Appendix E
Specifications

PG&E

TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

PRE-FINAL (90%)
TECHNICAL SPECIFICATION

VOLUME 1

for the construction of the

TOPOCK GROUNDWATER REMEDIATION PROJECT

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CH2M HILL

Oakland, CA

September 8, 2014

Project No. 435062 Copy No. _____

TABLE OF CONTENTS

VOLUME 1

DIVISION 23—HEATING, VENTILATING, AND AIR-CONDITIONING

DIVISIONS 24 THROUGH 25—NOT USED

DIVISION 26—ELECTRICAL

DIVISIONS 27 THROUGH 30—NOT USED

VOLUME 3

Submersible Well Pump PMP-*541, *542 Data Sheet
Submersible Well Pump PMP-*544, *545, *543 Data Sheet
Submersible Well Pump PMP-*546, *547, *548, *549 Data Sheet
Submersible Well Pump PMP-*641A, *641B Data Sheet
Submersible Well Pump PMP-441 Data Sheet
Submersible Well Pump PMP-*540 Data Sheet
Submersible Well Pump PMP-*640 Data Sheet

44 42 56.09 Non-Clog Dry-Pit Centrifugal Pumps
Supplements:
Influent Tank Farm, Decon Pad, Remedy Produced Water Conditioning Plant Sump Pumps Submersible Centrifugal Pump Data Sheet
Conditioning Water Tank Farm Sump Pump Submersible Centrifugal Pump Data Sheet

44 42 56.10 Horizontal End Suction Centrifugal Pumps
Supplements:
Influent Storage Tank Recirculation Pump #1, 2, 3, 4 Pump Data Sheet
Filter Feed Pump 1 – A Side, Filter Feed Pump 2 – A Side Data Sheet
Filter Feed Pump 1 – B Side, Filter Feed Pump 2 – B Side Data Sheet
Conditioned Water Transfer Pump 1 & 2 Data Sheet
Truck Loading Pump Data Sheet
Electric Motor Data Sheet

44 42 56.15 Air Operated Diaphragm Pumps
Supplement:
Solids Pump Air-Operated Diaphragm Pump Data Sheet

44 43 13.16 Cartridge Filters

44 44 13.01 Chemical Metering Pumps
Supplement:
Caustic Feed Pump 1 and 2 Data Sheet
Coagulant Feed Pump 1 and 2 Data Sheet
Acid Feed Pump 1 and 2 Data Sheet
Carbon Substrate Pumps, Well Maintenance Reagent Pumps Data Sheet

DIVISIONS 45 THROUGH 49—NOT USED

VOLUME 4

DRAWINGS

END OF SECTION

SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
2. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
   a. Part 61—National Emission Standards for Hazardous Air Pollutants.
   b. Part 273—Standards for Universal Waste Management.
3. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.
4. Section 31 23 23, Fill and Backfill.

1.02 DEFINITIONS

A. ACM: Asbestos-containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof.

C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.

D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on Drawings.

E. Renovation: Altering a facility or one or more facility components in any way.

F. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

G. Universal Waste Lamp: In accordance with 40 CFR 273, the bulb or tube portion of an electric lighting device, examples of which include, but are not limited to, fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.

H. Universal Waste Thermostat: A temperature control device that contains metallic mercury in an ampule attached to a bimetal sensing element, and mercury-containing ampules that have been removed from these temperature control devices in compliance with the requirements of 40 CFR 273.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition/Renovation Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.

1.04 REGULATORY AND SAFETY REQUIREMENTS

A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.

B. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the General Conditions, Contractor’s safety requirements shall conform to ANSI A10.6.

C. Furnish timely notification of this demolition project to applicable federal, state, regional, and local authorities in accordance with 40 CFR 61-Subpart M.

1.05 DEMOLITION/RENOVATION PLAN

A. Demolition/Renovation Plan shall provide for safe conduct of the Work and shall include:

1. Detailed description of methods and equipment to be used for each operation;
2. The Contractor’s planned sequence of operations, including coordination with other work in progress;
3. Procedures for removal and disposition of materials specified to be salvaged.

1.06 SEQUENCING AND SCHEDULING

A. The Work of this Specification shall not commence until Contractor's Demolition/Renovation Plan has been approved by Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FACILITIES TO BE DEMOLISHED OR RENOVATED

A. Facilities: Portions of buildings and other areas scheduled for selective demolition, partial demolition, and renovation Work are as shown on Drawings.

B. Structures: Existing above-grade structures indicated shall be removed. Site structures and existing site works shall be removed as indicated.

C. Utilities and Related Equipment:

1. Notify Engineer or appropriate utilities to turn off affected services at least 48 hours before starting demolition activities.
2. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by Engineer.
3. When utility lines are encountered that are not indicated on Drawings, notify Engineer and Owner prior to further work in that area.
4. Excavate and remove utility lines serving buildings to be demolished to a distance of 10 feet beyond the outside perimeter of the demolition.
5. Provide a permanent leak-proof closure for water and gas lines.
6. Plug sewer lines with concrete to a minimum plug length of 3 feet to prevent groundwater infiltration.

D. Paving and Slabs:

1. Sawcut and remove concrete and asphaltic concrete paving and slabs including aggregate base as indicated to a depth of 6 inches below existing adjacent grade.
2. Provide neat sawcuts at limits of pavement removal as indicated.

E. Concrete: Saw concrete along straight lines to a depth of not less than 2 inches. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished Work, and the

remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Where new concrete adjoins existing, the new Work shall abut or tie into the existing construction as indicated.

F. Patching:

1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces as to texture and finish.
2. Where new Work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new Work.
3. Patching shall be as specified and indicated, and shall include fill holes and depressions caused by previous physical damage or left as a result of removals in existing concrete walls with an approved patching material, applied in accordance with the manufacturer's printed instructions.

G. Electrical:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
2. When removing designated equipment, conduit and wiring may require rework to maintain service to other equipment.
3. Rework existing circuits, or provide temporary circuits as necessary during renovation to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record the Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panel boards as required to accomplish the finished work.
4. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
5. Raceways and cabling not scheduled for reuse.
6. Inaccessibly Concealed: Cut off and abandon in place.
7. Exposed or Concealed Above Accessible Ceilings: Remove.
8. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
9. Relocating Equipment: Extend existing wiring or run new wiring from the source.
10. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.

11. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).
12. Provide new typewritten panel board circuit directory cards.

3.02 PROTECTION

A. Dust and Debris Control: Prevent the spread of dust and debris to occupied portions of the site and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

B. Traffic Control Signs: Where pedestrian and driver safety is endangered in the area of removal Work, use traffic barricades with flashing lights.

C. Existing Work:

1. Survey the site and examine Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.
2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by Engineer.
3. Provide temporary weather protection during interval between removal of existing exterior surfaces and installation of new to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
4. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.
5. Do not overload pavements to remain.

D. Weather Protection: For portions of the building scheduled to remain, protect building interior and materials and equipment from weather at all times. Where removal of existing roofing is necessary to accomplish the Work, have materials and workmen ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent loss.

E. Trees: Protect trees within the Site that might be damaged during demolition and are indicated to be left in place, by a 6-foot-high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated

to remain that is damaged during the Work shall be replaced in kind, as approved by the Engineer.

F. Facilities:

1. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.
2. Floors, roofs, walls, columns, pilasters, and other structural elements that are designed and constructed to stand without lateral support or shoring, and are determined by Contractor to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Engineer.
3. Protect all facility elements not scheduled for demolition.
4. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities.

G. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner’s personnel and the general public from injury due to demolition Work.
3. Provide protective measures as required to provide free and safe passage of Owner’s personnel and the general public to occupied portions of the structure.

3.03 BURNING

A. The use of burning at the Site for the disposal of refuse and debris will not be permitted.

B. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Engineer. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by Engineer.

3.04 BACKFILL

A. Do not use demolition debris as backfill material.

B. Fill excavations, open basements and other hazardous openings to existing ground level or foundation level of new construction in accordance with Section 31 23 23, Fill and Backfill.

3.05 TITLE TO MATERIALS

A. All salvaged equipment will remain the property of Owner. Coordinate with Engineer on removal in accordance with Local, State and Federal requirements.

3.06 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor's Demolition Plan. Equipment and materials not shown on Drawings to be coordinated by Engineer.

B. Salvage equipment to the maximum extent possible.

3.07 REUSE OF MATERIALS AND EQUIPMENT

A. Remove and store materials and equipment to be reused or relocated to prevent damage, and reinstall as the Work progresses.

B. Properly store and maintain equipment and materials in same condition as when removed.

C. Store equipment and material designated to be reused in a location designated by Owner.

D. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.

E. Engineer will determine condition of equipment and materials prior to removal.

3.08 CLEANUP

A. Debris and rubbish shall be removed from basement and similar excavations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 117/117R, Standard Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. 318/318R, Building Code Requirements for Structural Concrete and Commentary.
   d. 350/350R, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   e. 347, Guide to Formwork for Concrete.
   f. SP-4, Formwork for Concrete.
2. APA – The Engineered Wood Association (APA/EWA).
3. Standard Specifications for Public Works Construction.
4. U.S. Department of Commerce: PS-1 – U. S. Product standard for construction and Industrial Plywood.
5. Western Wood Products Association (WWPA): G5, Western Lumber Grading Rules.

1.02 DESIGN REQUIREMENTS

A. Design, engineer, and construct formwork in accordance with ACI 301, ACI 347, ACI 318/318R and ACI 350/350R to provide concrete finishes specified in Section 03 30 00, Cast-in-Place Concrete.

B. Contractor responsible for form design, form removal procedures and sequences, shoring and re-shoring, and shore removals according to ACI 301, Section 2.

C. Make joints in forms watertight.

D. Limit panel deflection to 1/360th of each component span to achieve tolerances specified.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Layout of panel joints, form liners, and tie hole pattern.
   b. Form Ties-Tapered Through-Bolts: Proposed method of sealing form tie hole; coordinate with details shown.
   c. Manufacturer's data for form release agent.
   d. Manufacturer's literature for form materials, form accessories, and prefabricated forms, including type, size, quantity and strength of all form materials.
   e. Plan for jointing of facing panels.
   f. Details affecting the appearance.
   g. Assumed design values and loading conditions.
2. Samples: One each as follows:
   a. Form ties.
   b. Form liners.

1.04 INFORMATIONAL SUBMITTALS

A. Statement of qualification for formwork designer.

1. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).
2. Design computations for the formwork.
3. On-Site Contractor Quality Control Plan.
4. On-Site Contractor Quality Control Reports.

1.05 QUALIFICATIONS

A. Formwork Designer: Formwork, falsework, and shoring design shall be by an engineer licensed in the State of California.

1.06 CONTRACTOR QUALITY CONTROL

A. Perform work in accordance with ACI 301, ACI 318, ACI 347 and ACI 350/350R. Tolerance shall be as necessary to provide completed concrete structure within the tolerance specified in ACI 117.

B. Supply all labor, tools, equipment and materials to set forms so that the resultant concrete conforms to required shapes, lines, and dimensions of the design, as well as the necessary code requirements.

1. It is the Contractor's responsibility to design and build adequate forms and to leave them in in-place until the forms can be safely removed.
2. Fabricate form for easy removal without hammering or prying against concrete surfaces.
3. Bear responsibility for damage and injury caused by removing forms carelessly or before the concrete has gained sufficient strength.

C. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design and that supports, fastenings, wedges, ties, and items are secure.

D. Monitor forms during concrete placement and correct deficiencies.

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Wall Forms and Underside of Slabs and Beams:

1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in "new and undamaged" condition, of sufficient strength and surface smoothness to produce specified finish. Use plywood forms when using form liners. Plywood may be of lower finish grade when use in conjunction with form liners.

B. Form Liners:

1. Glass Fiber Reinforced Plastic Forms: Matched, tight fitting stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearances of finished concrete surface.
2. Lumber: Fir species No. 2 grade or better, with grade stamp clearly visible.
3. Steel: Minimum 16 gauge sheet, well matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished surfaces.

C. Sandblasted Surface Forms: Medium density overlay plywood for flat concrete surfaces to be sandblasted.

D. Painted Surface Forms: High-density overlay plywood for flat concrete surfaces to be painted.

E. All Other Forms: Materials as specified for wall forms.

F. Form Release Agent:

1. Material: Release agent shall be colorless, not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatments of concrete surfaces when applied to forms or form liners. A ready-to-use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations and can be used in potable water facilities.
2. Manufacturers and Products:
    a. BASF, Shakopee, MN; MBT, Rheofinish 211.
    b. Cresset Chemical Company; Crete-Lease 20-VOC.
3. Form Ties:
    a. Material: Removable snap-off type, galvanized metal, 3/4-inch break back dimension, fixed length, cone type.
    b. Spreader Inserts:
        1) Conical or spherical type.
        2) Design to maintain positive contact with forming material.
        3) Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
    c. Wire ties not permitted
    d. Flat bar ties for panel forms; furnish plastic or rubber inserts with minimum 1.5-inch depth and sufficient dimensions to permit patching of tie hole.
    e. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish the following:
4. Neoprene water stop 3/16 inch thick and 15/16 inch diameter whose center hole is one half diameter of tie, or molded plastic water stop of comparable size.
5. Through-Bolt: Tapered minimum 1-inch diameter at smallest end.
6. Nails, Spikes, Lag Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
7. Joint filler: A dense, closed-cell foam rubber.

G. Corners: Chamfered strip type; 3/4 inch by 3/4 inch size; maximum possible lengths.

H. Preformed Plastic Adhesive Waterstop Fuel Resistant (PPAWS FR): Extruded rope form (consisting of N.B.R. compound with poly propylene resins and other solvent resistant elastomers) between two protective silicone treated papers, 7/8 inch by 1 inch cross section, 1 inch lap splice, furnish and use with primer; Henry Company, SF312-Synko-Flex FR, or as approved.

I. TPV Waterstop: Waterstop shall be 4 inches tall, 3/16 inch thick, nontapered profile made from thermoplastic vulcanizate (TPV) serrated with center bulb. waterstop to be welded in accordance with manufacturer's requirements. Manufactured by JP Specialties, Inc.; Type JP436, or as approved.

PART 3 EXECUTION

3.01 FORM SURFACE PREPARATION

A. Thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants as erection proceeds and prior to coating surface.

B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by the manufacturer.

1. Apply prior to placement of reinforcing steel, anchoring devices and embedded items.
2. After form release agent is applied to forms, place concrete within 14 calendar days. If concrete is not placed within 14 calendar days, remove the forms and reapply the form release agent.
3. Do not apply form release agent where concrete surfaces are scheduled to receive special finishes which may be affected by the agent, such as crystal forming waterproofing. Soak contact surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

C. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

D. Form Liners: Provide liners with full sheets and place seams at horizontal and vertical grooves. Prepare as recommended by manufacturer.

1. Use anchorage systems recommended by manufacturer to anchor liner to formwork.
2. Do not use form release agent on formwork.

E. Earth Forms:

1. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete. Earth forms subject to Engineer's approval.
2. Do not use rock cuts for forms except where specifically indicated or permitted. When rock form is indicated or permitted, the rock face shall be sound and no rock shall extend inside the concrete lines indicated.

3.02 ERECTION

A. General: Unless specified otherwise, follow applicable recommendations of ACI 347 and ACI 301.

1. Erect formwork, shoring and bracing to achieve design requirements. Use selected materials to obtain required finishes.
2. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position.
3. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
4. Arrange assembly of formwork to permit dismantling and stripping. Do not damage concrete during stripping.
5. Align joints and make watertight to prevent leakage of mortar. Keep form joints to a minimum.
6. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with Drawings.
7. Obtain approval before framing openings in structural members which are not indicated on Drawings.
8. Retighten forms and bracing after concrete placement, if required.

B. Beveled Edges (Chamfer):

1. Form 3/4-inch bevels at exposed concrete corners and edges, unless otherwise shown.
2. Where beveled edges on existing adjacent structures are other than 3/4 inch, obtain Engineer's approval of size prior to placement of beveled edge.

C. Wall Forms:

1. Do not reuse forms with damaged surfaces.
2. Locate form ties and joints in an uninterrupted uniform pattern.
3. Inspect form surfaces prior to installation to assure conformance with specified tolerances.

D. Forms Supporting Form Liners:

1. Construct forms to structurally withstand deflection, movement, leakage, high hydraulic pressures resulting from rapid filling and heavy-high frequency vibration.
2. Lay out form joints and ties in uniform pattern, unless otherwise shown.

