set dosing rate.

E. Each pump 4 gph and larger shall be supplied with an integrated leak detection sensor. The sensor shall be situated such that any leak within the pump head shall be detected and an alarm signal shall be sent to the plant PLC for operator notification. The pump shall automatically shut down in the event a leak is detected. Each pump shall be affixed upon a spill containment pan as part of the pump support table as shown in the drawings.

F. Each pump shall include necessary control input cable, output cable and relay output cable.

2.6 PUMP ACCESSORIES

A. Mounting and Connections: Components shall include metering pumps with integral controllers and motors, control cables, sample valves, pressure gauges with diaphragm seals, shut-off valves, injection check valves, PE tubing for suction and discharge connections, valved and graduated calibration columns in pump suction, flushing connection valves for periodic flushing of the line. Each pump shall include a multifunction valve to provide necessary pump backpressure, pressure relief and anti-siphon capabilities.
   1. There shall be one calibration column per chemical pump system.
   2. All wiring integral to the chemical metering pumps shall be provided.
   3. All pipe connections must be firmly supported from a secure pipe support as indicated on the drawings to avoid any stress on the piping system.

2.7 SPARE PARTS

A. The Contractor shall furnish a complete set of spare check valves and a diaphragm for each configuration of metering pump.

2.8 MANUFACTURER

A. Manufacturer's Experience: The chemical feeding equipment shall be the product of a manufacturer who has designed and manufactured similar equipment and has a record of at least 5 years of successful operation of this type of process. The Contractor may be required to submit evidence to this effect together with a representative list of installations. The pump manufacturer shall maintain a permanent, local service department and a spare parts department. Pump must be supplied by local distributor responsible for parts, service and warranty claims.

B. Manufacturers or equal:
   1. Grundfos, DDA Smart-Dose, AR or FC Control Variant

C. The fabricator of the pump skid system may be different than the pump manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with manufacturer recommendations and shop drawings and as shown on the drawings.

B. General installation requirements shall be as specified in Section 43 20 10 – Pumps, General, and Section 46 33 00 – Chemical Feeding Equipment, General.

END OF SECTION

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SECTION 46 33 50
ON-SITE SODIUM HYPOCHLORITE GENERATION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the work necessary by the Contractor, On-site Sodium Hypochlorite Generation System (OSHGS) Supplier, to furnish, install, test and make ready for operation an On-site Sodium Hypochlorite Generation System. The Generation System includes, but is not limited to the Sodium Hypochlorite Generator Skid with integral piping, valves, system control cabinet with PLC as well as ancillary equipment as specified herein, installation, related testing, start-up and training services.

B. All electrical, mechanical, metal, painting and instrumentation work included herein shall conform to the applicable Sections or Divisions of this project except as otherwise shown or specified. The standard for pipe and conduit for the skid interconnect is schedule 80 PVC.

C. The Drawings show details of the components and their overall relationships. Not all items incidental to the OSHGS are shown or specified. It is the intent of these Contract Documents that the OSHGS Supplier is to provide a complete and workable system whether or not any specific component is shown or specified.

D. Power shall be provided by the contractor to the system control panels as shown on the OSHGS skid drawings. The contractor shall be responsible for providing all necessary conduit and wiring necessary for a complete electrical service to this location. All wiring shall comply with the National Electrical Code, 1996 edition.

E. The OSHGS Supplier shall furnish the following components of the OSHGS Generation System:
   1. Sodium Hypochlorite Generation cells
   2. Interconnect piping, valves, solenoid control valves and accessories
   3. Control cabinet, PLC, VFD's, networking communication components, and associated equipment
   4. Water Softener
   5. FRP Salt/brine Tank (~360 gallon) and accessories
   6. Solution Tank (1,500 gallon) and accessories
   7. Hydrogen Dilution System – dilution blowers & air flow switches
   8. Hydrogen Gas Detector
   9. Heat Exchanger and Water Heater Systems
   10. Acid cleaning Cart/System
   11. Cartridge Filters (3) - For Brine and Potable Water – Before/After Softener

F. The requirements of Section 11 00 00 - Equipment General Provisions apply to this Section.

1.2 SUBMITTAL PROCEDURES

A. Submittals shall be made in accordance with Section 01 33 20 –Submittals Procedures

B. Shop Drawings as required for the fabrication and installation of all the Generation System equipment in accordance with the following:

1. Manufacturer/Supplier's literature, illustrations, Specifications and bill of materials for each component of the system. Data shall include a complete description in sufficient detail to permit comparison with the technical Specifications.
2. Dimensions including anchor bolt layout, materials, size, weight and performance data.
3. Drawings showing fabrication, assembly, installation and wiring diagram. Wiring diagrams shall consist of, at a minimum, of control schematics; including coordination with other electrical control devices operating in conjunction with the Sodium hypochlorite generator feed system.
4. Motor Data: For each motor furnish a certified motor data sheet for the actual motor.
5. Pump Data: For each pump furnish a performance certification indicating: head, capacity, efficiency and horsepower.
6. A list of all parameters, ratings or other characteristics where the proposed Sodium hypochlorite generator system deviates from the requirements set forth in these Specifications.
7. Affidavits of compliance with referenced standards and codes.
8. Manufacturer/supplier's standards for Sodium hypochlorite generator system equipment.
9. Process flow diagrams.
10. Dimensioned inlet/outlet system connections.
11. The acceptable range of water pressure for proper system operation. If a pressure or flow regulator is required, it shall be provided.

C. Spare Parts List: The Contractor shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of manufacturer suggested spare parts for each piece of equipment specified. The Contractor shall also furnish the name, address and telephone number for the nearest distributor for each piece of equipment.