E. Forms for Curbs, Sidewalks, and Driveways:

1. Provide standard steel or wood forms.
2. Set forms to true lines and grades, and securely stake in position.

F. Form Tolerances: Provide forms in accordance with ACI 117/117R, ACI 347, ACI 318/318R, and ACI 350/350R, and the following tolerances for finishes specified:

1. Wall Tolerances:
   a. Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
   b. Wall Type W-A:
      1) Plumb within 1/4 inch in 10 feet or within 1 inch from top to bottom for walls over 40 feet high.
      2) Depressions in Wall Surface: Maximum 5/16 inch when 10-foot straightedge is placed on high points in all directions.
   c. Wall Type W-B:
      1) Plumb within 1/8 inch in 10 feet or within 1/2 inch from top to bottom for walls over 40 feet high.
      2) Depressions in Wall Surface: Maximum 1/8 inch when 10-foot straightedge is placed on high points in all directions.
   d. Slab Type S-A:
      1) Plumb within 1/4 inch in 10 feet or within 1/2 inch for the entire length.
      2) Depressions in Slab Surface: Maximum of 1/4 inch when 10-foot straightedge is placed on high points in all directions.
   e. Slab Type S-B:
      1) Plumb within 1/8 inch in 10 feet or within 1/4 inch for the entire length.
      2) Depressions in Slab Surface: Maximum of 1/8 inch when 10-foot straightedge is placed on high points in all directions.

f. Beam Type B-A:
   1) Plumb within 1/4 inch in 10 feet or within 1/2 inch for the entire length.
   2) Depressions in Beam Surface: Maximum of 1/2 inch for the entire length when 10-foot straightedge is placed on high points in all directions.
g. Column Type C-A:
   1) Plumb within 1/4 inch in 10 feet or within 1/2 inch for the entire length.
   2) Depressions in Column Surface: Maximum of 1/4 inch for the entire length when 10-foot straightedge is placed on high points in all directions.
h. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
i. Form Offset: Between adjacent pieces of formwork, facing material shall not exceed 1/8 inch.

2. Beam Tolerances:
   a. Exposed Straight Horizontal and Vertical Surfaces: Flat planes within tolerances specified.
   b. Lateral Alignment:
      1) Centerlines must be within plus or minus 1/2 inch from dimensions shown.
      2) At intersections, centerlines shall intersect within plus or minus 1/2 inch of dimensions shown.
   c. Beam Type B-A:
      1) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
      2) Elevations: Within plus or minus 1/2 inch, except where tops of beams become part of finished slab. In this case refer to slab tolerances.

G. Application - Form Release Agent:

1. Clean reused forms of concrete residue. Repair and patch as required to return forms to acceptable surface condition.
2. Apply form release agent on formwork prior to placement of reinforcing steel, anchoring devices, and embedded items.
3. Do not apply form release agent where concrete surfaces will receive special finishes which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

H. Inserts, Embedded Parts and Openings:

1. Provide formed openings where required for items to be embedded in or pass through the concrete work.
2. Locate and set in place items which will be cast directly into concrete.
3. Coordinate work of other sections in forming and placing openings, sleeves, bolts, anchors and other inserts.
4. Install accessories in accordance with the manufacturer's instructions, straight, level and plumb. Secure all embedded items before placing concrete. Ensure that items are not disturbed during concrete placement. Fill voids with readily removable material to prevent entry of concrete.
5. Provide block outs wherever necessary, even when not shown on Drawings.
6. Install waterstops, where required, continuous without displacing reinforcement. Install waterstop a minimum of 2 inches clear of reinforcing steel. Tie through hogrings or grommets to reinforcing steel. Heat seal joints watertight per waterstop manufacturer's instructions.
7. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
8. Close temporary openings with tight fitting panels, flush with inside face of forms and neatly fitted so joints will not be apparent in exposed concrete surfaces.
9. Locate and install construction joints to not impair strength and appearance of the structure as indicated or as approved by Engineer.
10. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.

I. Form Cleaning:

1. Clean forms as erection proceeds to remove foreign matter within forms.
2. Clean formed cavities of debris prior to placing concrete.
3. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drains to exterior of the formwork through the clean-out ports.
4. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within a heat enclosure. Use compressed air or other means to remove foreign matter.

3.03 FORM REMOVAL

A. General:

1. Notify the Engineer prior to removal of forms.
2. Remove forms in a manner that will not damage concrete.
3. Do not wedge pry bars, hammers or tools against finish concrete surfaces scheduled for exposure to view.

B. Nonsupporting forms (sides of beams, walls, columns, and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:

1. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
2. Curing and protection operations are maintained.

C. Elevated Structural Slabs or Beams: In accordance with ACI 318/318R, Chapter 6, and at such time as concrete has reached compressive strength equal to 80 percent of specified 28-day compressive strength as determined by test cylinders. In no case shall the formwork be removed less than the following number of days after concrete placement. Where forms may be removed without disturbing shoring, use half the values given, but in no event less than three days after concrete placement. Distance between supports indicated below refer to permanent structural supports only.

1. Joist, Beam and Girder Soffits:
   a. Clear Span Less than 10 Feet: 7 days.
   b. Clear Span 10 to 20 Feet: 14 days.
   c. Clear Span Greater than 20 Feet: 21 days.
2. Floor Slabs:
   a. Clear Span less Than 10 Feet: 4 days.
   b. Clear Span 10 to 20 Feet: 7 days.
   c. Clear Span Greater than 20 Feet: 10 days.

D. Construction Loads: Limit construction loads at all times to those which can be carried safely by the developed strength of the structure at the time of loading, and by formwork and shoring in-place at the time of loading.

E. Clean, oil, and store removed forms in a manner that the surfaces to be in contact with fresh concrete will not be damaged. Discard and remove from the job site damaged forms.

F. Re-shore under areas where slabs and beams are used to support shoring and formwork for construction of levels above.

END OF SECTION

SECTION 03 21 00
REINFORCING STEEL

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 301, Standard Specifications for Structural Concrete.
   b. 315, Details and detailing of Concrete Reinforcement.
   c. 318, Building Code Requirements for Structural Concrete and Commentary.
   d. 350/350R, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   e. SP-66, Detailing Manual.
2. American Welding Society (AWS): D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
3. ASTM International (ASTM):
   a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   c. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   d. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   e. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
4. Concrete Reinforcing Steel Institute (CRSI):
   a. 63, Recommended Practice for Placing Reinforcing Bars.
   b. 65, Recommended Practice for Placing Bar Supports, Specifications, and Nomenclature.
   c. Manual of Standard Practice.
5. International Code Council (ICC): Evaluation Services Report.
6. Wire Reinforcement Institute (WRI): WWR-500, Manual of Standard Practice, Structural Welded Wire Reinforcement.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66, and ACI 315:
   a. Materials List.
   b. Bending lists.
   c. Placement Drawings:
      1) Indicate bar sizes, spaces, locations and quantities of reinforcing steel, bending and cutting schedules, diagrams of bent bars, arrangement of concrete reinforcement, special reinforcement required for openings through concrete structures and supporting and spacing devices.
      2) Show location of splices. Obtain Engineer's approval of proposed reinforcing splices not indicated on Drawings.

B. Informational Submittals:

1. Certified Lab (Mill) test reports for reinforcing steel showing stress-strain curves and ultimate strengths.
2. Mechanical Threaded Connections:
   a. Current ICC Evaluation Services Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
   b. Verification device threads have been tested and meet requirements for thread quality, in accordance with manufacturer's published methods.
   c. Manufacturer's instructions.
3. Test results of field testing.
4. Contractor CQC Plan.
5. Contractor CQC Reports.
6. Manufacturer's installation procedures.

1.03 ADJUSTMENT PRICE - MEASUREMENT AND PAYMENT

A. The Contract Price shall include the cost of providing 5,000 pounds of reinforcing steel to be used as directed by Engineer and not to be fabricated or delivered to the Project until ordered by Engineer. At completion of the Project, Owner shall be given a credit for the unused amount and such credit shall be at the adjustment price included in the Contract, or as agreed upon.

1.04 QUALITY ASSURANCE

A. Perform concrete reinforced work in accordance with CRSI manual of standard Practice and Documents 63 and 65.

B. Comply with ACI 301, ACI 318, and ACI 350.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Unload, store, and handle bars in accordance with CRSI publication “Placing Reinforcing Bars.”

1. Store reinforcement of different sizes and shapes in separate piles or racks raised above ground to avoid rusting.
2. Protect from contaminants such as grease, oil and dirt.
3. Provide identification on reinforcement after bundles are broken and tags removed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615/A615M, Grade 60.

B. Mechanical Splices and Connections:

1. Metal Sleeve Splice:
   a. Furnish with cast filler metal, capable of developing, in tension or compression, 125 percent of minimum tensile strength of bar.
   b. Manufacturer and Product: Erico Products, Inc., Cleveland, OH; Cadweld T-Series.
2. Mechanical Threaded Connections:
   a. Furnish positive-locking, straight or taper-threaded bars and couplers developing in tension or compression 125 percent of yield strength of bar. Flanged coupler with nail holes for form attachment and internal coupler thread protection. System shall possess a current and valid International Code Council Evaluation Service Report.

b. Manufacturers and Products:
   1) Erico Products, Inc., Cleveland, OH; Lenton Reinforcing Steel Couplers.
   2) Richmond Screw Anchor Co., Inc., Fort Worth, TX; Richmond DB-SAE Dowel Bar Splicers.

C. Welded Wire Fabric:

1. ASTM A185 or ASTM A497.
2. Furnish flat sheets only, rolled sheets not permitted.

2.02 ACCESSORIES

A. Tie Wire: Black, soft-annealed 16-gauge wire.

B. Bar Supports and Spacers:

1. Use precast concrete bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
3. Use only precast concrete bar supports where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals. Bar supports shall be nonconductive and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
4. Precast concrete supports shall have same minimum strength (minimum 4,000 pounds per square inch at 28 days) and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to reinforcing steel.
5. In Beams, Columns, Walls, and Slabs Exposed to View after Form Removal: Use small precast concrete blocks made of same color as concrete in which they are embedded.
6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.
7. Use supports made of dielectric material for epoxy-coated reinforcing bars supported from formwork.

8. Precast Concrete Supports: Total bond precast high performance concrete bar supports as supplied by Con Sys Inc., Pinawa, MB, Canada.

2.03 FABRICATION

A. Follow CRSI Manual of Standard Practice, ACI SP-66, and ACI 315.

B. Bend bars cold.

C. Welding reinforcing bars is not permitted.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

B. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants. Remove rust by vigorous rubbing with burlap cloth or wire brushing.

C. Coat wire projecting from precast concrete bar supports with dielectric material, epoxy, or plastic.

3.02 INSTALLATION

A. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary. Field Bending is not allowed unless approved by the Engineer. Do not bend reinforcement after embedment in hardened concrete. Accommodate formed openings.

B. Spacing and Positioning: Conform to ACI 318 and CRSI's recommended practice for placing reinforcing bars. Place, support and secure reinforcement against displacement. Do not deviate from the required position.

C. Location Tolerances: In accordance with CRSI publication, "Placing Reinforcing Bars."

D. Splicing:

1. Lap splices to be in accordance with Lap Splice Dimension Table on Drawings.
2. Follow ACI 318.

3. Use lap splices, unless otherwise shown or permitted in writing by Engineer. Securely wire together lap splices.
4. Welded Splices: Welding reinforcing bars is not permitted.
5. Stagger splices in adjacent bars where indicated.
6. Reinforcing splices have been located on Drawings. Additional splices shall be reviewed and approved by the Engineer.

E. Mechanical Splices and Connections:

1. Use only in areas specifically approved in writing by Engineer.
2. Install threaded rods as recommended by manufacturer with threads totally engaged into coupling sleeve and in accordance with ICC Evaluation Services Report or equivalent code agency report.
3. For metal sleeve splice, follow manufacturer's installation recommendations.
4. Maintain minimum edge distance and concrete cover.

F. Tying Reinforcing Bars:

1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.

G. Reinforcement Around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening unless otherwise indicated on Drawings. Extend steel reinforcing a standard lap length unless otherwise indicated on Drawings beyond opening at each end.

H. Straightening and Rebending: Field bending of reinforcing steel bars is not permitted.

I. Unless permitted by Engineer, do not cut reinforcing bars in field.

J. Place and secure embedded metalwork and conduit.

K. Place reinforcement with clear distance of 1-inch, minimum, between reinforcement and anchor bolts, form ties, or other embedded metalwork unless otherwise shown on Drawings.

L. Unless noted otherwise on Drawings, maintain concrete cover for reinforcement as follows: 3 inches for concrete cast against earth; 2 inches otherwise.

M. Tolerances:

1. Maintain concrete cover over reinforcement within 1/2 inch of specified cover where the specified cover is greater than 2-1/2 inches.
2. Maintain concrete cover over reinforcement within 1/4 inch of the specified cover where the specified cover is 2-1/2 inches or less.
3. Maintain spacing of reinforcing bars within 1 inch of the required spacing.

N. Do not displace or damage vapor barrier.

3.03 WELDED WIRE FABRIC INSTALLATION

A. Use only where specifically shown.

B. Extend fabric to within 2 inches of edges of slab, and lap splices at least 1-1/2 courses of fabric or minimum 8 inches.

C. Tie laps and splices securely at ends and at least every 24 inches with tie wire.

D. Place welded wire fabric on concrete blocks and rigidly support equal to that provided for reinforced bars. Do not use broken concrete, brick, or stone.

E. Follow ACI 318 and WRI WWR-500.

F. Do not use fabric that has been rolled. Install flat sheets only.

3.04 TESTS AND INSPECTION

A. Notify the Engineer when reinforcing steel is in place and provide sufficient time in the schedule for the Engineer to inspect the reinforcing steel prior to placement of concrete. Concrete placed without inspection and approval by the Engineer may be subject to rejection and removal at no additional cost to the Owner.

B. An independent testing agency shall be retained by Contractor and approved by Owner to inspect each mechanical splice and verify each component is installed in accordance with manufacturer’s instructions and ICC Evaluation Services Report or equivalent code agency report.

C. Special inspection will be provided by Owner where required.

D. The Engineer's (and Special Inspector's) inspection of steel reinforcing prior to concrete placement will not relieve the Contractor from responsibility to conform to Drawings and Specifications.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): M182, Burlap Cloth Made From Jute or Kenaf.
2. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. 302.1R, Guide for Concrete Floor and Slab Construction.
   d. 304.2R, Placing Concrete by Pumping Methods.
   e. 305.1, Specification for Hot Weather Concreting.
   f. 306.1, Standard Specification for Cold Weather Concreting.
   g. 308R, Standard Practice for Curing Concrete.
   h. 309R, Guide for Consolidation of Concrete.
   i. 309.2R, Identification and Control of Consolidation-Related Surface Defects in Formed Concrete.
   j. 318, Building Code Requirements for Structural Concrete.
   k. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures.
   l. CP-1, Technical Workbook for ACI Certification of Concrete Field Testing Technician – Grade 1.
3. American National Standards Institute (ANSI): NSF 61, Drinking water Supply Components – Health Effects.
4. ASTM International (ASTM):
   a. A185/A185M Steel Welded Wire Reinforcement for Concrete.
   b. A615/615M Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   c. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   d. C33/C33M, Standard Specification for Concrete Aggregates.
   e. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   f. C40, Test Method for Organic Impurities in Fine Aggregates for Concrete.

g. C42, Standard Test method for Obtaining and testing Drilled Cores and Sawed Beams of Concrete.
h. C88, Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
i. C94/C94M, Standard Specification for Ready-Mixed Concrete.
j. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
k. C131, Test Method for Resistance to Degradation of Small-size Coarse aggregate by Abrasion and Impact in the Los Angeles Machine.
l. C136, Test Method for sieve Analysis of Fine and Coarse Aggregates.
m. C138, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
n. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
o. C150/C150M, Standard Specification for Portland Cement.
p. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
q. C171, Standard Specifications for Sheet Materials for Curing Concrete.
r. C172, Practice for Sampling Freshly Mixed Concrete.
s. C173, Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
t. C192/C192M Making and Curing Concrete Test specimens in the Laboratory.
u. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
v. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
w. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
x. C289, Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
y. C309, Specifications for Liquid Membrane –Forming Compounds for Curing Concrete.
z. C311, Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use of a Mineral Admixture in Portland-Cement Concrete.
aa. C441, Standard Test method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction.

bb. C469, Test method for Static Modulus of Elasticity and Poisson's Ratio of Concrete Compression.
cc. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
dd. C595/C595M, Standard Specification for Blended Hydraulic Cements.
ee. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
ff. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
gg. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
hh. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
ii. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
jj. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
kk. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
ll. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
mm. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
nn. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
oo. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
pp. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
qq. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
rr. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
ss. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
tt. D75, Practices for Sampling Aggregates.
uu. D1751, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

vv. D1752, Standard Specification for Preformed Sponge Rubber and cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
ww. D4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding.
xx. E329, Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
yy. E1155, Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.