D. Operation and Maintenance Manual: Provide technical operation and maintenance manuals in accordance with Section 01 33 20 –Submittal Procedures and as follows:
   1. Required Operation Data:
      a. Complete, detailed operating instructions for each piece of equipment
      b. Explanations for all safety considerations relating to operations
      c. Recommended spare parts lists
   2. Required Maintenance Data:
      a. Maintenance data shall include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions economically throughout its full design life.
      b. Explanation with illustrations as necessary for each maintenance task
      c. Recommended schedule of maintenance tasks
      d. Lubrication charts and tables of alternate lubricants
      e. Troubleshooting instructions
      f. List of maintenance tools and equipment
      g. Name, address and phone number of manufacturer and manufacturer's local service representative.

E. Special Tools: provide one (1) set of all special tools required to complete assembly or disassembly of the system components.

1.3 QUALITY ASSURANCE

A. OSHGS Suppliers Qualifications:
   1. Assume full responsibility for the completeness and proper operation of the OSHG.
   2. The OSHGS Supplier shall have experience in furnishing equipment of similar capacity and service capability to the equipment described herein. As part of their submittal package, the system manufacturer shall submit the following:
   3. Evidence of at least 10 years' experience with on-site sodium hypochlorite generation equipment ranging in capacity from 20 to 24000 pounds per day of 100% chlorine equivalent.
   4. Evidence that equipment of similar design has been in successful operation in at least ten separate installations for at least five years within the continental United States.
   5. Current NSF Standard 61 Certification for the system being offered.
   6. Supply units containing all necessary appurtenances and components for a complete and operating system confirming to this specification. The Sodium hypochlorite generation equipment shall be pre-assembled and factory tested to assure compliance with all operational requirements. The OSHG System shall be shipped as a single unit. Loose hypochlorite generation components shall not be acceptable. No field assembly or wiring will be permitted with the exception of external conduits. Equipment footprint as shown on the drawings shall not be exceeded.

B. The Contractor shall install the OSHGS, as specified in this specification and as shown on the drawings. The Contractor shall be responsible for connecting all conduit, wire, pipe, etc. for the OSHGS supplied equipment to the project equipment, including piping from the feed pumps to the injection points to provide a complete and fully operational OSHGS.

C. The OSHGS Supplier shall inspect the installation of the Generation System and the Contractor shall correct any deficiencies. Following the correction of all errors, the OSHGS Supplier shall provide a Certification of Proper Installation for the Generation System.

D. The OSHGS Supplier shall be responsible for programming the Generation System package control software. The OSHGS Supplier will define the PLCs for use in the OSHGS (Allen Bradley MicroLogix 1400 with embedded Ethernet/IP).

E. The OSHGS Supplier shall perform functional, performance and start-up testing of the Generation System. The Contractor shall schedule the OSHGS Supplier and notify the Engineer Owner and at least 14 days before the scheduled date for performing these tests.

F. The OSHGS Supplier shall train Owner's personnel and provide detailed instructions in the operation of the Generation Equipment.

1.4 REFERENCES

A. The following references apply:
   1. American National Standards Institute (ANSI).
   2. American Society for Quality Control (ASQC).
   3. American Society of Mechanical Engineers (ASME).
   4. American Society for Testing Materials (ASTM).
   5. American Water Works Association (AWWA).

6. British Standards Institute (BSI).
7. Canadian Standards Association (CSA).
8. The Chlorine Institute (CI).
9. Confinement of Substances Hazardous to Health (COSHH).
10. European National Standard (EN).
11. Institute of Electrical and Electronics Engineers (IEEE).
12. International Standards Organization (ISO).
13. Member States of the European Council (EC).
14. Mine Safety and Health Administration (MSHA).
15. National Electrical Code (NEC).
16. National Electrical Manufacturers Association (NEMA).
17. National Fire Code (NFC).
18. National Institute of Occupational Safety & Health (NIOSH).
19. Occupational Safety and Health Administration (OSHA).
20. Standard Fire Code (SFC).
21. Uniform Fire Code (UFC).
22. Water Environment Federation (WEF).

1.5 SYSTEM DESCRIPTION

A. Service: Drinking Water, Booster Pump Station to maintain disinfection residual.

B. Feed Points: Under normal operating conditions, site generated sodium hypochlorite solution (nominally 0.8 percent [±0.05%] by weight) will be injected into the discharge piping at locations shown on the drawings to maintain disinfection residual.

C. Functional Requirements:
1. Instrumentation, controls, logic, programming, interlocks and valving shall be provided by the OSHGS Supplier as required for the system to operate as described below.
2. General arrangement, piping sizes and accessories are shown on the Contract Drawings.

D. Generator Operation
1. The generator shall automatically start and stop based on the high and low levels in the sodium hypochlorite solution tank.
2. The water softener resin shall automatically be regenerated with salt solution from the brine tank.
3. The generator shall shut down and alarm for the following conditions:
   a. Low electrolyte level in cell
   b. Hypochlorite temperature exceeds 130°F (55°C)
   c. Inlet flow falls below a preset value
   d. Rectifier high or low amperage.
   e. Rectifier high temperature
   f. Hydrogen dilution blower failure
4. The following additional alarms shall be provided on the control panel:
   a. Low-low level for Hypochlorite Storage Tank
   b. High-high level for Hypochlorite Storage Tank

1.6 HYDROGEN SAFETY MANAGEMENT

A. The generators shall have no waste products associated with its use other than hydrogen gas, which is to be vented to the atmosphere. Hydrogen Dilution blowers will be used to purge all residual hydrogen out of the system and storage tanks and dilute the hydrogen concentration 100 to 1 or below 25% of the LEL.

B. Any proposed system must meet every operational and material aspect of this specification. Hydrogen management shall be accomplished by the passive venting of each electrolytic cell without potential restrictions. This flow path should not have baffle plates, orifice plates or backpressure valves between the last point of product generation and atmospheric evacuation.

C. The presence of over-pressure rupture disks is not acceptable as the initiation of disk rupture would render the system inoperable. No hydrogen shall be vented directly to the hypochlorite storage tank where an accumulation could occur.

D. Under no circumstance will waste hydrogen be allowed to flow from one cell or cell compartment to the next. All hydrogen must immediately be released from each cell pack.

E. Minimum passive venting capability from each electrolytic cell pack shall be 4.0 square inches for every 100 pounds of chlorine production.

F. The hydrogen dilution system shall dilute the hydrogen concentration to below 25% of the LEL or 1% by volume.

G. Generator skid hydrogen dilution shall include passive vents connected to each cell and blower connected to the vent header. Sodium hypochlorite storage tanks shall be evacuated by blower.

H. Under no circumstance will the Hydrogen Safety Management requirements (Part 2.02) be relaxed or modified as they are critical operator safety features and core to the generator design. NOTE: THIS HYDROGEN SAFETY DESIGN MUST BE MET, REGARDLESS OF ONSITE GENERATOR MANUFACTURER SELECTED, AND WILL BE REQUIRED FOR SUBMITTAL APPROVAL.

1.7 WARRANTY REQUIREMENTS

A. Prior to acceptance of the Sodium hypochlorite generator system, provide written warranty from the OSHGS Supplier that includes the following statements:
   1. OSHGS Supplier has inspected the installation during and after completion and the Sodium hypochlorite generator system is free from faults and defects and is in conformance with the Contract Documents.
   2. OSHGS Supplier must provide the following after sales services:
      a. Must provide a 24-hour 365-day toll free service hot line.
      b. On site technician availability.
      c. Same day or overnight parts availability.
      d. Must provide evidence of spare parts availability on this system such as electrodes, rectifiers, control cabinets, metering pumps.

3. Sodium hypochlorite generator system will remain free of defects for a period of three (3) years from the date of final acceptance and all other equipment supplied for one (1) year
4. The electrolytic cells including cell body shall have a three (3) year full replacement warranty and a prorated straight-line replacement warranty for years 4-7 from the date of final acceptance.
5. The warranty period shall start from the date of commissioning of the system.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Provide one sodium hypochlorite generator system, capable of generating on-site sodium hypochlorite solution (concentration range of 0.8% ±0.05%). All wetted components, materials and equipment in contact with finished, potable water shall conform to the applicable NSF requirements (60 or 61).

B. Sodium hypochlorite system will have a 1,500 gallon storage tank supplied by OSHGS manufacturer.

C. The electrolytic system shall generate an aqueous solution of a maximum concentration of 0.8% (± 0.05%) by weight sodium hypochlorite expressed as chlorine. The minimum capacity shall be demonstrated to be equal to the capacity specified for each installation while not exceeding the maximum raw material quantities.

D. Generator performance is to be measured as a function of total consumption for salt and power. Expected ranges of consumption for salt will be 2.5-3.0 pounds of salt and 1.8-2.4 KWH per pound of equivalent chlorine (PE). Product concentration will be in the range of 0.80% ±0.05%. Solar salt shall contain no organic binders, flow control agents, or resin cleaning material and meet the following specifications:

COMPONENT	WEIGHT
Sodium Chloride (dry basis)	99.7% minimum
Insolubles	0.15% maximum
Surface Moisture	0.20% maximum

E. Performance will be measured as the sum of the unit measurements for salt (PPE) and power (KWHPPE) and will not exceed 6.0 consumable units. Example: salt consumption at 3.0 PPE and 2.0 KWHPPE will measure 5.0 consumable units and will be considered proper performance. Note that electrolytic cells require an initial acclimation period of approximately 300 operational hours. Performance measured before the calls have completed this exercise may not satisfy specification requirements. Water softener salt consumption and or chiller or heater power consumption will be excluded from the calculation. Incoming process water must be potable, less than 10 PPM hardness and temperature must be in the range of 55-78°F. Higher temperatures will result in lower

efficiency and a higher total consumable value. A minimum of 50 psi water pressure is required at the inlet to the water softener.

F. The electrolytic cell shall consume in the range of 14.0-17.0 gallons of water per pound of chlorine equivalent output. The raw water supply to the softener shall be potable and free of organics and suspended solids.

G. The generator shall have no waste products associated with its use other than hydrogen gas, which is to be vented to the atmosphere, and the periodic backwash discharge (liquid waste product) from the water softener. Hydrogen Dilution blowers will be used to purge out all residual hydrogen out of the system and storage tanks.

H. The generator package shall be mounted in the general location shown on the drawings and shall be factory wired, plumbed and mounted on a self-contained skid assembly.

I. The process shall operate in a batch environment allowing for consistent hypochlorite concentrations and greatest efficiencies.

J. The generator package shall consist of the electrolytic cells, electrolyte management system, rectifier cabinet, control panel containing system controls, and all necessary interconnecting wiring and hardware.

K. The generator package shall have the following redundant interlocked safety features:
1. Cell high temperature switch.
2. Cell low level switch, for each cell
3. Water flow sensor
4. Transformer high temperature switch
5. Automatic current regulation

L. The rack mounted flow control panel will consist of a water rotameter, water sensor, brine rotameter and a positive displacement gear pump with variable speed drive.

M. The variable speed drive will respond to a 0-5 VDC signal generated by the PLC algorithm in order to maintain constant current relative to variable water temperature or flow rate.

N. The generator skid will be supplied with a 4-20 MA electrolyte temperature sensor that will function to return a linear signal proportional to 0-100°C, which will allow continuous operation up to 130°F without interruption. Under no circumstance will bimetaic “snap” switches be permitted as the primary over-temperature sensor.