5. International Concrete Repair Institute (ICRI): 03732, Selecting and Specifying Concrete Surface Preparation for Coatings, Sealers, and Polymer Overlays.
6. National Ready Mixed Concrete Association (NRMCA).
7. U. S. Bureau of Reclamation (USBR):
   a. Guide to Concrete Repair – 1997.
   b. M-47, Standard Specification for Repair of Concrete, August 1996.

1.02 DEFINITIONS

A. Basin Train: Series of interconnected basins that operate as a unit with same water level.

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

C. Contractor's Licensed Design Engineer: Individual representing Contractor who is licensed to practice engineering as defined by statutory requirements of professional licensing laws in state or jurisdiction in which Project is to be constructed.

D. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in liquid containment structures and below grade habitable spaces that are 0.005-inch wide and wider, and cracks in other structures that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

E. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.

F. Hot Weather: As defined in ACI 305.1.

G. Hydraulic Structure: Liquid containment structure.

H. New Concrete: Less than 60 days old.

I. Slurry Mixture: Mixture of sand, 3/8-inch maximum nominal aggregate size, cement, and water for wall construction joints with waterstop.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:

1. General:
   a. Except as otherwise specified, provide concrete composed of portland cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
   b. Proportion materials in a manner such as to secure the lowest water-cement ratio which is consistent with good workability, plastic, cohesive mixture, and one which is within the specified slump range.
   c. Proportion fine and coarse aggregate in a manner such as not to produce harshness in placing nor honeycombing in structures.
2. Watertightness of Concrete work: It is the intent of this Section to secure for every part of the Work concrete and grout of a homogeneous structure, which when hardened will have the required strength, watertightness, and durability.
   a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
   b. Construction, contraction and expansion joints have been positioned in structures as indicated on Drawings, and curing methods specified for purpose of reducing the number and size of these expected cracks, due to normal expansion and contraction expected from the specified concrete mixes.
   c. Class A, B-1, B-2 and Class D Concrete – Watertight: Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all the leakage is stopped.

d. Except for hairline cracks and crazing, visible cracks shall be pressure-injected in the following areas with epoxy, as specified in Section 03 64 23, Crack Repair Epoxy Injection Grouting:
   1) Floors and walls of water-bearing structures.
   2) Walls and overhead slabs of passageways of occupied spaces, outsides of which are exposed to weather, or may be washed down and are not specified to receive a separate waterproof membrane.
   3) Other Items Not Specified to Receive a Separate Waterproofing Membrane: Slabs over water channels, wet wells, and other similar surfaces.

e. Walls or slabs as specified above that leak or sweat because of porosity or cracks too small for successful pressure grouting: Seal on water or weather side by coatings of surface sealant system as specified in this Section.

f. Grouting and Sealing: Continue as specified above until structure is watertight and remains watertight for not less than one year after final acceptance or date of final repair, whichever occurs later in time.

g. Workmanship and Methods: Provide concrete work, including detailing of reinforcing conforming with the best standard practices and as set forth in ACI 318, Manuals, and Recommended Practices.

1.04 SUBMITTALS

A. Action Submittals:

1. Mix Designs:
   a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
   b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
   c. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed), for the following:
      1) Portland cement.
      2) Fly ash.
      3) Slag cement.
      4) Aggregates, including specified class designation for coarse aggregate.
      5) Admixtures.

6) Concrete producer has verified compatibility of constituent materials in design mix.

d. Test Reports:
   1) Cement: Chemical analysis report.
   2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
   3) Water-Soluble Chloride-Ion Content in Hardened Concrete: Unless otherwise permitted, in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
   4) Shrinkage Test Results: In accordance with ASTM C157/C157M as modified herein.

e. Aggregates:
   1) Coarse Aggregate Gradation: List gradings and percent passing through each sieve.
   2) Fine Aggregate Gradation: List gradings and percent passing through each sieve.
   3) Combined gradation for coarse and fine aggregates. List gradings and percent passing through each sieve.
   4) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
   5) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.

f. Test Reports:
   1) Alkali Aggregate Reactivity: Aggregate shall be classified as nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.

g. Admixtures:
   1) Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
   2) Color Pigment: Product data including application rate and color char.

2. Product Data: Specified ancillary materials.
   a. Name and manufacturer of each cementitious material, aggregate source, admixture, and curing compound.
      1) The Engineer reserves the right to require submission of manufacturer's test data and certification of compliance with specification.
      2) The Engineer reserves the right to require submission of samples of concrete materials for testing before or during use in concrete.

3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
    a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
    b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
    c. Methods for temperature protection during placement.
    d. Types of covering, insulation, housing, or heating to be provided.
    e. Curing methods to be used during and following protection period.
    f. Use of strength accelerating admixtures.
    g. Methods for verification of in-place strength.
    h. Procedures for measuring and recording concrete temperatures.
    i. Procedures for preventing drying during dry and windy conditions.
4. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
    a. Procedures for measuring, and recording temperatures of reinforcement and other embedded items prior to concrete placement.
    b. Use of retarding admixture.
    c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
    d. Types of shading and wind protection to be provided.
    e. Curing methods, including use of evaporation retardant.
    f. Procedures for measuring and recording concrete temperatures.
    g. Procedures for preventing drying during dry, windy conditions.
5. Thermal Control Plan: For concrete sections with a minimum specified dimension that is greater than 2 feet 6 inches.
6. Concrete repair techniques.
7. Concrete Placement Drawings and Schedule:
    a. Drawings for each individual concrete placement. An individual concrete placement is defined as a portion of concrete work placed in one continuous operation between specified lines or joints.
        1) Show locations, dimensions, blockouts, openings, recesses, waterstops, and finishes. Identify construction joints, control joints, contraction joints and expansion joints. Submit

concrete placement drawing with or prior to reinforcement placing drawing.

2) Show details of items embedded in or associated with placement, except reinforcing steel.
3) Include a separate drawing showing placement sequence.
4) Place a title block with Contractor's name, contract title and number, placement identification, and identifying drawing number in lower right corner of each drawing.

b. List reference drawings from which details shown on placement drawing were obtained on each drawing.
c. Reference related steel reinforcement drawings associated with placement on each drawing.
d. Complete, detailed concrete placement schedule showing the Contractor's plan for reinforcement of individual features, units, and other elements of concrete work.
e. Detail as necessary to show location, sequence, and date of concrete placements scheduled for each item of concrete work.
f. Show submittal of detail drawings and placement of reinforcement and embedded items.

8. Material Approval Data for Joint Filler: Name and manufacturer of joint filler. The Engineer reserves the right to require submission of manufacturer's test data and certification of compliance with specifications.

B. Informational Submittals:

1. Pre-installation conference minutes of meeting.
2. Manufacturer's application instructions for bonding agent and bond breaker.
3. Manufacturer's Certificate of Compliance to specified standards:
   a. Bonding agent.
   b. Bond breaker.
   c. Repair materials.
4. Statement of Qualification:
   a. Batch Plant: Certification as specified herein.
   b. Mix designer.
   c. Installer.
   d. Testing agency.
5. Field test reports.
6. Recorded temperature data from concrete placement where specified.
7. Concrete Delivery Tickets:
   a. For each batch of concrete before unloading at Site.

b. In accordance with ASTM C94/C94M, including requirements 14.2.1. through 14.2.10.
c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

8. On-Site Contractor Quality Control Plan.
9. On-Site Quality Control Reports.
10. Project Record Documents: Accurately record as-built concrete dimensions and tolerances and locations of embedded utilities and components on placement drawings and submit to Engineer prior to final completion.

1.05 QUALITY ASSURANCE

A. Concrete construction shall conform to requirements of ACI 117 and ACI 301, except as modified herein.

B. Comply with ACI 305R when concreting during hot weather.

C. Comply with ACI 306R when concreting during cold weather.

D. Maintain one copy of ACI 301 on Site.

E. Acquire cement and aggregate from same source for all Work.

F. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
4. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
   a. Where field testing is required of Contractor, personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

G. Thermal Control Plan: When required, shall include the following minimum requirements:

1. Calculated or measured adiabatic temperature rise of concrete.
2. Upper limit for concrete temperature at time of placement.
3. Description of specific measures and equipment that will be used to ensure maximum temperature in placement will not exceed specified maximum temperature limit.
4. Calculated maximum temperature in placement based on expected conditions at time of placement and use of proposed measures to control temperatures.
5. Description of specific measures and equipment that will be used to ensure temperature difference will not exceed specified temperature difference limit.
6. Calculated maximum temperature difference in placement based on expected conditions at time of placement and use of proposed measures to control temperature differences.
7. Description of equipment and procedures that will be used to monitor and log temperatures and temperature differences.
8. Drawing showing locations for temperature sensors in placement.
9. Description of format and frequency of providing temperature data to Engineer.
10. Description of measures to address and reduce excessive temperatures and temperature differences, if they occur.
11. Description of curing procedures, including materials and methods, and curing duration.
12. Description of formwork removal procedures to ensure temperature difference at temporarily exposed surface will not exceed temperature difference limit, and how curing will be maintained.
13. Alternate temperature limits when permitted by Engineer.
    a. Determination of alternate temperature limits shall be based on detailed thermal and crack analyses.
    b. Analyses shall be stamped by Contractor’s Licensed Design Engineer.
14. If concrete design mixture is changed, thermal control plan must be updated.

H. Mockup Panels:

1. Use Engineer-selected portion of as-cast wall surface hidden from view to develop and test patching techniques and mixes. If in the judgment of the Engineer no appropriate hidden portion or adequate area of wall is available, provide mock-up panel as directed by Engineer.
   a. Obtain Engineer's approval prior to using material to repair project structures.
   b. Demonstrate application, curing, and finishing procedures of repair material.
   c. Approved repairs shall establish standards of quality by which Work will be judged.

I. Preinstallation Conference:

1. Required Meeting Attendees:
   a. Contractor, including pumping, placing and finishing, and curing subcontractors.
   b. Ready-mix producer.
   c. Admixture representative.
   d. Testing and sampling personnel.
   e. Engineer or Engineer's designee.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time. Give attendees 4 days advance notice of the meeting time and place.
3. Agenda shall include:
   a. Introduction of personnel and responsibilities.
   b. Work sequence proposed.
   c. Approved concrete mix designs.
   d. Discussion of batch ticket to be presented with each truck.
   e. Admixture types, dosage, performance, and redosing at Site.
   f. Placement methods, techniques, equipment, consolidation, and form pressures.
   g. Slump and placement time to maintain slump.
   h. Testing procedures including frequency.
   i. Transmitting test reports from Owner's testing lab.
   j. Transmitting field testing information on concrete.
   k. Storage of cylinders on Site for Owner's testing lab.
   l. Finish, curing, and water retention.
   m. Protection procedures for weather conditions, including thermal control plan if determined by Engineer to be needed.
   n. Other specified requirements requiring coordination.

4. Conference minutes as specified in Section 01 31 19, Project Meetings (to be completed).

1.06 SEQUENCING AND SCHEDULING

A. Notify the Engineer at least 48 hours prior to commencing concrete work.

B. Allow Engineer to perform an immediate inspection of concrete surfaces upon removal of forms.

C. Notify the Engineer upon discovery of any honeycombing, foreign-embedded items and defective concrete.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cementitious Materials:

1. Cement:
   a. Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M, Type V cement.
   b. Meet equivalent alkalis requirements of ASTM C150, Table 2.
   c. Meet false-set requirement of ASTM C150, Table 4.
   d. Blended Hydraulic Cement:
      1) Unless otherwise specified, conform to requirements of ASTM C595/C595M IP (HS) and IS (<70)(HS).
      2) Portland cement used in blended hydraulic cement, conform to requirements of ASTM C150/C150M.
   e. Furnish from one source.
2. Supplementary Cementitious Materials (SCM):
   a. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
      1) Shall not be produced from process that has utilized hazardous or potentially hazardous materials.
      2) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 2.5 percent.
      3) Do not decrease sulfate resistance of concrete by use of pozzolan.
         a) Demonstrate pozzolan will have an “R” factor less than 2.5, where:
            (1) R = (C-5) /F.
            (2) C: Calcium oxide content of pozzolan determined in accordance with ASTM C114.

(3) F: Ferric oxide content of pozzolan in percent determined in accordance with ASTM C114.

4) Pozzolan when tested in accordance with ASTM C441, shall conform to the following: 65 percent minimum reduction in mortar expansion at 14 days, and 0.02 percent maximum mortar expansion at 14 days. Expansion shall be less than control sample expansion.
5) Pozzolan content shall not be less than 15 percent or more than 25 percent by weight of the total cementitious materials.
6) Store and batch pozzolan and cement separately.
   a) Slag Cement: In accordance with ASTM C989, Grade 100 or Grade 120.
7) Shall not be produced from process that has utilized hazardous or potentially hazardous materials.
8) Slag content shall not be less than 15 percent or more than 25 percent by weight of the total cementitious materials.
   a) Total SCM Content in Mix Design shall not be less than 15 percent or more than 25 percent by weight of the total cementitious materials.
   b) Sulfur Trioxide: Maximum 4.0 percent.

B. Aggregates: Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.

1. Fine and coarse aggregate shall not be of a carbonate-based rock. Coarse and fine aggregates shall not contain any materials that are deleteriously reactive with the alkalis in the cement in an amount sufficient to cause excessive expansion of mortar or concrete. The amount of coal and lignite in the fine aggregate shall be less than 0.5 percent.
2. Normal-Weight Aggregates:
   a. In accordance with ASTM C33/C33M, except as modified herein.
   b. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
   c. Alkali Silica Reactivity: See Article Concrete Mix Design.
3. Fine Aggregates:
   a. Clean, sharp, natural sand.
   b. ASTM C33/C33M.
   c. Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
      1) Limit material finer than 75-µm (No. 200) sieve to 3 percent mass of total sample.

4. Coarse Aggregate:
   a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
   b. ASTM C33/C33M, Size No. 67.
   c. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.
5. Nonslip Aggregate:
   a. Hard, homogeneous, nonglazing, rustproof, unaffected by freezing, moisture, or cleaning compounds.
   b. Fully graded between 1/32-inch to 1/4-inch size and composed of minimum 60 percent aluminum oxide or silicon carbide abrasive bonded by vitreous ceramic material.

C. Admixtures: Unless otherwise permitted, furnish from one manufacturer.

1. Characteristics:
   a. Compatible with other constituents in mix.
   b. Contain no chlorides.
   c. Do not use admixtures known to be toxic after concrete is 30 days.
   d. Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
2. Air-Entraining Admixture: ASTM C260/C260M.
3. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
   a. Use a neutralized vinsol resin formulation for air-entraining admixture used with ASTM C494, Type F or G; and ASTM C1017, Type I or II chemical admixtures.
   b. Manufacturers and Products:
      1) BASF Admixtures Inc., Shakopee, MN; Pozzolith Series or PolyHeed Series.
      2) Euclid Chemical Co., Cleveland, OH; Eucon Series.
      3) W. R. Grace & Co., Cambridge, MA; Daracem Series or Mira Series.
4. Retarding Admixture: ASTM C 494/C 494M, Type B. Approval does not relax hot-weather placement requirements.
5. Accelerating Admixture: ASTM C 494/C 494M, Type C. Approval does not relax cold-weather placement requirements. Calcium chloride is prohibited.

6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type A, D, F or Type G, to achieve workability without exceeding specified water/cement ratio and slump.
    a. Manufacturers and Products:
        1) BASF Admixtures Inc., Shakopee, MN; Glenium Series, PS 1460, or Rheobuild 1000.
        2) Euclid Chemical Co., Cleveland, OH; Eucon Series or Plastol Series.
        3) W. R. Grace & Co., Cambridge, MA; ADVA Series, Daracem Series, or EXP 950.
7. Color Pigment: ASTM C979/C979M, ACI 303.1 and ASTM C494, inert, synthetic mineral or metaloxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
    a. Color: As selected by Architect from manufacturer's full range.
        1) Color admixture for electrical duct bank shall be a red colored, water reducing admixture.
        2) Raw pigments are not an equivalent and may not be substituted.
        3) Curing and sealing compound shall comply with ASTM C309 and be of the same manufacturer as the colored admixture, for use with integrally colored concrete.
8. Do not use calcium chloride as an admixture.
9. Admixtures with no standard, ASTM or other, designation may be used where permitted.

D. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water, unless alternative sources of water are permitted.

1. Water shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement, with limits for each as indicated below.
2. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, including optional requirements of Table 2, and concentration of chemicals in combined mixing water shall be less than:
    a. Chloride Content: 500 ppm.
    b. Sulfate Content as SO_4: 3,000 ppm.
    c. Alkalis as (Na_2O + 0.658 K_2O): 600 ppm.
    d. Total Solids by Mass: Less than 50,000 ppm.

2.02 ANCILLARY MATERIALS

A. Bonding Agent: Unless otherwise specified, in accordance with the following:

1. ASTM C881/C881M, Type V.
2. Two-component, moisture insensitive, 100 percent solids epoxy.
3. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
4. Manufacturers and Products:
   a. BASF Building Systems Inc., Shakopee, MN; Concresive Standard LVI.
   b. Euclid Chemical Co., Cleveland, OH; Euco #352 Epoxy System LV.
   c. Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.
   d. Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.

B. Bond Breaker:

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

C. Repair Material: Manufactured, non-shrink, cementitious materials specifically formulated for patching concrete in conjunction with a compatible bonding material.

D. Crack Repair: In accordance with requirements of Section 03 64 23, Crack Repair Epoxy Injection Grouting.

E. Epoxy Grout: Two-component epoxy resin bonding system capable of developing a minimum bond strength of 1,100 psi in 48 hours; ASTM C881 Type IV, Grade 3, Class B and C; Euclid Chemical Company EUCO 452 GEL; or as approved.

F. Sealant: Follow Section 07 92 00, Joint Sealants.

G. Concrete Sealer:

1. Product and Manufacturers – One of the following or equal:
   a. SEAL 341 by Hilyard Chemical Company, St Joseph, Missouri.
   b. Horn Clear Seal EM-180 by A.C. Horn, Inc.

H. Vapor Retarder: Follow Section 07 26 00, Vapor Retarders.

2.03 CONCRETE MIX DESIGN

A. General:

1. See Supplement at the end of this section for mix design requirements for each class of concrete used on Project.
2. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.
3. Selection of constituent materials and products in mix design are optional, unless specified otherwise.
4. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, water-reducing admixture in pumped concrete, in concrete with a water-cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.
5. Unless otherwise permitted, use water-reducing admixture and high-range, water-reducing admixture in columns, piers, pilasters, and walls.
6. Use water-reducing admixture or high-range, water-reducing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.
7. Use water-reducing and retarding admixture when anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
8. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor, and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.
9. Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials and aggregate packing.
10. Color Pigment: Where require in Supplement, add color pigment to concrete mixture according to manufacturer’s written instructions and to result in hardened concrete color consistent with approve mockup.

B. Potential Alkali-aggregate Reactivity of Concrete:

1. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).

2. Aggregates shall have been tested to determine potential alkali-aggregate reactivity in concrete in accordance with ASTM C1260 or ASTM C1567.
    a. Aggregates that indicate expansion greater than 0.10 percent at 16 days after casting shall not be used unless they have been shown to be nondeleteriously reactive in accordance with ASTM C227 or ASTM C1293, with less than 0.04 percent expansion at 1 year for cement-aggregate combinations or less than 0.04 percent expansion at 2 years for combinations with pozzolan or slag.
    b. Alkali content of cement used in proposed concrete mixture shall not be greater than alkali content of cement used in test for potential alkali-aggregate reactivity.
    c. Use low-alkali cement or incorporate pozzolan into concrete mixture as necessary to satisfy testing for potential alkali reactivity.

C. Proportions:

1. Concrete Proportions: Comply with ACI 301, 4.2.
2. Design mix to meet aesthetic, durability, and strength requirements.
3. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight and maximum of 25 percent of total cementitious materials.

D. Concrete Shrinkage Limits: Where shrinkage limits are specified, design mix for following shrinkage limits and test in accordance with ASTM C157/C157M, with the following modifications:

1. Prisms shall be moist cured for 7 days prior to 28-day drying period.
2. Comparator reading at end of 7-day moist cure shall be used as initial length in length change calculation.
3. Reported results shall be average of three prisms.
4. If shrinkage of a specimen departs from average of that test age by more than 0.004 percent, disregard results obtained from that specimen.
5. Unless otherwise specified, results at end of 28-day drying period shall not exceed 0.040 percent if 3-inch prisms are used, or exceed 0.038 percent if 4-inch prisms are used. Aggregate will be rejected if test values exceed these limits.

E. Slump Range at Site:

1. Slump value to be 4 inches maximum at point of delivery due to water alone.
2. Add high-range, water-reducing admixture at site only as allowed by Engineer to increase slump to 6 inches plus or minus 1/2 inch, maximum.
3. Slump tolerance shall meet requirements of ACI 117.

F. Combined Aggregate Gradation:

1. Combined Gradation Limits: Fine aggregate shall be in range of 36 percent to 40 percent of total aggregate weight.
2. Combined Gradation Limits: Limits shown are for coarse aggregates and fine aggregates mixed together (combined). Select one of the gradations shown in the following table:

Sieve Sizes	Combined Gradation Percentage Passing		
	1-1/2" Max.	**1" Max.**	**3/4" Max.**
2"	100	-	-
1-1/2"	95 - 100	100	-
1"	65 - 85	90 – 100	100
3/4"	55 - 75	70 – 90	92 - 100
1/2"	-	-	68 - 86
3/8"	40 - 55	45 – 65	57 - 74
No. 4	30 - 45	31 – 47	38 - 57
No. 8	23 - 38	23 – 40	28 - 46
No. 16	16 - 30	17 – 35	20 - 36
No. 30	10 - 20	10 – 23	14 - 25
No. 50	4 - 10	2 – 10	5 - 14
No. 100	0 - 3	0 – 3	0 - 5
No. 200	0 - 2	0 – 2	0 - 2

G. Concrete Mixes:

1. Proportioning of Concrete Mix: Proportion mixes on required average on compressive strength f'cr, for each class of concrete, using calculated standard deviation and its corresponding specified compressive strength f'c, in accordance with ACI 318, Part 3, Chapter 5.
2. Mixes:
   a. Adjusting of Water: After acceptance, do not change mixes without acceptance by Engineer, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
   b. Total Water Content of Each Concrete Class: Not exceed those specified in Table A in this Section.
   c. Checking Moisture Content Fine Aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
3. Change in Mixes: Undertake new trial batch and test program as specified in this Section.
4. Hand Mixed Concrete:
   a. Hand mix concrete only when acceptable to the Engineer.
   b. Prepare hand mixed concrete on watertight, level platform in batches not to exceed 1/3 cubic yard each.
   c. Aggregate:
      1) First spread required amount of coarse aggregate on platform in an even and uniform layer, and then over such aggregate spread the proper proportion of fine aggregate.
      2) Combined Depth of Both Such Layers: Not greater than 1 foot.
   d. Cement:
      1) First evenly spread required quantity of cement over fine aggregate.
      2) Then turn entire batch with shovels at least twice before adding water.
   e. Water:
      1) Following step d.1) above, uniformly sprinkle or spray proper amount of water over batched materials.
      2) Then turn with shovels not less than three times before being removed from the platform.
5. Classes of Concrete:
   a. Provide concrete consisting of three classes, referred herein as Classes A, B, and CE specified in this Section and use where specified or indicated on Drawings.

b. Weight of Concrete Classes: Provide classes of concrete having minimum weight of 140 pounds per cubic foot.
c. Class A Concrete: Use for structural concrete, including precast concrete items.
d. Class CE Concrete: Use for electrical conduit encasements.
e. All Other Concrete, unless otherwise specified (herein below) or indicated on Drawings: Use Class B concrete.
f. Use Class A concrete for the following structures:
   1) TCS Loop Injection and Extraction Well and Well Casing Vaults.
   2) IRZ Injection and Extraction Well and Well Casing Vaults.
   3) Inner Recirculation Loop Injection and Extraction Well and Well Casing Vaults.
   4) Precast Trench boxes.
   5) IRZ Carbon Substrate Storage Tank Foundation.
   6) IRZ Unloading Pad.
   7) MW-20 Bench Carbon Amendment Building.
   8) TW Bench Carbon Amendment Building.
   9) TW Bench Storage Tank Foundation.
   10) Elevated Pipe Supports.
g. Use Class B concrete for the following structures:
   1) TCS Pond Improvements.
   2) Noncritical structural elements.
h. Pumped Concrete: Provide pumped concrete that complies with all requirements of this Section.
i. Do not place concrete with slumps outside the limits indicated in Table A.

TABLE A
CONCRETE WITH AIR ENTRAINMENT*

Class	Specified Compressive Strength f'c at 28 Days (Pounds per Square Inch)	Maximum Net Water to Cement Ratio	Maximum Cement per Cubic Yard of Concrete by Weight (Pounds)	Slump Range** (Inches)
A	5,000	0.40	752	4
B	3000	0.45	564	4
CE	2000	0.48	450	3 to 6

NOTE: *Class A and B to have air entrainment of 6% +/-1%.
Slump for slabs, decks, walks and beams shall not exceed 3-1/2 inches.
**Slump due to water alone. See section 2.3E "Slump Range at Site."

j. Admixtures: Provide admixtures as specified in this Section.

k. Air Entraining Admixture:
   1) Add agent to batch in portion of mixing water.
   2) Batch solution by means of mechanical batcher capable of accurate measurement.

2.04 CONCRETE MIXING

A. General: In accordance with ACI 301, except as modified herein.

B. Truck Mixers:

1. For every truck, test slump of samples taken per ASTM C94/C94M, paragraph 12.5.1.
2. Where specified slump is more than 4 inches, and if slump tests differ by more than 2 inches, discontinue use of truck mixer, unless causing condition is corrected and satisfactory performance is verified by additional slump tests.

2.05 TEMPERATURE LIMITS

A. For concrete sections with a minimum specified dimension that is greater than 2 feet 6 inches, and unless otherwise permitted:

1. Provide documentation that maximum concrete temperature in structure will not exceed 158 degrees F, and maximum temperature differential between center of section and external surfaces of concrete will not exceed 35 degrees F.

2.06 SPONGE RUBBER JOINT FILLER

A. ASTM D1752, Type 1, except as otherwise specified or shown on Drawings.

B. Test Specimen Compression Load: 50 to 15 pounds per square inch.

C. Joint Filler Adhesive: Non-bituminous adhesive recommended by filler manufacturer.

D. Pre-molded sponge rubber fully compressible with recovery rate of minimum 95 percent.

2.07 SOURCE QUALITY CONTROL

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

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joint locations conform to the approved placement drawings.

B. Verify requirements for concrete cover over reinforcement are met.

C. Verify waterstops are provided in joints called for on Contract Drawings.

D. Verify that anchors, seats, plates, reinforcement, embeds, openings, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

E. Verify appropriate mix design for designated placement, see Article Concrete Mix Design, paragraph G.5.

F. Engineer's inspection and approval of foundations are required prior to any concrete being placed. Verify with Engineer that all surfaces on which concrete is to be placed has been inspected and is adequate for concrete placement.

3.02 PREPARATION

A. Meet requirements of ACI 301, except as modified herein.

B. Remove standing water, ice, mud, and debris from foundation surfaces to be covered by concrete.

C. Prepare rock surfaces free from oil, objectionable coatings, and loose, semi-detached and unsound fragments. Immediately before placement of concrete, wash rock surfaces with an air-water jet and dry to a uniform surface-dry condition.

D. Prepare earth foundations free from frost or ice.

E. Thoroughly moisten surfaces of absorptive foundations to be covered with concrete so that moisture will not be drawn from fresh concrete.

F. Remove hardened concrete, wood chips, ice and other debris from the interior of forms.

G. Place form release agent or wet forms just prior to placing concrete. Form release agent or any other deleterious material are not acceptable on previously placed concrete surfaces.

H. Treat surfaces of mud mat concrete as construction joints, in accordance with Article Joints of this Section.

I. Install vapor retarder under interior building slabs-on-grade. Lap joints minimum 6 inches and seal water-tight by taping edges and ends.

J. Slope positively floors containing sumps, gutters, or floor drains.

K. Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces such as column pedestals, foundation walls, or as indicated. Use joint filler and a sealant as specified in Section 07 92 00, Joint Sealants.

L. Place epoxy grout in full accordance with manufacturer's instructions, including compressed air cleaning of all contact surfaces.

3.03 PLACING CONCRETE

A. Inspection: Notify Engineer and Special Inspector at least 72 hours prior to starting to place concrete. The Engineer shall inspect all surfaces on which concrete is to be placed.

B. Placement into Formwork:

1. Place concrete in accordance with ACI 301, ACI 304, ACI 309, and ACI 318.
2. Do not place concrete until all formwork, installation of items to be embedded, and preparation of surfaces involved in the placement have been approved. Moistened and keep moist formwork and foundation surfaces on which cast-in-place concrete is placed until overlying concrete is placed.
3. Do not place concrete during heavy rain (more than 0.3 inch per hour or 0.03 inch in 6 minutes). If unusual adverse weather such as heavy rain, severe cold, heavy snow, high wind, or other adverse conditions occurs, or is forecast to occur during placement, an interruption in placing operations may be approved or directed. Fully consolidate all placed concrete materials before stopping work. Allow for construction

schedule risk and added expense that could occur as a result of adverse weather. Weather delays shall receive no additional compensation. Conform to ACI 306.1 for additional cold weather placement requirements.

4. Concrete Temperature at Placing: 50 to 80 degrees F.
5. Where vapor retarder or barrier is required, coordinate subgrade preparation with requirements in Division 07 of Specifications.
6. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs which shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
    a. Place concrete in as nearly a continuous operation as practical and in a manner to produce a concrete mass with sufficient continuity and continuance so that it shall harden and act as a monolithic mass with no discontinuous joints or potential places of separation or weakness.
    b. Provide sufficient concrete placing capacity and equipment to deliver and place concrete without undue delay; do not permit cold joints to occur. Discharge concrete into forms within 90 minutes following the first introduction of water and cement or cement and aggregates, whichever occurs first. If the air temperature is 85 degrees F or higher, the time limit specified above shall be reduced to 60 minutes unless the Engineer's approval has been obtained for means to maintain acceptable concrete quality without such time reduction.
    c. Do not use concrete that has been subjected to more than 250 total revolutions of any combination of mixing and agitating equipment following the first introduction of aggregates to the mixer.
7. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
    a. Place concrete on prepared foundation or previously completed concrete materials in near horizontal layers.
    b. The depth of the first layer shall not exceed 12 inches and for subsequent layers it shall not exceed 18 inches.
    c. Place each successive layer as soon as practicable after the preceding layer is completed.
8. Use placement devices, for example chutes, pouring spouts, and pumps as required to prevent segregation, deposits concrete as close as practicable to its final position, and that produces layers of widths and thicknesses as necessary for compaction to the required dimensions.
9. Vertical Free Fall Drop to Final Placement: Not more than 3 feet.

10. For placements where drops are greater than specified:
    a. Use placement device such that free fall below placement device conforms to required value.
    b. Limit free fall to prevent segregation caused by aggregates hitting steel reinforcement.
11. Do not use aluminum conveying devices.
12. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
13. When Class I concrete arrives at the Project with slump below 3 inches, water may be added only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. Slump adjustment, with water, shall be made only one time.
14. Start wall lifts with 2 to 3 inches of grout.
15. Placement of concrete under water is not permitted.
16. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
    a. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
    b. Bring slab surfaces to correct level with straight-edge and strike-off. Use bullfloats or darbies to smooth surface, free of humps and hollows. Do not disturb slab surfaces prior to beginning finishing operations.
    c. Maintain reinforcing in proper position during concrete placement operations.
17. Joints in Footings and Slabs:
    a. Ensure space beneath plastic waterstop completely fills with concrete.
    b. During concrete placement, make visual inspection of entire waterstop area.
    c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, and place remaining concrete to full height of slab.
    d. Apply procedure to full length of waterstop.
18. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.
19. Cure concrete as specified in Section 03 39 00, Concrete Curing.

C. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Minimum Slopes of Chutes: Angled to allow concrete to readily flow without segregation.
4. Conveyor Belts:
   a. Approved by Engineer.
   b. Wipe clean with device that does not allow mortar to adhere to belt.
   c. Cover conveyor belts and chutes.

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

E. Pumping of Concrete:

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

F. Concrete sections with a minimum specified dimension that is greater than 2 feet 6 inches:

1. Cure and protect concrete in accordance with accepted thermal control plan and as follow:
   a. Minimum curing period shall be 14 days.
   b. Unless otherwise permitted, preserve moisture by maintaining forms in place.
2. Strength measurement shall be representative of in-place concrete within 2 inches of concrete surface.
3. Concrete strength shall be verified through correlation of concrete temperature and compressive strengths established by cylinder compressive tests and in accordance with ASTM C1074.
4. Unless otherwise specified, control concrete temperatures to within specified limits from time concrete is placed until time internal temperature has cooled from its maximum, such that difference between average daily ambient and maximum internal concrete temperature at

time of protection removal, is less than specified temperature difference limit.

5. Unless otherwise specified, place one temperature sensor at center of mass of placement and one temperature sensor at a depth 2 inches from center of nearest exterior surface. Place additional sensor at each location to serve as a backup in event that other temperature sensor fails. In addition, provide temperature sensor in shaded location for monitoring ambient onsite temperature.
   a. Unless otherwise specified, monitor temperatures hourly using electronic sensors capable of measuring temperature from 32 degrees F to 212 degrees F to an accuracy of 2 degrees F.
   b. Ensure temperature sensors are operational before placing concrete.
   c. Unless otherwise specified, provide data from sensors to Engineer on a daily basis, until requirements are met.
   d. Compare temperatures and temperature differences with maximum limits specified in Article Temperature Limits every 12 hours, unless otherwise permitted. If either exceeds specified limits, take immediate action as described in accepted thermal control plan to remedy situation. Do not place additional mass concrete until cause of excessive temperature or temperature difference has been identified and corrections are accepted.

G. Consolidation and Visual Observation:

1. Consolidation Equipment and Methods: ACI 301 and ACI 309.
   a. Consolidation equipment shall be flexible, electric or pneumatic-drive immersion type vibrators with a minimum operating speed of 7,000 rpm when immersed.
2. Provide at least one standby vibrator and one extra generator in operable condition at Site at all times prior to placing concrete and during placement, to be used in the event of a breakdown of primary equipment.
3. Do not place vibrator against reinforcing or forms, or use vibrator to transport concrete within forms.
4. Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.
5. Vibrate concrete in vicinity of joints to obtain impervious concrete.
6. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to

set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

H. Hot Weather:

1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
   a. Maintain concrete temperature below 80 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
   b. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
   c. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
   d. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
   e. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.
2. Concrete Curing: As specified in Section 03 39 00, Concrete Curing.

I. Cold Weather Placement:

1. Unless otherwise permitted, shall be in accordance with requirements of ACI 306.1 and as follows:
   a. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
   b. Uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of placement. Maintain concrete within this temperature range for not less than 7 days.
   c. Do not use calcium chloride, salt, and other materials containing anti-freeze agents or chemical accelerators, unless otherwise accepted in mix designs.
   d. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Engineer.

e. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
f. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
g. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
h. Cure concrete as specified in Section 03 39 00, Concrete Curing.
   1) Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.

2. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.
3. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.
4. Maintain curing conditions as specified in Section 03 39 00, Concrete Curing.

3.04 JOINTS

A. General - Maximum Size of Concrete Placements:

1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
2. Locate expansion, control, and contraction joints where shown on Drawings.

B. Construction Joints (CJ):

1. Construction joints are joints which are purposely placed in concrete to facilitate construction; to reduce initial shrinkage stresses and cracks; to allow time for the installation of embedded metalwork; or to allow for subsequent placing of other concrete.
2. Bond is required at construction joints regardless of whether or not reinforcement is continuous across the joint.

3. Unless otherwise shown or permitted, locate construction joints as follows:
    a. Locate construction joints as shown on Drawings or where approved by the Engineer in joint location submittal.
    b. Provide vertical construction joints in walls and slabs at maximum spacing of 40 feet, unless shown or approved otherwise.
    c. When vertical expansion, contraction, or control joint spacing does not exceed 60 feet, intermediate construction joints are not required.
    d. Uniformly space vertical construction joints within straight sections of walls and slabs, avoiding penetrations.
4. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
5. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.
6. Relocation, addition, or elimination of construction joints shall be subject to the approval by the Engineer.
7. Clean, roughen, and surface dry surfaces of construction joints to be covered with fresh concrete. The roughened surface shall meet the requirements of ACI 318, Section 11.7.9.
    a. Remove laitance, loose or defective concrete, coatings, sand, curing compound and other foreign material.
    b. Sandblast, steel shot-blast, or high-pressure water jet surfaces, or use other method approved by the Engineer to create a surface equivalent to or larger than CSP 5 in accordance with ICRI 03732. Wash surface thoroughly, and surface dry immediately before placement of adjoining concrete.
    c. Do not use a mortar layer on construction joints.

C. Contraction Joints (CRJ):

1. Contraction Joints are joints placed in concrete to provide for volumetric shrinkage of a monolithic unit or movement between monolithic units.
2. Construct contraction joints so no bond exists between concrete surfaces forming the joint.

D. Minimum Time between Adjacent Placements:

1. Construction or Control Joints: 7 days unless otherwise specified.

2. Construction joint between top of footing or slab, and column or wall: As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.
3. Expansion or Contraction Joints: 1 day.
4. For columns and walls with a height in excess of 10 feet, wait at least 2 hours before depositing concrete in beams, girders, or slabs supported thereon.
5. For columns and walls 10 feet in height or less, wait at least 1 hour prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon.

3.05 REPAIRING CONCRETE

A. General:

1. Inject cracks that leak with crack repair epoxy as specified in Section 03 64 23, Crack Repair Epoxy Injection Grouting.
2. Repair surface defects, including tie holes, immediately after form removal.
3. Remove honeycombed and other defective concrete down to sound concrete.
4. Use manufactured, nonshrink, cementitious materials specifically formulated for patching concrete in conjunction with a compatible bonding material. The complete repair procedure along with a list of all materials to be used must be submitted to and approved by Engineer before any repair work is started. Preparation of defective areas to be approved by Engineer prior to patching.
5. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Engineer.
6. Obtain quantities of repair material and manufacturer’s detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
7. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.

B. Tie Holes:

1. Unless otherwise specified, fill with specified repair material.
   a. Prepare substrate, liberally coat with a bonding agent, and then thoroughly fill with the repair material per manufacturer's written recommendations.
2. When required, color of tie-hole patch shall match adjacent concrete.
   a. Demonstrate patch of tie hole on tie-holes selected by Engineer.
   b. Clean and dampen tie holes before applying mortar. Do not use separate bonding agent.
   c. Fill with site-mixed portland-cement repair mortar per ACI 301.
   d. Cure repair mortar with water.

C. Alternate Form Ties, Through-Bolts:

1. Mechanically roughen entire interior surface of through hole.
2. Apply bonding agent to roughened surface and drive elastic vinyl plug to half depth.
3. Dry pack entire hole from both sides of plug with nonshrink grout, as specified in Section 03 62 00, Nonshrink Grouting.
4. Use only enough water to dry pack grout.
5. Dry pack while bonding agent is still tacky.
6. If bonding agent has dried, remove bonding agent by mechanical means and reapply new coat of bonding agent.
7. Compact grout using steel hammer and steel tool to drive grout to high density.
8. Cure grout with water.
9. When specified, color of alternate form tie-hole patch shall match adjacent concrete.
   a. Demonstrate patch of hole on mockup panels.
   b. Fill hole with nonshrink grout as described in paragraph above, except hold materials back 1 inch from concrete surfaces.
   c. Allow nonshrink grout to fully cure.
   d. Remove dried bonding agent by mechanical means.
   e. Clean and dampen remaining depressions before applying mortar.
   f. Do not use separate bonding agent on existing surfaces in remaining depression.
   g. Fill with site-mixed portland-cement repair mortar per ACI 301.
   h. Cure repair mortar with water.

D. Exposed Metal Objects:

1. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
2. Repair area of chipped-out concrete as specified for defective areas.

E. Blockouts at Pipes or Other Penetrations: Where shown install in accordance with requirements of Drawings.

3.06 CONCRETE WALL FINISHES

A. Type W-1 (Ordinary Wall Finish):

1. Patch tie holes.
2. Knock off projections.
3. Repair defective areas.
4. Inject cracks in accordance with requirements of Section 03 64 23, Crack Repair Epoxy Injection Grouting.

B. Type W-2 (Smooth Wall Finish):

1. All interior formed surfaces shall have a smooth form finish as defined in ACI 301 and specified herein.
   a. Patch tie holes.
   b. Grind off fins and other projections.
   c. Repair defective areas to provide smooth uniform appearance.
   d. Inject cracks in accordance with requirements of Section 03 64 23, Crack Repair Epoxy Injection Grouting.

C. Type W-7 (Smooth Rubbed Wall Finish):

1. All exposed, exterior vertical surfaces shall have a smooth rubbed finish as defined in ACI 301 and specified herein.
2. Only water curing will be permitted on walls scheduled to be rubbed.
3. Perform rubbing while green concrete can be physically worked and smoothed without adding other materials, if structurally possible, the day following placement. Finish no later than 3 days after placement has been completed.
4. Remove forms at such a rate that finishing, form tie filling, fin removal, and patching can be completed on same day forms are removed while curing wall.

5. After patches have set sufficiently to permit working on surface, thoroughly saturate entire surface with water for period of 3 hours and rub until uniform surface is obtained.
6. Rub either by hand with carborundum stone of medium-coarse grade or abrasive of equal quality, or mechanically operated carborundum stone.
7. Mechanically operated carborundum stones shall be approved by Engineer before concrete finishing.
8. No cement grout, other than cement paste drawn from concrete itself by rubbing process shall be used.
9. Finish paste formed by rubbing by either brushing or floating as follows:
    a. Brushing:
        1) Carefully strike with clean brush.
        2) Brush in long direction of surface being finished.
    b. Floating:
        1) Spread uniformly over surface and allow to reset.
        2) Finish by floating with canvas, carpet face, or cork float, or rub down with dry burlap.
10. Continue water curing of wall during finishing operation in areas not being rubbed.
11. Move water curing onto rubbed areas as soon as water will not erode rubbed surface.

D. Type W-8 (Rubbed Wall Finish):

1. Meet requirements for Type W-7, except allow paste obtained from rubbing to set at least 24 hours.
2. After thoroughly saturating with water, coat surface with mixture of 85 percent cement and 15 percent lime with sufficient water to give creamy consistency. Demonstrate on sample panel prior to production finishing.
3. Rub this mixture into surface with coarse carborundum stone and brush with damp brush.
4. Brush in long direction of surface being finished.
5. Latex bonding admixture may be used. Consult with Euclid Chemical Co., Cleveland, OH or BASF Building Systems Inc., Shakopee, MN.

E. Prepare concrete surfaces to be water-proofed as specified in Section 07 13 00, in strict accordance with water-proofing manufacturer's instructions. On surfaces to be water-proofed, defects shall include, but not limited to, voids, air holes, and honeycomb that the normal application of water-proofing will not fill or otherwise seal effectively.

3.07 CONCRETE SLAB FINISHES

A. General:

1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
3. Finish slab in accordance with specified slab finish.
4. Do not dust surfaces with dry materials nor add water to surfaces.
5. Cure concrete as specified in Section 03 39 00, Concrete Curing.
6. All exterior slab surfaces shall be sloped a minimum of 1/8 inch in 1 foot or as indicated on Drawings. All exterior slab surfaces shall have a troweled finish as defined in ACI 301.
7. Edges:
   a. Chamfer edges of permanently exposed concrete, except slabs and top edges of walls, with a 45 degree bevel 3/4 inch by 3/4 inch, unless otherwise shown on Drawings.
   b. Tool exposed edges of slabs and top edges of walls to a radius of 1/4 inch unless otherwise shown on Drawings.

B. Type S-1 (Steel Troweled Finish):

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
2. Wood float to true, even plane with no coarse aggregate visible.
3. Use sufficient pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, hand steel trowel concrete to produce smooth, smooth dense surface, free from trowel marks.
5. Provide light steel-troweled finish (two trowelings) at air-entrained slabs. Provide hard steel-troweled finish (ringing sound from the trowel) for nonair-entrained slabs.
6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
7. Power Finishing:
   a. Approved power machine may be used in lieu of or in addition to hand finishing in accordance with directions of machine manufacturer.
   b. Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high and low spots in slab.

c. Do first steel troweling for slab S-1 finish by hand.

C. Type S-2 (Wood Float Finish):

1. Finish slab to receive fill and mortar setting bed by screeding with straightedges to bring surface to required finish plane.
2. Wood float finish to compact and seal surface.
3. Remove laitance and leave surface clean.
4. Coordinate with other finish procedures.

D. Type S-3 (Underside Elevated Slab Finish): When forming is removed, grind off projections on underside of slab and repair defective areas, including small shallow air pockets where schedule of concrete finishes requires:

1. Prepare surfaces to match Type W-7 (Smooth Rubbed Wall Finish).

E. Type S-5 (Broomed Finish):

1. Finish as specified for Type S-1 floor finish, except use only a light-steel troweled finish, and then finish surface by drawing fine-hair broom lightly across surface.
2. Broom in same direction and parallel to expansion joints, or, in case of inclined slabs, perpendicular to slope, except for round roof slab, broom surface in radial direction.

F. Type S-6 (Sidewalk Finish):

1. Slope walks down 1/4 inch per foot away from structures, unless otherwise shown.
2. Strike off surface by means of strike board and float with wood or cork float to true plane, then flat steel trowel before brooming.
3. Broom surface at right angles to direction of traffic or as shown.
4. Lay out sidewalk surfaces in blocks, as shown or as directed by Engineer, with grooving tool.

G. Concrete Curbs:

1. Float top surface of curb smooth, and finish all discontinuous edges with steel edger.
2. After concrete has taken its initial set, remove front form and give exposed vertical surface an ordinary wall finish, Type W-1.

3.08 CONCRETE SLAB TOLERANCES

A. Slab Tolerances:

1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
3. Slab Type S-A: Steel gauge block 5/16 inch thick.
4. Slab Type S-B: Steel gauge block 1/8 inch thick.
5. Slab Type S-A and S-B: Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.
6. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.
7. Slab Flatness and Levelness:
   a. Floor finish tolerances shall meet requirements specified herein, and as measured in accordance with ASTM E1155.
   b. Levelness tolerance, FL, shall not apply to slabs placed on unshored form surfaces or shored form surfaces after removal of shores.
   c. Levelness tolerances, FL, shall not apply to cambered or inclined surfaces, and shall be measured within 72 hours after slab concrete placement.

Slab Type S-A			
Minimum Overall F Numbers		Minimum Local F Numbers	
Flatness, FF	Levelness, FL	Flatness, FF	Levelness, FL
20	15	15	10
Slab Type S-B			
Minimum Overall F Numbers		Minimum Local F Numbers	
Flatness, FF	Levelness, FL	Flatness, FF	Levelness, FL
30	20	15	10

Slab Type S-C			
Minimum Overall F Numbers		Minimum Local F Numbers	
Flatness, FF	Levelness, FL	Flatness, FF	Levelness, FL
50	30	25	15

B. Slab Elevation and Thickness:

1. Finish Slab Elevation: Slope slabs to floor drains and gutter. Slabs shall adequately drain regardless of tolerances.
2. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

3.09 BEAM AND COLUMN FINISHES

A. Type B-1: Match wall Type W-1.

B. Type B-2: Match wall Type W-2.

C. Type C-1: Match wall Type W-1.

D. Type C-2: Match wall Type W-2.

3.10 BACKFILL AGAINST STRUCTURES

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

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

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

3.11 CURING

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Comply with the requirements specified in Section 03 39 00, Concrete Curing.