2.2 ELECTROLYTIC CELLS

A. Multiple electrolytic cells shall be provided as follows:

SYSTEM I.D.	CELL QUANTITY	CELL CAPACITY	ACTIVE SURFACE
OSG 192	• 4 Cells	20	2” x 12”

Any system using fewer electrolytic cells than that specified above must demonstrate its ability to achieve 75% production capacity with one of the cells removed from service.

B. The electrolytic cells shall be constructed of clear acrylic materials, allowing for front and rear visual inspection of the electrodes.

C. Each electrolytic cell will be constructed utilizing DSA coated titanium anodes and titanium cathodes. The cells are to be configured in a vertical or horizontal format with a recirculating loop provided for each cell. This recirculating loop will allow the passive removal of hydrogen from each cell via the upper hydrogen vent. Under no circumstance will hydrogen be allowed to be driven from one cell or cell loop to the next.

D. Each cell loop will also incorporate a level sensor so as to preclude any possibility of exposing an active electrode surface.

E. All D.C. cable connections will be direct to the outermost electrode for both anode and cathode. High current bus configurations will not be allowed to penetrate the electrode housing.

F. The wetted cell components will consist only of the electrodes and acrylic cell body. No internal baffles, spacers or connecting hardware will be allowed.

G. Maximum allowable cell current density shall be no more than 1.25 amps per square inch. The OSHGS Supplier shall provide calculations showing all relevant cell data. Data shall include electrode area measurements, and current flows. Electrode service factor shall be expressed as amps per square inch of active electrode surface.

H. The Electrolytic Cells shall be mounted for clear and easy access on the OSHGS skid.

2.3 CONTROL SYSTEM

A. The OSHGS Supplier shall provide a NEMA 4X, 304 stainless steel, Sodium Hypochlorite Control Panel, which shall include controls for the entire sodium hypochlorite generation and feed system. The panel shall be mounted onto the generator skid and pre-wired at the factory to system components.

B. All controls and operation logic specified herein and as shown on the instrumentation loop diagrams required for the system shall be programmed in a Programmable Logic Controller (PLC). The PLC shall be Allen Bradley MicroLogix 1400 with embedded Ethernet/IP. Contractor shall coordinate with OSHGS Supplier and instrumentation supplier for proper integration of the system.

C. Operator interface will monitor residual chlorine measurement. Residual chlorine measurement signal will come from the Chlorine Analyzer (supplied and installed by Contractor) as an isolated 4-20 mA analog signal. Operator interface will allow Operator to enter residual chlorine Set Point and process control parameters.

D. The control signal to VFD (metering pump dose) will be increased if last measurement approaches the Set Point. A bigger deviation from set point creates bigger changes to the pump signal. The "changes" to the output will be smaller as Measurement approaches the Set Point. The "changes" to the output will change polarity (dose will be decreased) if control signal over-shoot, i.e. last measurement is above Set Point

E. The control panel shall display all relevant operating parameters and/or alarm conditions.

F. The control panel cabinet will be UL 508 approved and house the operator interface terminal (OIT), PLC, VFD's, hydrogen blower controls, and terminal strips to fully support the functions of generator operation, tank level and metering pump proportional control.

G. The OIT shall have the following features as a minimum:
   1. Context sensitive help screens for each alarm parameter
   2. Allen Bradley Panel View Plus 7
   3. Serial communications port for PLC connection
   4. Ethernet communications port to allow for VNC view from plant network.

H. The control cabinet logic will function at the PLC level where operating parameters will be measured, corrected, scaled, reported and controlled. The OIT will serve as the operator interface, data input screen, and alarm log.

I. The control cabinet to have a 4-port ethernet network switch, N-tron or Equal.

J. The generator PLC and display will control and monitor all functions and operational parameters including, but not limited to, the following:
   1. The generator shall automatically start and stop based on the high and low levels in the sodium hypochlorite storage tank.
   2. The generator shall shut down and alarm for the following conditions:
      a. Low electrolyte level in cell.
      b. Hypochlorite temperature exceeds 130°F (55°C).
      c. Inlet flow falls below a preset value.
      d. Rectifier high or low amperage.
      e. Rectifier high temperature.
      f. Hydrogen dilution blower failure.
   3. Low-low level alarm for hypochlorite storage tank.
   4. High-high level alarm for hypochlorite storage tank.
   5. Enclosure cabinet, 24" x 24" x 8", with ample interior volume so as to be easily wired and serviced.
   6. 6" color touchscreen human-machine interface (HMI) with dedicated screens, including help dialogs covering all basic operations and detailed alarm explanations, for each portion of the process and Ethernet communications for PLC connection.
   7. Allen Bradley MicroLogix 1400 programmable logic controller (PLC) with Ethernet communication protocol.

8. Rectifier controls.
9. Blower controls.
10. Analog inputs from the flow meter and residual analyzer to drive each VFD based on the appropriate flow, residual, or compound loop algorithm.
    a. Under no circumstances will external controllers be allowed to control the VFD output.
11. Logging and storing alarm history.
12. Security protection.
13. Dedicated 24 VDC power supply for PLC and HMI.
14. Emergency stop pushbutton.
15. Cabinet-mounted electrical disconnect switch.
16. Start-up shall be accomplished without the need for a laptop computer or proprietary software.

K. The OSHGS Supplier shall be responsible for programming the Generation System package control software. The OSHGS Supplier shall deliver to the Owner all PLC and HMI code for future reference prior to final acceptance.

2.4 ON-SITE SODIUM HYPOCHLORITE GENERATOR SKID SYSTEM

A. Provide one sodium hypochlorite generator feed system with a capacity of 80 pounds per day of equivalent chlorine. Rectifier, piping and blowers shall also be sized for 80 pounds per day. The generator feed system shall include at minimum two electrolytic cells operated in series and shall be factory skid mounted on a stainless steel skid.

B. The generator package shall consist of electrolytic cells, electrolyte management system, stainless steel rack with flow control panel, rectifier cabinet, PLC-based control system, HMI display, water softener with flow meter, and all necessary interconnecting wiring, hardware, piping, fittings, etc.

C. The generator will be built and configured to allow one of the electrolytic cells to be removed (replaced with a pipe spool) and still run at 75% production capacity with only minor adjustments to the required generator controls.

D. Each generation system shall be pre-piped, wired and skid mounted. The OSHGS skid frame shall be constructed of 304 stainless steel. The skid frame shall be configured to allow easy access to all components. All vertical and horizontal frame connections shall be welded.

The skid frame shall support as a minimum the following mounted equipment:

1. Generator electrolytic cells
2. Power supply/rectifier
3. Water and brine rotameters
4. Control panel
5. Interconnect pipes valves and fittings
6. Interconnect conduit and wiring
7. Water flow sensor
8. Variable speed brine pump.

2.5 TRANSFORMER RECTIFIER

A. The 6-pulse D.C. Rectifier will consist of a fully isolated three phase step down transformer and bridge rectifier. D.C. voltage output will be fixed with multiple primary taps for ± 5-10% voltage correction. Under no circumstance will switching rectifiers or phase angle fired SCR voltage correction be permitted. D.C. ripple will be less than 4% with a power factor of 99% or better.

B. The transformer rectifier will be a fixed voltage unit where the current will be allowed to float as a function of electrolyte conductivity.
   1. Constant current will be achieved via an active feedback loop where rectifier amperage is measured and reported to the PLC. The control algorithm calculates the appropriate amount of brine to mix with the incoming water so as to maintain constant current.

C. Rectifier efficiency will be 93% or greater.

D. Each transformer/rectifier will also house a 4-20 mA D.C. current transducer and NEMA 4X digital display of amperage.

E. The rectifier cabinet and base frame will be constructed of 304 Stainless Steel and will be of a modular design. All internal wiring connections and components will be easily accessible by removing the front access panel.

F. The transformer enclosure will be removable from the skid assembly as one piece, allowing for unobstructed access to the transformer.

G. The transformer rectifier shall be provided with the following accessories:
   1. DC bridge utilizing three diode assemblies and an aluminum heat sink with 120 VAC cooling fan.
   2. Panel-mounted electrical disconnect switch.

H. The transformer rectifies shall be designed for the following operating conditions:

TRANSFORMER I.D.	CAPACITY (KVA)	PRIMARY VOLTAGE	SECONDARY VOLTAGE
	9.6	480VAC/3PH/20A	N/A

2.6 WATER SOFTENER

A. A dual-tank automatic water softening system shall be provided to remove hardness in the feed stream to the OSHGS, plus provides brine water makeup. The softener shall be designed for the following operating conditions:

SOFTENER I.D.	DUAL TANK DIMENSIONS	EFFICIENCY*	KINETICO MODEL NO.
OSG 191	17" ø x 46" H	4,000	CP-208S

*Expressed as grains exchanged per pound of salt

B. The water softener shall be dual tank, continuously operational and capable of automatically regenerating without the use of electrical timers or gear motors. Regeneration cycles shall be flow dependent only.

C. Softener shall remove hardness to less than ½ gpg. One tank will be on-line during service. A water meter shall automatically initiate system regeneration. The water meter shall measure the processed volume and be adjustable. Water softeners that regenerate on a fixed time will not be acceptable. When the ion exchange capacity of one resin tank is nearly exhausted, the hydraulically-driven, flow-controlled switchover valve will automatically divert flow to the alternate tank while initiating brine backwashing of the first tank for regeneration of the ion exchange resin. During regeneration cycles, one tank shall provide water to service and to the regenerating tank. Regeneration shall use salt solution from the brine tank.

D. The regeneration control valve shall be top mounted (top of media tank), and manufactured from non-corrosive materials. Control valve shall not weigh more than four pounds. Control valve shall provide service and regeneration control for two media tanks. Inlet and outlet ports shall accept a quick connect, double O-ring sealed adapter. Interconnection between tanks shall be made through the regeneration valve with a quick connect adapter. Control valve shall operate using a minimum inlet pressure of 25 psi. Pressure shall be used to drive all valve functions. No electric hook-up, electric timers, or gear motors shall be required. Control valve shall incorporate four operational cycles including; service, brine draw, slow rinse, and a combined fast rinse and brine refill. The brine cycle shall flow shall be opposite the service flow, providing a countercurrent regeneration. Control valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control. The control valve will prevent the bypass of hard water to service during the regeneration cycle.

E. The tanks shall be designed for a maximum working pressure of 125 psi and hydrostatically tested at 300 psi. Tanks shall be made of polyethylene and reinforced with fiberglass wrapping. Each tank shall include a 2.5 in. threaded top opening. Upper and lower distribution system shall be of a slot design. Distributors will provide even flow of regeneration water and the collection of processed water.

F. Each softener shall include a non-solvent, high capacity cation resin having a minimum exchange capacity of 30,000 grains/ft^3 when regenerated with 15.0 lbs/ft^3. The media shall be solid, of a proper particle size and shall contain no plates, shells, agglomerates or other shapes, which might interfere with the normal function of the water softener.

G. The water softener shall be provided with the following accessories:

1. 1-1/2-inch inlet and outlet pipe connections.

2. 1/2-inch HDPE tube with in-line check valve for feeding brine for regeneration.
3. 1/4-inch wastewater discharge to sewer for backwash waste.