3.12 FIELD QUALITY CONTROL

A. General:

1. Furnish a batch ticket (delivery ticket) for each load of concrete received. Concrete delivered without a batch ticket containing complete information as specified below shall be rejected. Collect and complete the batch ticket at the placement site and deliver all batch tickets to the Engineer on a daily basis. The Engineer shall have access to the batch tickets at any time during placement. Provide the following information on each batch ticket:
   a. Supplier's name and date.
   b. Truck number.
   c. Project number and location.
   d. Concrete class designation and item number.
   e. Cubic yards batched.
   f. Time batched.
   g. Mix design number.
   h. Type, brand and amount of each admixture.
   i. Type, brand and amount of cement and pozzolan.
   j. Mass (weights) of fine and coarse aggregate, respectively.
   k. Moisture of fine and coarse aggregate, respectively.
   l. Gallons of batch water (including ice).
2. Add the following information to the batch ticket at the placement site:
   a. Gallons of water added by truck operator plus quantity of concrete in the truck each time water is added.
   b. Number of revolutions of drum at mixing speed (for truck mixed concrete).
   c. Discharge time.
   d. Location of batch in placement.
   e. Water cement ratio.
3. The Contractor will be allowed to add water to the batched concrete once at the site, provided that the specified water to cement ratio is not exceeded and the amount of water withheld at the batch plant is on the delivery ticket.
4. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
5. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
   a. Maintain records of placed concrete items. Record truck number, date and stop times, location of placed concrete, quantity, air temperature, concrete placement temperature, slump, air content,

admixture quantities, test samples collected and times, and cast test cylinder numbers.

6. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
   a. For Each Concrete Mixture: Provided results of air content tests for first load of the day are within specified limits, testing need only be performed at point of delivery for subsequent loads of that concrete mixture except that testing should be performed at point of placement every 4 hours.
7. Evaluation will be in accordance with ACI 301 and Specifications.
8. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
9. Frequency of testing may be changed at discretion of Engineer.
10. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M, and shrinkage specimens (ASTM C157/C157M) at placement (discharge) end of line.
11. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified in Section 03 39 00, Concrete Curing, by 7 additional days.
3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Engineer.

C. Shrinkage Tests:

1. When required to conform to shrinkage limits, collect actual concrete materials being batched and before liquids have been added to mix.

2. Mix sampled material in a laboratory at proportions matching batched concrete.
3. Test shrinkage characteristics every 5,000 cubic yards of concrete used on job and every 3 months during construction when compression test cylinders are made.
4. Concrete Shrinkage Limits: Test in accordance with ASTM C157/C157M, with the following modifications:
   a. Prisms shall be moist cured for 7 days prior to 28-day drying period.
   b. Comparator reading at end of 7-day moist cure shall be used as initial length in length change calculation.
   c. Reported results shall be average of three prisms.
   d. If drying shrinkage of a specimen departs from average of that test age by more than 0.004 percent, disregard results obtained from that specimen.
   e. Results at end of 28-day drying period shall not exceed 0.040 percent if 3-inch prisms are used, or exceed 0.038 percent if 4-inch prisms are used.
   f. If 7-day or 14-day shrinkage tests results exceed shrinkage limits established by design mix testing, furnish additional 14 days of water curing beyond original curing period, for concrete surfaces of hydraulic structures represented by prisms. Modify concrete mix design to reduce shrinkage prior to casting additional concrete on Project.

D. Cold Weather Placement Tests:

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

E. Tolerances:

1. Walls: Measure and inspect walls for compliance with tolerances specified in Section 03 10 00, Concrete Forming and Accessories.
2. Slab Finish Tolerances and Slope Tolerances:
   a. Make floor flatness measurements day after floor is finished and before shoring is removed to eliminate effects of shrinkage, curing, and deflection.
   b. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
   c. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

F. Defective Concrete:

1. Defective Concrete: Concrete not conforming to required lines, levels, details elevations, dimensions, tolerances or specified requirements.
2. Defective concrete will be determined by the Engineer and shall be repaired or replaced at no additional cost to the Owner. Perform repair in accordance with Guide to Concrete Repair (USBR) and as specified in the Article “Repairing Concrete” above.
3. Repair of Hardened Concrete Not Within Specified Tolerances. Accomplish such repair to bring it within the specified tolerances in a manner approved by the Engineer, after consultation with the Engineer regarding the repair method. Notify the Engineer sufficiently in advance to enable his attendance as to the time when the repair shall be performed.
4. Defective concrete that shall be exposed to public view shall be repaired in a manner that shall result in a concrete surface with a uniform appearance. Grinding of concrete surface exposed to view shall be limited in depth such that no aggregate particles are exposed more than 1/6 inch in cross section at the finished surface. Where grinding has caused or will cause exposure of aggregate particles greater than 1/6 inch in cross section at the finished surface, repair the concrete by excavating and replacing the concrete at no additional cost to the Owner.
5. Prevention of Repeated Failure to Meet Tolerances: When concrete placements result in hardened concrete that does not meet specified tolerances, the Contractor shall upon request submit to the Engineer an outline of all preventative actions, such as modifications to forms, modified procedure for setting screeds, and different finishing techniques, to be implemented by the Contractor to avoid repeated

failures. The Engineer reserves the right delay concrete placements until the Contractor implements such preventive actions that are approved by the Engineer.

6. Modify or replace concrete not conforming to required levels and lines, details, and elevations.
7. Repair or replace concrete not properly placed or not of the specified type.
8. Disposal of defective concrete removed will be the responsibility of the Contractor and shall be conducted in accordance with local, state and federal laws and regulations.

3.13 MANUFACTURER'S SERVICES

A. Provide representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed), for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

1. Concrete Producer Representative:
   a. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
   b. Establish control limits on concrete mix designs.
   c. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump and air content if needed.
2. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.
3. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.14 PROTECTION OF INSTALLED WORK

A. Protect finished work under provisions of ACI 301.

B. After curing as specified in Section 03 39 00, Concrete Curing, and after applying final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect it from material and damage as a result of other construction work.

1. Protect concrete from damage until final acceptance of the Work by the Engineer.
   a. Do not load, remove forms or shoring, or backfill against concrete until concrete has gained sufficient strength to safely support its weight and imposed loads.
   b. Protect fresh concrete against erosion from rain, hail, sleet, or snow; contamination from foreign materials; and damage from foot traffic until the concrete has hardened.
   c. Remove and dispose of temporary covering when no longer required.

C. Protect concrete when freezing temperatures are imminent:

1. Maintain concrete at a temperature of 50 degrees F or greater for 72 hours, minimum, after placement. Vent heater and prevent concrete from drying where artificial heat is employed.
2. Protect concrete from freezing during water curing. After discontinuance of water curing, maintain at a temperature of 50 degrees F or greater for the next 72 hours.
3. Discontinue protection against cold weather such that the drop in temperature of the concrete will be gradual and will not exceed 5 degrees F per hour and 40 degrees F in 24 hours for thin sections and 5 degrees F per hour and 20 degrees F in 24 hours for massive section greater than 36 inches in thickness.

D. Maintain concrete with minimal moisture loss at relatively constant temperature for a period of time necessary for satisfactory hydration of cement and hardening of concrete.

E. Remove formwork in accordance with the requirements of Section 03 10 00, Concrete Forming and Accessories.

F. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.15 SCHEDULE OF CONCRETE FINISHES

A. Form Tolerances: As specified in Section 03 10 00, Concrete Forming and Accessories.

B. Special Floor Finishes: As specified in Section 03 35 00, Concrete Finishing.

C. Provide concrete finishes as scheduled:

Area	Type of Finish	Required Form Tolerances
Exterior Wall Surfaces		
Above-grade/exposed (above point 6" below finish grade)	W-2	W-B
Above-grade/covered with brick veneer or other finish material	W-1	W-A
Backfilled/waterproofed (below point 6" below finish grade)	W-1	W-A
Backfilled/not waterproofed (below point 6" below final grade)	W-1	W-A
Interior Wall Surfaces		
Open top water-holding tanks and basins/not painted or coated	W-2	W-A
Covered water-holding tanks and basins/not painted or coated	W-1	W-A
Buildings, pipe galleries, and other dry areas/not painted or coated	W-2	W-A
Exterior Slabs		
Roof slab/exposed	S-5	S-B
Roof slab/covered with roofing material	S-1	S-A
Water-holding tanks and basins/top of wall	S-5	S-B
Top of footing	S-2	S-A
Other water-holding tanks and basins	S-1	S-A
Stairs and landings	S-5	S-B
Sidewalks	S-6	S-B

Area	Type of Finish	Required Form Tolerances
Other exterior slabs	S-5	S-A
Interior Slabs		
Buildings, pipe galleries, and other dry areas	S-1	S-B
Slabs to receive mortar setting bed for tile	S-2	S-A
Slabs to receive resilient flooring or carpet	S-1	S-A
Underside of elevated slabs	S-3	S-A
Beams and Columns		
Beams/not coated	B-2	B-A
Columns/not coated	C-2	C-A

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-In. or 50-Mm Cube Specimens).
   b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s product data sheet(s).

B. Informational Submittals:

1. Agenda: Conference prior to slab placement.
2. Manufacturer’s written procedures for slab preparation, product application, protection of finished surface, and post-application cleanup.
3. Product manufacturers representatives’ names and phone numbers.
4. Manufacturer’s Certificate of Compliance for products to be furnished.
5. Manufacturer’s Certificate of Proper Installation.
6. Statement of Qualifications:
   a. Manufacturer’s Product Service Record.
   b. Application personnel.
   c. Manufacturer’s representative.
7. Manufacturer’s installation instructions.
8. Manufacturer’s written instructions for maintenance and repair of floor finishes installed.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer’s Product Service Record: Five previous projects at least 5 years old where product was used at representative coverage per square foot.

2. Floor Product Manufacturer: Manufacture components of floor material, except the epoxy, in own plant and under control of trained quality control manager.
3. Application Personnel: Four previous projects of successful installation of specified materials or manufacturer's training.

B. Preinstallation Training: Manufacturer-approved training of application personnel and quality control inspectors for these floor finishes.

C. Conference Prior to Slab Placement:

1. Conducted by Contractor.
2. Agenda:
   a. Concrete mix design.
   b. Placing techniques.
   c. Finishing techniques.
   d. Floor hardener application procedures.
   e. Equipment required for these procedures.
3. Attendees:
   a. Contractor's superintendent.
   b. Subcontractor's representative involved in slab installation and finishing.
   c. Engineer.

D. Mockups: Install one 10-foot by 20-foot area for each type of finish floor to demonstrate that the proposed material and methods produce a finished product acceptable to the Engineer.

1. Mockup will establish the standard of quality for floor finishes.
2. Use specified materials at a location designated by Engineer or Owner.
3. Notify Engineer 5 days in advance of commencement of mockup floor slab application and training.
4. Do not purchase floor materials until mockup slab installation has been accepted by the Engineer or Owner.

E. Color Samples: Minimum 2-inch by 2-inch Sample applications of floor finishes available.

PART 2 PRODUCTS

2.01 CLEAR LIQUID SEALER DUST PROOFER

A. Colorless, aqueous solution of zinc and magnesium fluorosilicate.

B. Each gallon of solution shall contain a minimum of 2 pounds of fluorosilicate compound.

C. Manufacturers:

1. Master Builders Co., Cleveland, OH.
2. Sonneborn, Minneapolis, MN.
3. Euclid Chemical Co., Cleveland, OH.

2.02 DRY SHAKE HARDENERS

A. Mix: Surface hardener with metallic or natural aggregate, premixed and packaged at factory, delivered to Project Site ready to apply.

B. Natural Aggregate: Mixture of specially processed graded iron aggregate, selected portland cement, and necessary plasticizing agents formulated, processed, and packaged under stringent quality control at the manufacturer's factory.

1. Manufacturers and Products:
   a. Natural concrete gray, "Surflex" by Euclid Chemical Co. or "Mastercron" by Master Builders, Cleveland, OH.
   b. Light reflective, (off-white) 50 percent light reflective "Surflex" by Euclid Chemical Co. or "Light Reflective Mastercron" by Master Builders, Cleveland, OH.

C. Metallic Aggregate: Metallic aggregate, cementitious binder, plasticizer, water-reducing admixtures, and other ingredients free from nonferrous particles, rust, and material intended to disguise rust.

1. Manufacturers and Products: Natural, concrete gray, and colored "Euco-Plate HD" by Euclid Chemical Co. or "Masterplate 200" by Master Builders, Cleveland, OH.

2.03 GROUND AND POLISHED CONCRETE

A. Grinding Equipment:

1. Three or four head counter rotating variable speed floor grinding machine with at least 600 pounds down pressure.
2. Duct extraction system, pre-separator, and squeegee attachments with minimum flow rating of 322 cubic feet per minute.

3. Grinding Heads:
   a. Metal bonded 16, 25, 40, 60, 80, 150, and 180 grits.
   b. Resin bonded, phenolic diamonds, 100, 200, and 400 grits.

B. Densifying Impregnator: Ready-to-use liquid developed for specific use.

1. Manufacturer and Product: L.M. Scofield Company; Scofield Lithium Densifier Formula ONE LD.

C. Curing Compound for Polished, Hardened Concrete: Ready-to-use liquid developed for specific use.

1. Manufacturer and Product: L.M. Scofield Company; Scofield Formula ONE Finish Coat.

PART 3 EXECUTION

3.01 CLEAR LIQUID SEALER DUST PROOFER APPLICATION

A. Before application, thoroughly cure floors to receive treatment for minimum 28 days, keep clean, unpainted, free from membrane curing compounds, and perfectly dry with all Work above them completed.

B. Apply hardener evenly to surface, using three coats, allowing 24 hours between coats.

1. First coat 1/3 strength, second coat 1/2 strength, and third coat 2/3 strength, mix with water.
2. Apply each coat so as to remain wet on surfaces for 15 minutes.
3. Apply approved treatment in accordance with manufacturer’s instructions.
4. After final coat is completed and dry, remove surplus hardener from surface by scrubbing and mopping with water.

3.02 INSTALLATION OF DRY SHAKE HARDENERS

A. Application:

1. Application Rate: 2 pounds per square foot or as recommended by manufacturer.
2. Penetration: Top 1/8-inch to 3/16-inch depth of floor slab.
3. Commence application immediately upon completion of floating surface area; bleed water shall not be present during and after application.

4. Distribute 2/3 of specified total quantity evenly on concrete surface to receive treatment by mechanical spreader; do not throw shake product.
5. Apply first to areas adjacent to forms, entry ways, columns, and walls where rapid moisture loss may occur.

B. Finishing:

1. Commence first mechanical float with finishing machines using float blades as soon as shake has absorbed moisture, as indicated by darkening of the surface area.
2. Float until moisture from base slab penetrates through first shake application.
3. Immediately distribute remaining 1/3 of total required shake by spreader and commence second mechanical float, as specified above.
4. Compact surface further by third mechanical float as time and setting characteristics of concrete allow.
5. Do not add water to surface area. In drying conditions, an evaporation retarder may be used to prevent plastic shrinkage cracking and rapid surface drying, subject to manufacturer's recommendations and approval of Engineer.
6. Hand or mechanically trowel surface while stiffening progresses, as indicated by loss of sheen with blades relatively flat.
7. Run trowel blades as soon as possible to achieve representative finish obtained on mockup panel.
8. Avoid excessive trowel blade speed which may "burn" or darken floor surface resulting in loss of wear.
9. Remove marks and pinholes in final raised trowel operation.

C. Curing:

1. Cure treated floor surface to meet the recommendations of the dry shake hardener manufacturer. Apply curing compounds as soon as possible without marring the slab surface.
2. Commence slab protection when curing compound is dry.
    a. Cover slab with nonstaining kraft building paper to protect area from droppings.
    b. Maintain floor free of traffic and loads for at least 10 days after completion.

3.03 CONCRETE GRINDING AND POLISHING

A. Cut and Shine Levels using definitions from Concrete Polishing Association of America:

1. Depth of Cut: Grade 1, cream finish.
2. Shine Level: Class 1, 400 grit polish.

B. Beginning of Work by Applicator indicates acceptance of placed concrete for scheduled operations.

C. Grind the concrete floor to within 2 to 3 inches of walls with 16, 25, 40, 60, 80, 150 and 180 grit, removing construction debris, floor slab imperfections and until there is a uniform scratch pattern and desired concrete aggregate exposure.

D. Fill construction joints and cracks with filler products recommended for use with approved densifying impregnator and curing compounds.

E. Apply densifying impregnator undiluted at approximately 200 square feet per gallon using a stiff, long bristled broom. Cover the entire area liberally. Using a broom, work the densifier into the substrate for 30 minutes. During this 30 minute period, continually keep the substrate wet with densifier. Squeegee excess material off the floor. Allow 12 to 24 hours for full cure.

F. Grind the floor to within 2 to 3 inches of walls with metal bonded diamond grits of 150 and 300. Grind direction to be 90 degrees from each previous grind and removing all the scratches from the previous grit. Vacuum the floor thoroughly after each grind using a squeegee vacuum attachment.

G. Polish the floor, to desired sheen level, with phenolic resin bonded diamond grits of 100 and 400 first polishing the edges with pads of the same grit and then the field of the floor removing all scratches from the previous grit. After each polish, clean the floor thoroughly using clean water and an auto scrubber or a mop and a wet vacuum.

H. After the floor has dried, apply curing compound at a rate of 300 square feet per gallon. Using a broom, work the material into the floor for a minimum of 10 minutes. Tight squeegee the remaining material from the floor without leaving squeegee marks or puddles. Allow to cure for 12 to 24 hours.

I. Use a high speed (2,000 to 3,000 rpm) burnishing machine and hogs hair burnishing pad, buff the surface to a high shine.

3.04 TESTS AND INSPECTION

A. Vapor Transmission Test: Conduct test on new and existing concrete to show that no surface moisture exists prior to application of specified special floor treatment, as follows:

1. Place polyethylene plastic sheet, minimum 4 feet by 4 feet and sealed along four sides with duct tape to prevent moisture transmission by evaporation, over concrete floor area for 24 hours.
2. Indication of moisture transmission will be apparent by accumulation of moisture on enclosed surface of polyethylene plastic sheet.
3. Do not apply concrete bonding agent until test results indicate moisture is not being transmitted from concrete surface.

B. Strength Tests: Test metallic aggregate topping for compressive strength by making 2-inch by 2-inch cubes in accordance with ASTM C109.

C. Epoxy Joint Filler:

1. Allow 90 days after slab placement before filling joints.
2. Mix and install in accordance with manufacturer's instructions.
3. Fill contraction or construction joints in areas receiving armored joint treatment.

3.05 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Project Site in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed), for installation assistance, inspection and certification of proper installation, and training of application personnel.

1. Technical assistance with design and adjustment of concrete mixes to receive floor finishes and toppings.
2. Technical assistance to assure and certify application and installation of system being used.
3. Consultation, direction, and certification of mockup, for full-scale application of floor finishes, and at other times as needed.
4. Attendance at the conference prior to slab placement to finalize proper methods and procedures.

END OF SECTION

SECTION 03 39 00
CONCRETE CURING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   b. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
2. NSF International: 61, Drinking Water System Components – Health Effects.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' data indicating compliance with the requirements specified herein for the following products:
   a. Evaporation retardant.
   b. Curing compound.
   c. Clear sealer.
   d. Clear floor hardener.
2. Curing methods proposed for each type of element such as slab, walls, beams, and columns in each facility.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed), for the following:
   a. Curing compound showing moisture retention requirements.

1.03 QUALITY ASSURANCE

A. Comply with ACI 301 and ACI 302.

PART 2 PRODUCTS

2.01 MATERIALS

A. Curing Compound:

1. Water-based, high-solids content, non-yellowing, clear, curing compound meeting requirements of ASTM C309 Type I, Class A & B.
2. Curing compound shall be compatible with coatings (including sealer, water-proofing, bonded cementitious topping, or floor tile) which are to be applied to the concrete surface.
3. Manufacturers and Products:
   a. BASF Construction Chemicals, Shakopee, MN:
      1) Kure 1315.
      2) Kure-N-Seal.
   b. Euclid Chemical Co., Cleveland, OH:
      1) Super Diamond Clear VOX.
      2) Kurez VOX.
   c. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.

B. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
   a. Master Builders Co., Cleveland, OH; Confilm.
   b. Euclid Chemical Co., Cleveland, OH; Eucobar.

C. Clear Sealer (One-Component Penetrating Silane Sealer):

1. Manufacturers and Products:
   a. Chemrex, Inc., Shakopee, MN; Masterseal SL.
   b. Euclid Chemical Co.; Eucoguard 200.

D. Clear Floor Hardener:

1. Colorless, aqueous solution of zinc and magnesium fluorosilicate.
2. Each gallon of solution shall contain a minimum of 2 pounds of fluorosilicate compound.
3. Manufacturers:
   a. Chemrex, Inc., Shakopee, MN.
   b. Euclid Chemical Co., Cleveland, OH.
   c. Sonneborn, Minneapolis, MN.

E. Slip-Resistant Treatment:

1. Slip-Resistant Finish: Natural aggregate, nonmetallic dry-shake material.
2. Manufacturer and Product:
   a. Euclid Chemical Company; Non-Slip.
   b. Or as approved.

F. Absorptive Mats: Burlap-polyethylene, minimum 8 ounces per square yard bonded to prevent separation during handling and placing.

G. Water: Clean and potable, containing less than 500 ppm of chlorides.

PART 3 EXECUTION

3.01 CONCRETE CURING

A. General:

1. Where surfaces are to receive coatings, painting, cementitious material, or other similar finishes, use only water curing procedures. Refer to Interior Finish Schedule for surfaces to receive coatings.
2. Use only water curing on potable water structures.
3. Where curing compound cannot be used, water curing as described below or special methods using moisture shall be agreed upon by Engineer prior to placing concrete.
4. As required in Section 03 30 00, Cast-in-Place Concrete, if result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified below, by 7 additional days.

B. Use one of the following methods as approved by Engineer:

1. Walls:
   a. Method 1: Leave concrete forms in place and keep surfaces of forms and concrete wet for 7 days.
   b. Method 2: Continuously sprinkle with water 100 percent of exposed surfaces for 7 days starting immediately after removal of forms.
   c. Method 3: Apply curing compound, where allowed, immediately after removal of forms.

2. Slabs, Pavements, Sidewalks, and Curbs:
   a. Method 1: Protect surface by water ponding for 7 days.
   b. Method 2: Cover with burlap or cotton mats and keep continuously wet for 7 days.
   c. Method 3: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously wet for 7 days.
   d. Method 4: Continuously sprinkle exposed surface for 7 days.
   e. Method 5 (For Pavements, Sidewalks, and Curbs only; Methods 1 through 4 Only for Slabs): Apply curing compound, where allowed, immediately after final finishing when surface will no longer be damaged by traffic.

3.02 EVAPORATION RETARDANT APPLICATION

A. Use on flatwork when environmental conditions are anticipated to cause rapid drying of the concrete surface. Do not use evaporation retardant on potable water structures, unless product is NSF 61 approved.

B. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture.

C. Reapply as needed to ensure a continuous moist surface until final finishing is completed.

3.03 CLEAR SEALER APPLICATION

A. Apply to floor slabs.

B. Before application and with Work above completed, water cure concrete walls and floors for a minimum of 28 days to receive sealer, keep clean, unpainted, and free from membrane curing compounds.

C. Apply with stiff brush, short nap roller, squeegee, garden sprayer, or conventional paint spray equipment.

D. Apply at a coverage rate of 125 square feet per gallon to 200 square feet per gallon. Cure sealer on slabs for the following minimum cure time at ambient temperatures shown prior to allowing foot traffic:

1. 90 degrees F: 2 hours.
2. 75 degrees F: 4 hours.
3. 50 degrees F: 8 hours.
4. 35 degrees F: 16 hours.

3.04 CLEAR FLOOR HARDENER APPLICATION

A. Apply where indicated on Drawings.

B. Before application and with Work above completed, water cure concrete walls and floors for a minimum of 28 days to receive sealer, keep clean, unpainted, and free from membrane curing compounds.

C. Apply hardener evenly, using three coats, allowing 24 hours between coats.

1. First coat 1/3 strength, second coat 1/2 strength, and third coat 2/3 strength, mix with water.
2. Apply each coat so as to remain wet on surface for 15 minutes.
3. Apply approved hardener in accordance with manufacturer’s instructions.
4. After final coat is completed and dry, remove surplus hardener from surface by scrubbing and mopping with water.

3.05 SLIP-RESISTANT FINISH

A. Apply at a rate of 25 pounds per 100 square feet.

B. Imbed in concrete surface.

C. Broadcast application is unacceptable.

D. Commence curing immediately after completion of finish operation. Cure treated floor surface to meet the recommendations of the slip-resistant finish manufacturer.

3.06 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services (to be completed), for installation assistance, inspection, and certification of proper installation for products specified.

B. Provide clear sealer manufacturer’s representative to demonstrate proper application of product.

C. Provide clear floor hardener manufacturer’s representative to demonstrate proper mixing and application of product.

D. Provide slip-resistant treatment manufacturer's representative to demonstrate proper application of product.

E. Provide curing compound manufacturer's representative to demonstrate proper application of curing compound to show coverage in one coat.

END OF SECTION

SECTION 03 40 00
PRECAST CONCRETE

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
   b. 318, Building Code Requirements for Reinforced Concrete.
2. ASTM International (ASTM):
   a. A36, Standard Specification for Structural Steel.
   b. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
   c. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   d. C857, Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   e. ASTM International C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
3. Precast/Prestressed Concrete Institute (PCI):
   a. MNL-117, Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.
   b. MNL-120, Design Handbook for Precast and Prestressed Concrete, Third Edition.

1.02 SUBMITTALS

A. Action Submittals:

1. Sealer for Exterior Surfaces: Product data with mixing/application instructions.
2. Form Liners: Manufacturer’s literature and product data.
3. Calculations and Technical Data: Proposed details and design calculations, signed and sealed by a Professional Engineer licensed in California, for stresses in all critical sections of precast members for all loading conditions including transportation, handling, and erection.

4. Precast Concrete Underground Utility Trench System:
   a. Engineering layout drawings, including dimensions of components and identification and location of each trench part in the trench layout.
   b. Bill of Materials.
   c. Detailed catalog cuts for bases, covers, standard miters, tee sections, cross sections, end walls, reducers, radius corners, lifting bars, sealants and tie plates.
5. Precast Concrete Well and Well Casing Vaults, Meter Vaults and Valve Vaults:
   a. Design, including calculations and drawings, signed and sealed by a Professional Engineer licensed in the State of California.
   b. Concrete mix design.
   c. Joint sealing and pipe passage details.

B. Informational Submittals:

1. For Precasting Manufacturers Not Listed in Article Quality Assurance:
   a. Experience record on production of precast concrete as shown, with information on precasting plant that will indicate capability to satisfactorily perform the Work.
   b. Evidence of current PCI plant certification.
2. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
3. Test Reports:
   a. For precast manufacturer's concrete test cylinders.
   b. Inspection of installed panels.
4. Precast Concrete Underground Utility Trench System: Manufacturer's printed instructions for installation of the precast concrete trench system components.
5. Precast Concrete Vaults:
   a. Setting instructions.
   b. Fabrication schedule and plant operations contact name and phone number.

1.03 QUALITY ASSURANCE

A. Qualifications of Precasting Manufacturers:

1. Precast Concrete: Product of manufacturer with 3 years of experience producing precast concrete products of quality specified.
2. Precast Plant: PCI certified plant with current certification.

3. Precasting manufacturers with apparent capability to meet the specifications of this Section.
4. Calculations and Drawings stamped by an Engineer registered in the State of California.

B. Coordination: Precaster shall be provided approved submittals for the precast concrete well and well casing vaults, meter vaults and valve vaults, and review these submittals and coordinate final dimensions of precast concrete vaults to piping. Note any conflicts which cannot be accommodated to Contractor and Engineer prior to fabrication of precast concrete vaults.

PART 2 PRODUCTS

2.01 MATERIALS

A. Formwork:

1. One-piece, full-length, and without seams.
2. As specified in Section 03 10 00, Concrete Forming and Accessories.

B. Reinforcing Steel: As specified in Section 03 21 00, Reinforcing Steel.

C. Cement: As specified in Section 03 30 00, Cast-in-Place Concrete.

D. Aggregates: As specified in Section 03 30 00, Cast-in-Place Concrete, for 3/4-inch maximum size. Furnish of consistent quality, gradation, and color for precast architectural panels to produce uniformity of appearance in all panels.

E. Admixtures: As specified in Section 03 30 00, Cast-in-Place Concrete.

F. Embedded Items:

1. ASTM A36 steel.
2. Anchor Studs: Headed anchor studs (HAS), deformed bar anchors (DBA), or threaded studs as manufactured by Nelson Stud Welding Co., Lorain, OH.
3. Furnish inserts for lifting tilt-up walls, bolting stiffeners, attaching braces, and as otherwise required.
4. Tie Plates in Precast Concrete Utility Trench: Hot dipped galvanized.
5. Access Hatch, Access Door, and Lid Embedded Frames: As specified in Section 05 50 00, Metal Fabrications.
6. Lifting Insert: Stainless steel Type 316.

G. Grout: Nonshrink, nonmetallic Type II grout as specified in Section 03 62 00, Nonshrink Grouting.

H. Sealer for Exterior Surfaces:

1. Silane Sealer: One-component penetrating sealer, hydrophilic (isopropyl alcohol as a carrier) with 40 percent active ingredients.
2. Manufacturers:
   a. Master Builders Co.
   b. Euclid Chemical Co.

I. Access Hatches, Access Doors and Lids: As specified in Section 05 50 00, Metal Fabrications.

J. Ladders: As specified in Section 05 50 00, Metal Fabrications.

K. Flexible Plastic Gasket Material: Federal Specification SS-S-210A and AASHTO M-196B; Hamilton-Kent Manufacturing Company, Concrete Sealants, Inc., or equal.

L. Polyurethane Sealant: As specified in Section 07 92 00, Joint Sealants.

M. Stone Fill: Standard size No. 67 aggregate, or as approved.

2.02 CONCRETE MIX

A. As specified in Section 03 30 00, Cast-in-Place Concrete.

B. Design Strength: 5,000 psi at 28 days.

C. Water/Cement Ratio: 0.38 maximum.

D. For colored precast concrete, coordinate ingredients and procedures to achieve uniformity of color per ASTM C979/C979.

2.03 DESIGN REQUIREMENTS

A. Structural Precast Members:

1. Meet applicable sections of PCI MNL-120.
2. Design for spans and superimposed live and dead loads shown plus dead loads of members.

B. Precast Concrete Underground Utility Trench System:

1. Components shall be designed to conform to requirements of ASTM C857, ASTM C858, and ACI 318, and as specified herein.
2. Provide a one-piece trench section with solid bottom having all components designed for AASHTO HS20, 32,000 pound axle loads.
3. Provide trench system cross-section dimensions as detailed and per indicated location shown on Drawings.
4. Provide the precast base in 10-foot lengths unless otherwise approved by the Engineer or required to satisfy the horizontal and vertical alignment, or to complete closures, shown on Drawings.
5. Provide steel reinforced concrete lids on all length of trench section except where galvanized steel lid is shown on Drawings at a specific location. Length of the galvanized steel lid shall be as indicated on Drawings.
6. Provide bolted tie plates with 6-inch minimum length channel strut embedded in the bases to connect the sections together to minimize shifting and/or differential settlement. Provide a tie plate every 50 feet minimum designed with capability for accommodating thermal expansion and contraction anticipated at the Project site conditions.
7. Manufacturers:
    a. Trenwa, Ft. Thomas, Kentucky.
    b. Barkman, Winnipeg, Canada.
    c. Modern Precast Concrete, Pennsylvania.
    d. Or approved equal.

C. Precast Well and Well Casing Vaults, Meter Vaults and Valve Vaults:

1. Design wall panels of vaults to meet loading requirements of AASHTO Classification H-20 traffic loading.
2. Design wall panels to withstand soil and water pressure of 96 pounds per cubic foot on outside of vault with vault empty on inside; ground water table/100 year flood elevation to be equal to finished grade for design purposes.
3. Design base slab so there is a factor of safety of 1.5 against buoyancy and top steel can handle net uplift pressures. Ground water table/100 year flood elevation to be equal to finished grade for design purposes.
4. Manufacturer:
    a. Jensen Precast, California.
    b. Or approved equal.

2.04 FABRICATION

A. General:

1. Comply with PCI MNL-117.
2. Reinforcing Steel:
   a. Place in position before concrete is cast.
   b. Keep clean and free from form oil or other substances harmful to bond.
3. Coordinate dimensions, determine type, quantity, size, and location of, and furnish necessary embedded items in precast concrete. Coordinate location of embedded items in cast-in-place concrete necessary to connect precast items.

B. Surface Finish for Precast Structural Units:

1. Furnish concrete finish, as specified in Section 03 30 00, Cast-in-Place Concrete, to additional concrete field placed on precast units.
2. Other Surfaces: Smooth screeded finishes, unless otherwise shown.

C. Sealer:

1. Apply to panels or walls as indicated on Drawings or specified herein, at Site in accordance with manufacturer's instructions.
2. Protect surface until installed in the Work.
3. Repair damage as approved by manufacturer.