H. Acceptable Manufacture- Kinetico CP 208s

2.7 BRINE TANK [PNEUMATIC FILL FRP]

A. A fiberglass-reinforced plastic (FRP) salt/brine storage tank shall be provided for the following operating conditions:

TANK I.D.	DIAMETER	WALL HEIGHT	BRINE CAPACITY (GAL)	SALT CAPACITY (LBS)
TNK 191	4'-0"	4'-0"	360	3,600

B. Design Criteria

1. The brine tank vessel shall be designed for pressure service conditions as specified for Type I Grade 1 tanks in ASTM D 3299. Brine tank vessel shall conform to the following structural design criteria:

   Working Pressure: Hydrostatic load of SG 1.2
   Wind Load: 100 mph
   Maximum Temperature: 140 °F

   A 10:1 safety factor shall be used for internal pressure loadings and a 5:1 safety factor shall be used for external and vacuum loadings.

C. Quality Assurance

1. Tanks shall be manufactured in an RTP-1 Accredited manufacturing facility.
2. Visual defects shall be better than Level II on the inside of the vessel and better than Level III on the outside in accordance with ASTM D 2563 Table 1.
3. The manufacturer shall have been regularly engaged in the design and manufacture of brine make-up and storage systems tanks such as specified herein for at least five years. The manufacturer's experience shall include at least fifteen installations of equal or larger capacity than specified herein, that have been in operation for at least five years.

D. Materials and Construction

1. The brine tank shall be vertical and consist of FRP vessel, salt fill line, water distribution system, outlet plenum, salt and brine level controls, and all internals. The brine tank shall be cylindrical with a flat bottom and domed top. Vessel size and configuration shall be as shown on the drawings. Unit shall be complete with flanges, nozzles, manways, lifting lugs, anchor lugs, and other appurtenances.
2. The vessel shell shall be helically filament wound according to ASTM D-3299. Any shell fabrication by hand lay-up shall not be acceptable. Only the tank

bottom and dome may be fabricated by hand lay-up. Any tank made of PVC, polypropylene, or any other material shall not be acceptable. Contact molded components and accessories, shall be fabricated in accordance with ASTM D 4097 and NBS PS 15-69. The resin used shall be a premium isophthalic polyester type such as AROPOL 7241 T-15 by Ashland Chemicals or approved equal. The resin will be exposed continuously to a saturated brine solution.

3. All non molded surfaces shall be coated with resin incorporating paraffin to facilitate a full cure of the surface. All cut edges, bolt holes, secondary bonds shall be sealed with a resin coat prior to the final paraffinated resin coat. All voids to be filled with a resin paste.
4. The laminate shall consist of a single resin rich layer, with either c-veil or Nexus 111-00010 reinforcement followed by two 1-1/2-ounce layers of -1/2-ounce layers of random chopped strand glass, fully wetted out with resin. This interior surface shall yield a minimum 100-mil thick corrosion barrier. Filament wind over this to the required thickness. Exterior surface coat shall be paraffinated. Vessels shall be surface coated on the exterior with gel coat containing ultra violet light such as UV-9. No thixotropic or other additives shall be used.
5. Other than those associated nozzles, couplings, manways, and top and bottom heads, the towers shall be filament wound in one piece with no more than one joint.
6. The minimum properties of filament wound laminate shall be as specified in ASTM D 3299.
7. 24" diameter manways shall be in accordance with ASTM D 3299. As a minimum, two manways (lower side, top) shall be provided for each tank. The top manway cover shall include over-pressurization relief protection.
8. Flanged nozzles, double flanged gusseted nozzles, bottom drain nozzle, and threaded full couplings shall be provided as required. Flanged nozzles with 1/8-inch thick EPDM full-face gaskets of 60 durometer shall be provided by the supplier. Press-molded flanges are not acceptable. Threaded full couplings shall be FRP.
9. The tank shall include salt fill connection, softener water connection, brine outlet connection, drain, overflow, salt level indicator, brine level indicator, and vent.
10. The minimum properties of contact molded laminate shall be as specified in ASTM D 4097.
11. Anchorage: Each tank shall be furnished with concrete anchors and hold down lugs, complete with 304 stainless steel plates, for proper anchoring of the tank as required by the design calculations. A minimum of four (4) hold down lugs shall be provided.
12. Unless otherwise specified, all fasteners, and metal attachments, such as anchors, brackets, etc. shall be ANSI 316SS.
13. If necessary based on installation location, vessels designed for outdoor use shall have the bottom 6'-0" of straight sheel insulated for protection against freezing. Insulation shall be 2" thick polyurethane foam and be covered with a 1/8" thick FRP protective covering and receive a white pigmented gel coat with UV inhibitors. The top of the insulation will be capped to seal out any moisture.

E. Accessories

1. The brine tank shall be provided with a full-radiused Sch 40 304 stainless steel salt fill line designed to receive salt pneumatically unloaded from a truck. Long-radius fittings shall be used. One aluminum quick connect adapter and cover shall be provided to connect the truck's hose to the brine tank salt fill line as indicated on the drawings. One gooseneck vent shall be integrally molded into the brine tank dome. A vent dust collector bag shall be furnished and installed. The dust collector shall be properly sized for the salt fill rate and the brine tank capacity. The dust collector shall be polyester cloth material.
2. A water distribution system and a brine collection plenum shall be provided. Each assembly shall be securely installed in the brine/salt storage tank. Each assembly shall be designed to produce a saturated brine solution as required by the hypochlorite generators.
3. The brine tank shall be provided with a liquid level control assembly, including:
    a. A pressure sensing-type electronic level transmitter.
    b. Normally-closed, solenoid pilot-operated diaphragm valve shall have a brass body be ASCO 8210 Series. The solenoid valve shall open when brine solution level in the Brine Storage Tank is low. The solenoid valve shall close when the brine solution level in the Brine Storage Tank is high.
4. For tanks using granular or fine grade (less than 12 mesh) solar salt, a quartz rock filter bed shall be installed in the sump. The filter bed shall consist of a 5" layer of 0.125" x 0.125" on top of a 7" layer of 0.250" x 0.250". The filter bed shall be evenly-distributed over the entire bottom of the vessel. All quartz rock shall be AWWA-washed and NSF-certified.
5. The salt level sensor shall be a cable measurement transmitter. Cable measurement transmitter shall continuously measure salt level in the brine tank with 0.25% accuracy. Measuring cable length shall extend the entire height of the brine tank to measure salt at all levels. The cable shall be constructed of material resistant to saturated brine. Transmitter shall be Bin Master "Smart Bob II A.O." or equal.
6. For tanks with straight shell greater than 12'-0", an OSHA-approved fiberglass ladder with safety cage shall be provided. The ladder shall be mounted to the vessel, but fully supported by concrete or other suitable support base. Attachment fasteners shall be stainless steel.
7. A fiberglass-encapsulated nameplate shall be provided. At a minimum, the nameplate shall include the following information:
    1) Project name
    2) Installation location
    3) Service
    4) Specific gravity
    5) pH
    6) Pressure rating
    7) Temperature rating
    8) Resin
    9) Size

10) Capacity
11) Shipping Weight
12) Date of manufacture

8. Unless otherwise specified, all pipe and fittings shall be Sch 80 PVC and all fasteners stainless steel.

2.8 SODIUM HYPOCHLORITE STORAGE TANK

A. The OSHGS manufacturer shall supply one 1,500 gallon hypochlorite storage tank to be installed by the Contractor under the direction of a representative of the OSHGS manufacturer.

B. The OSHGS manufacturer shall supply the polyethylene sodium hypochlorite solution tank with the following accessories:

1. Level sensor and associated flanged connection. The level transmitter shall provide a 4-20 mA level signal for proper operation of the generation system.
2. Vent connection.
3. Fill connection.
4. Forced air blower connection.
5. Pump suction connection.
6. Drain and overflow connections.

2.9 SODIUM HYPOCHLORITE DOSING SYSTEM (NOT INCLUDED IN THIS PACKAGE)

A. The SH metering pumps shall be supplied and installed by the Contractor.

B. Each pump shall be supplied with a PVC stands, backpressure valve, pressure relief valve, pulsation dampener, wye strainer, pressure gauge and calibration column. See Section 46 33 42 - Diaphragm Type Metering Pumps.

C. The metering pumps shall be controlled by the SH Generation System controls, as specified herein.

2.10 HEAT EXCHANGER (MICROCHLOR)

A. The OSHGS shall provide a heat exchanger as part of this equipment package.

B. A titanium and PVC heat exchanger will be provided on the OSHGS rack capable of raising the incoming cold water temperature 8-12°F.

C. The process will function to bleed waste heat from the product hypochlorite to the incoming cold water.

D. A bypass valve will be provided for seasonal adjustment. Additionally, a flushing valve and drain will be provided.

E. All wetted components and fasteners will be titanium and all internal gasketing will be Viton.

F. The heat exchanger will not require power or control circuitry and will function in a completely passive fashion.

2.11 WATER HEATER

A. As part of this equipment package, the OSHGS shall provide an adequately sized water heater to heat the water prior to the OSGHS elements reaching high temperatures. Water heater shall be designed for full capacity of the OSGHS unit.

2.12 HYDROGEN DILUTION AND FLOW SENSOR

A. The hydrogen dilution system shall dilute the hydrogen concentration to below 25% of LEL or 1% by volume.

B. A hydrogen dilution blower shall be designed for the following operating conditions:

BLOWER I.D.	CAPACITY (ACFM)	STATIC PRESSURE (IN WC)	MOTOR HP	ELECTRICAL SERVICE
	163	4”	1/2	240V/1Ph/60Hz

C. The blower shall be AMCA type B spark resistant of cast aluminum construction. The blower shall be cast with commercial grade 319 cast aluminum, having a 3/16” minimum wall thickness. Housing halves should be attached with tapered lugs having a minimum 45 degree taper from centerline for additional strength. Inlets and outlets shall be round.

D. The blower wheel hub shall be an integral part of the wheel casting. The wheel shall be a radial-type wheel. The blower shall be statically balanced by removal of material only – no additional weights are to be used in the balancing process.

E. The blower shall be arrangement 4 with a base of 12 gauge steel (minimum).

F. Hydrogen dilution blower shall be PB Series by Cincinnati Fan or equal.

G. The hydrogen dilution blower shall be provided with the following accessories:

1. Inlet guard.
2. Teflon shaft seal.
3. Current sensor.
4. Air flow switch positioned in the dilution ductwork vent stack.
5. Software controlled safety interlocks to detect control system sequence failure.

2.13 HYDROGEN DETECTOR

A. A hydrogen gas monitoring system shall be provided to continuously measure and display gas concentration and provide alarms when preset limits are exceeded. A transmitter will send the signal to the control panel.

B. Hydrogen Gas room monitor / detector shall be provided.
   1. Enclosure: NEMA 4X
   2. Display: Two line, 8 Character, Alphanumeric LCD Display
   3. Output signal: Linear 4-20 mA

C. Acceptable Manufacture and Model: Conspec Controls Model CN06

2.14 ACID CLEANING CART / 7 GALLON SYSTEM

A. A pre-assembled, mobile cart including acid cleaning tank and centrifugal pump shall be provided by the OSHGS Supplier for periodic washing of the electrolytic cells.

B. The cart shall be pre-piped and pre-wired prior to shipment. All piping, fittings, and valves shall be Sch 80 PVC. The 120VAC, single-phase plug shall be included for connection to a standard electrical receptacle.

C. A discharge hose, quick-connect couplings, and appurtenance shall be included to transfer acid to and from the electrolytic cells.

2.15 COMMERCIAL STRENGTH HYPOCHLORITE DILUTION PANEL (NOT INCLUDED)

2.16 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. The OSHGS Supplier shall furnish, one set of the following spare parts for each installation, with each onsite sodium hypochlorite generator system:
   1. Two (2) electrolytic cell level switch
   2. Two (2) electrolytic cell temperature sensor
   3. One (1) spare parts kit for each metering pump
   4. One (1) set of spare parts kit for the backpressure and pressure relief valves.
   5. One (1) spare brine pump.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the completion of the contract.

2.17 CARTRIDGE FILTERS

A. A wall-mounted cartridge type filter housings holding a 10" cartridge for dirt, rust, and particulate matter from the brine stream shall be provided. The filter housing shall be feature NPT inlet and outlet connections and mounting bracket that must be non-metallic construction. A polypropylene cap with Buna-N O-ring shall be supplied.

B. 50 micron, suitable for use on both brine and potable water before and after softener

2.18 MANUFACTURERS (NO OR EQUAL)

A. Approved Manufacturers:
   1. MicroClor System as manufactured by PSI Water Technologies, Inc. (a UGSI Company)

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. The Contractor shall inspect all equipment and materials against approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of the approved Shop Drawings shall be immediately returned to the OSHGS Supplier for replacement or repair.

B. The Contractor shall be responsible for the delivery, storage and handling of products in accordance with the manufacturer's recommendations.

C. Equipment and materials shall be stored in a dry location and protected from the elements according to the OSHGS Supplier's instructions.

D. Equipment and materials shall be handled in an approved manner according to the OSHGS Supplier's instructions.

3.2 INSTALLATION

A. Installation of the generator, metering pumps, tanks and appurtenances shall be performed by the Contractor and shall be in accordance with the Drawings and with the OSHGS Supplier's instructions and recommendations. Conflicts of information shall be called to the attention of the Engineer.

B. All equipment units or assemblies shall be installed on concrete bases and secured with anchor bolts in accordance with the OSHGS Supplier's recommendations and as shown. The concrete bases shall be poured up to 1-inch below the metal bases, legs or soleplates. Equipment legs or base plates shall be accurately shimmed to grade and the spaces between filled with an approved non-shrink grout. After the grout has reached its initial set, exposed edges shall be cut back 2 inches and the edges neatly finished with 1 to 2-cement mortar. Where channel base plates are used, the void inside the channel shall be filled with non-shrink mortar and the open ends plastered with 1 to 2-cement mortar. Contractor shall be responsible for the design of the equipment pads. The contractor shall coordinate with OSHGS supplier for skid placement and anchoring.

C. Contractor shall inspect all concrete pads for proper elevation, dimensions, cutouts, evenness and anchor bolt locations and correct if necessary.

D. Contractor shall provide a drain for each piece of equipment, according to the OSHGS Supplier's instructions.

E. Installation shall include furnishing and applying an initial supply of lubricants, as provided by the OSHGS Supplier.

F. Contractor shall support piping independent of equipment. Equipment shall be free from all loads and stresses induced by the piping.

G. All equipment including motors, belts and drives shall be aligned to the best industrial standards. Field check and adjust all equipment alignments in the presence of the Engineer.

H. The contractor shall inspect all equipment before installation, if damaged; notify the Engineer and OSHGS Supplier promptly. Do not install damaged equipment until the OSHGS Supplier makes repairs in accordance with OSHGS Supplier's written instruction and approval.
   1. Tie-down lugs for tanks shall be grouted or shimmed to prevent excessive loads being transferred to the tank shell.
   2. Make all electrical connections in conformance with the requirements of the electrical specifications.

3.3 START-UP SERVICES AND TESTING

A. The chlorination equipment manufacturer shall furnish the services of a qualified field engineer to check installation, start-up and instruct operating personnel in the proper operation and maintenance of the equipment

B. Contractor shall verify that structures, equipment, pumps and motors are compatible for an efficient system. OSHGS Supplier is responsible to verify that generation equipment and system controls are integrated for system operation.

C. Contractor and OSHGS Supplier shall make equipment adjustments required to place system in proper operating condition.

D. Contractor and OSHGS Supplier shall test the sodium hypochlorite feed system for proper operation in the presence of the Owner and Engineer.

E. The OSHGS Supplier shall furnish all testing equipment and devices required.

F. If the sodium hypochlorite feed system fails to meet any of the specified performance requirements, Contractor and/or OSHGS Supplier shall modify and/or replace defective equipment until it meets specified requirements. Re-test system to verify satisfactory operation.

G. Demonstrate the accuracy of each metering pump using job supplied calibration column.

H. The OSHGS Supplier's field services:
   1. Retain, for a period of not less than two (2) days for installation of each generation system, factory trained representatives of the manufacturer of each component with demonstrated ability and experience in the installation and operation of the equipment. For each installation, the representative shall perform the services listed below:
      a. Inspect the completed installation and prepare an inspection report.
      b. Test, calibrate and adjust all components for optimum performance.
      c. Assist in initial start-up and field-testing.
      d. Instruct Owner's personnel in the operation and user maintenance of all components. Conduct a training seminar at the site.
      e. Supervise the correction of any defective or faulty work before and after acceptance by Owner.

I. Dosing Pump manufacturer's field services (See metering pump specification):

END OF SECTION