D. Precast Concrete Well and Well Casing Vaults, Meter Vaults and Valve Vaults:

1. Type and Size: Precast concrete walls and base slab (and removable top slab where indicated on Drawings) with dimensions listed provided on drawing schedule and details.
2. System Fabrication: Prefabricate components at factory; ship, assemble and combine with site-prepared materials; includes these principal items:
   a. Precast, reinforced concrete.
   b. Access Hatches, Access Doors and Lids.
   c. Lifting Inserts (for removable top slabs where indicated on drawings).
3. General:
   a. Poured and vibrated and constructed using steel forms.

b. Outside surfaces with uniform vertical broom finish, or abrasive, non-slip finish applied in factory; other exposed surfaces, follow Section 03 30 00, Cast-in-Place Concrete.
c. If wall joints or wall to base slab joints are needed, use tongue and groove design; sealed water-tight with flexible plastic gasket material and polyurethane sealant.
d. Wall penetrations for piping fabricated at factory.
e. When provided, top slab is to be sloped to shed water.

2.05 SOURCE QUALITY CONTROL

A. Prepare minimum three standard concrete test cylinders for each 50 cubic yards or fraction thereof of concrete placed in the precast work in accordance with ASTM C31.

B. Test and record concrete strengths.

PART 3 EXECUTION

3.01 ERECTION

A. Verify that anchorage inserts are in correct locations.

B. Handle and erect precast concrete with care as recommended by manufacturer.

C. Erect precast units plumb, straight, level, square, and in proper alignment.

D. Fasten units securely in place and brace to maintain position, stability, and alignment until permanently connected and structure is complete and stable.

E. Field Cutting: Not allowed without prior approval of Engineer.

3.02 PRECAST CONCRETE UNDERGROUND UTILITY TRENCH SYSTEMS

A. Install the precast concrete underground utility trench system in strict accordance with the manufacturer’s printed instructions and as shown on Drawings to provide a completed system in accordance with the grades and horizontal alignment as shown on Drawings.

B. Set the trench bases on a minimum 4-inch depth bed of sand to ensure continuous, uniform support. Ensure no protruding rocks in the trench bottom or sides are closer than 4 inches to the precast concrete sections.

C. Provide mitered ends, tee sections, cross sections, and end walls to construct a fully enclosed trench base section for a completed system as shown on Drawings.

D. Handle the base sections and covers when transporting and installing in the prepared trench in a manner that prevents damage to any component of the completed system. Remove and replace any damaged (in the opinion of the Engineer) component.

E. All joints between sections shall be water-resistant. Provide joint sealant material provided by the system manufacturer. Install in accordance with the trench system manufacturer's printed instructions.

F. After the bases have been securely set in the prepared trench and pulled together bolt together the furnished tie plates.

G. Backfill the space between the exterior walls of precast sections and the side walls of the prepared trench as shown on Drawings with dry sand material as specified in Section 31 23 23.15, Trench Backfill, and compact to the requirements for pipe installation as specified in Section 31 23 23.15, Trench Backfill.

H. Provide corner guards on all corners of tees, crosses and interior corners of turns 45 degrees and greater to protect contained pipe from abrasion.

I. After the base section installation has been completed and the trench backfilled and compacted, install the trench lids.

1. On trenches with concrete lids, furnish and install a neoprene gasket the full length of the horizontal lid bearing surface on each side of the base to minimize movement that may chip the lid sections. Clean the bearing surface of any foreign material before installing the neoprene gasket and then clean the exposed surface of the gasket before setting the lid to ensure a continuous, uniform bearing surface.
2. Avoid overlapping the joints as this may cause an uneven bearing surface that could result in damage to the lid.

J. Fill the recessed cavity surrounding each lifting eye with sealant in accordance with the requirements specified in Section 07 92 00, Joint Sealants, sealant Type 3 or 5.

3.03 PRECAST WELL AND WELL CASING VAULTS, METER VAULTS AND VALVE VAULTS

A. Field Installation: Allowable stresses shall not be exceeded; accessories supplied by manufacturer shall be installed by manufacturer's approved personnel.

B. Excavate in accordance with Section 31 23 16, Excavation, for Work of this Section. Hand-trim excavation for accurate placement of vault to elevations indicated.

C. Place bedding material level in one continuous layer not exceeding 6 inches compacted depth; compact to 95 percent standard Proctor.

D. Install vault and related components on bedding.

E. Backfill around sides of vault; tamp in place and compact to 95 percent standard proctor.

F. Maintain optimum moisture content of bedding material to attain required compaction density.

3.04 PATCHING

A. To minimize shrinkage, mix and place patching mixture to match color and texture of surrounding concrete.

B. Demonstrate patching method and obtain acceptance and approval.

3.05 CLEANING

A. After installation, clean soiled precast concrete surfaces with detergent and water, using fiber brush and sponge.

B. Use acid solution only to clean particularly stubborn stains after more conservative methods have been tried unsuccessfully.

C. Use extreme care to prevent damage to precast concrete surfaces and to adjacent materials.

D. Rinse thoroughly with clean water immediately after using cleaner.

3.06 FIELD QUALITY CONTROL

A. Inspection:

1. With Engineer, inspect precast architectural wall panels for chips, cracks, discoloration, and other damage.
2. Compare every panel to approved mockup panel and finish sample panel.
3. Record location and condition of damaged or nonmatching panels.

B. Resolution:

1. Repair damage to satisfaction of Engineer and Owner.
2. Remove panels with damage or repairs not acceptable to Engineer.
3. Install new acceptable panels in place of those removed.
4. Perform reinspection and obtain acceptance by Engineer.

3.07 PROTECTION

A. Protect precast units from chipping, spalling, cracking, or other damage to the units after delivery to Site.

B. After erection, protect units from damage.

END OF SECTION

SECTION 03 62 00
NONSHRINK GROUTING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   b. C621, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrinkable).
   c. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   d. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.02 SUBMITTALS

A. Action Submittals:

1. Product data of grouts.
2. Proposed method for keeping existing concrete surfaces wet prior to placing grout.
3. Forming method for fluid grout placements.
4. Curing method for grout.

B. Informational Submittals:

1. Manufacturer's Written Instructions:
   a. Adding fiber reinforcing to batching.
   b. Cement-water ratio of grout topping.
   c. Mixing of grout.
2. Manufacturer's proposed training schedule for grout work.
3. Manufacturer's Certificate of Compliance:
   a. Grout free from chlorides and other corrosion-causing chemicals.
   b. Nonshrink grout properties of Category II and Category III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
4. Manufacturer's Certificate of Proper Installation.
5. Statements of Qualification: Nonshrink grout manufacturer's representative.

6. Test Reports:
    a. Test report for 24-hour evaluation of nonshrink grout.
    b. Test results and service report from demonstration and training session.
    c. Field test reports and laboratory test results for field-drawn Samples.

1.03 QUALIFICATIONS

A. Nonshrink Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.

B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Nonshrink Grout Test Form. Independent testing laboratory to certify that testing was conducted within last 18 months.

1.04 GUARANTEE

A. Manufacturer's guarantee shall not contain disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and materials furnished.

B. Manufacturer guarantees participation with Contractor in replacing or repairing grout found defective as a result of faulty materials, as determined by industry standard test methods.

PART 2 PRODUCTS

2.01 NONSHRINK GROUT SCHEDULE

A. Furnish nonshrink grout for applications in grout category in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Filling tie holes	I	I	I
Blockouts for gate guides	I or II		II
Precast joints	I or II		II
Column baseplates single-story	I or II		II

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Machine bases 25 hp or less	II	II	II
Bases for precast wall sections	II	II	II
Baseplates for columns over one story	II	II	II
Precast base joints higher than one story	II	II	II
Through-bolt openings	II	II	II
Machine bases 26 hp and up	III	III	III
Baseplates and/or soleplates with vibration, thermal movement, etc.	III	III	III

2.02 NONSHRINK GROUT

A. Category I:

1. Nonmetallic and nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Test in accordance with ASTM C1107/C1107M:
   a. Grout shall have flowable consistency.
   b. Flowable for 15 minutes.
4. Grout shall not bleed at maximum allowed water.
5. Minimum strength of flowable grout, 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.
6. Manufacturers and Products:
   a. BASF Building Systems, Inc., Shakopee, MN; Construction Grout.
   b. Euclid Chemical Co., Cleveland, OH; NS Grout.
   c. Dayton Superior Corp., Kansas City, KS; 1107 Advantage Grout.
   d. US MIX Co., Denver, CO; US Spec MP Grout.
   e. L & M Construction Chemicals, Inc., Omaha, NE; Duragrout.

B. Category II:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
    a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
    b. Temperatures of 40 degrees F, 80 degrees F, and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 to 9 yard loads in ready-mix truck.
8. Manufacturers and Products:
    a. BASF Building Systems, Inc., Shakopee, MN; Master Flow 928.
    b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
    c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
    d. Dayton Superior Corp., Kansas City, KS; Sure Grip High Performance Grout.
    e. L & M Construction Chemicals, Inc., Omaha, NE; Crystex.

C. Category III:

1. Metallic and nongas-liberating.
2. Prepackaged aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
    a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
    b. Temperatures of 40 degrees F and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 to 9 yard loads in ready-mix truck.
8. Manufacturer and Product:
    a. BASF Building Systems, Inc., Shakopee, MN; EMBECO 885.
    b. L & M Construction Chemicals, Inc., Omaha, NE; Ferrogrout.

PART 3 EXECUTION

3.01 NONSHRINK GROUT

A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's representative's training instructions.

B. Form Tie or Through-Bolt Holes: Provide nonshrink grout, Category I and Category II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes; coordinate dry pack dense grout application with vinyl plug in Section 03 10 00, Concrete Forming and Accessories, and bonding agent in Section 03 30 00, Cast-in-Place Concrete.

C. Grouting Machinery Foundations:

1. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material.
2. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts.
3. Form with watertight forms at least 2 inches higher than bottom of plate.
4. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.

3.02 FIELD QUALITY CONTROL

A. Evaluation and Acceptance of Nonshrink Grout:

1. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
2. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Use restraining caps for cube molds in accordance with ASTM C1107/C1107M.
3. For large grout applications make three additional cubes and one more flow cone test. Include bleed test for each additional 25 cubic feet of nonshrink grout placed.
4. Consistency: As specified in Article Nonshrink Grout. Grout with consistencies outside range requirements shall be rejected.
5. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
6. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
7. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.

8. Perform bleeding test to demonstrate grout will not bleed.
9. Store cubes at 70 degrees F.
10. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.

3.03 MANUFACTURER'S SERVICES

A. General:

1. Coordinate demonstrations, training sessions, and applicable Site visits with grout manufacturer's representative.
2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of nonshrink grout.
3. Necessary equipment and materials shall be available for demonstration.

B. Training:

1. Training is required for all Type II and Type III grout installations.
2. Grout manufacturer's representative shall train Contractor to perform grout work.
3. Establish location at Site and schedule time for grout manufacturer's demonstration and training session of proposed nonshrink grouts. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, such as, baseplates and tie holes to provide actual on-the-job training.
4. Use minimum of three bags for each grout Category II and Category III. Mix grout to fluid consistency and conduct flow cone and two bleed tests, make a minimum of six cubes for testing of two cubes at 1 day, 3 days, and 28 days. Use remaining grout for final Work.
5. Training shall include methods for curing grout.
6. Transport test cubes to independent test laboratory and obtain test reports.

END OF SECTION

SECTION 03 64 23
CRACK REPAIR EPOXY INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): T237, Standard Method of Test for Testing Epoxy Resin Adhesive.
2. American National Standards Institute (ANSI).
3. ASTM International (ASTM):
   a. C882, Standard Specification for Test Method for Bond Strength of Epoxy-Resin System Used with Concrete by Slant Shear.
   b. D570, Standard Test Method for Water Absorption of Plastics.
   c. D638, Standard Test Method for Tensile Properties of Plastics.
   d. D648, Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
   e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
   f. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.02 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Crack Injection: Method of sealing or repairing cracks by injecting a polymer.

C. Large Cracks: Wider than 0.015 inch.

D. Small Cracks: Width equal to 0.015 inch or less.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for epoxy adhesives.
2. Technical data for metering, mixing, and injection equipment.

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for epoxy adhesives.
2. Installation instructions for repairing core holes with epoxy grout.
3. Manufacturer's Certificate of Compliance, in accordance with General Conditions. Certified test results for each batch of epoxy adhesive.
4. Statements of Qualification for Epoxy Adhesive:
   a. Manufacturer's Site representative.
   b. Injection applicator.
   c. Injection pump operating technician.
5. Epoxy adhesive two component ratio and injection pressure test records for concrete crack repair work.

1.04 QUALITY ASSURANCE

A. Qualifications for Epoxy Injection Staff:

1. Manufacturer's Site Representative:
   a. Capable of instructing successful methods for restoring concrete structures utilizing epoxy injection process.
   b. Understands and is capable of explaining technical aspects of correct material selection and use.
   c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
   a. Licensed and certified by epoxy manufacturer.
   b. Minimum 3 years' experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection including 2,000 linear feet of wet crack injection to stop water leakage.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Package adhesive material in new sealed containers and label with following information:

1. Manufacturer's name.
2. Product name and lot number.
3. ANSI Hazard Classification.
4. ANSI recommended precautions for handling.
5. Mix ratio by volume.

B. Storage and Protection: Store adhesive containers at ambient temperatures below 110 degrees F and above 45 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. BASF Building Systems, Shakopee, MN; SCB Concresive Series.
2. Sika Corp., Lyndhurst, NJ; Sikadur Series.
3. Euclid Chemical Co., Cleveland, OH; Euco Series.

2.02 EPOXY ADHESIVE

A. Two-component A and B structural epoxy adhesive for injection into cracks or other voids in concrete structures for bonding or grouting.

B. Adhesive Properties:

	Test Method	
7-day, Tensile Strength, psi	ASTM D638	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	1.0% min.
Compressive Yield Strength, 7 days @ 73°F, psi	ASTM D695[a]	8,000 min.
Compressive Modulus, psi	ASTM D695[a]	$1.5x10^5$ min.
Heat Deflection Temperature, °F	ASTM D648[a]	120 min.[a]
Water absorption @ 24 hours, Maximum %	ASTM D570	1.0
Bond Strength @ 2 days psi	ASTM C882	1,000 min.
Bond Strength @ 14 days psi	ASTM C882	1,500 min.
Slant Shear Strength: (5,000 psi Compressive Strength Conc.) *Where test results are available psi.*	AASHTO T237[b]	
Cured 3 days @ 40 deg F—Wet Concrete		3,500 min.
Cured 1 day @ 77 deg F—Dry Concrete		5,000 min.

	Test Method	
	Cured 3 days @ 77 deg ± 3 deg F	5,000 min.

[a]Cure test specimens so that peak exothermic temperature of adhesive does not exceed 100°F.

[b]See referenced specifications for preparation method of test specimens.

2.03 SURFACE SEAL

A. Sufficient strength and adhesion for holding injection fittings firmly in place, and to resist pressures preventing leakage during injection.

B. Capable of removal after injection adhesive has cured.

2.04 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of adhesive.

B. Pot Life Test:

1. Condition Components A and B to required temperature.
2. Measure components in ratio of Component B as stated on manufacturer's label into an 8-fluid ounce paper cup.
3. Start stopwatch immediately and mix components for 60 seconds using wooden tongue depressor, take care to scrape sides and bottom of cup periodically.
4. Probe mixture once with tongue depressor every 30 seconds, starting 2 minutes prior to minimum specified pot life.
5. Pot Life Definition: Time at which a soft stringy mass forms in center of cup.

C. Fabrication of Slant Shear Specimens for Testing Bond of Injectable Adhesives to Wet Concrete at 40 Degrees F:

1. Scope: Test method for preparation of diagonal concrete mortar blocks used in determining slant shear strength of low viscosity injectable adhesives in accordance with AASHTO T237 when concrete is wet.
2. Materials:
   a. Diagonal concrete mortar blocks prepared in accordance with AASHTO Test Method T237 and cured to produce a mortar with compressive strength of 5,000 psi or greater.
   b. Paraffin wax.

c. Masking Tape: 3/4 inch wide.
d. Suitable 20-mil-thick shim stock.

3. Preparation:
   a. Place a 20-mil shim between diagonal faces of two blocks and align so ends and sides are square.
   b. Bind block with masking tape covering gap between blocks.
   c. Leave a gap between blocks on one face uncovered for removal of shim and application of adhesive.
   d. Paint melted paraffin wax over masking tape.
   e. Shallow dam may be built up around opening using paraffin wax or modeling clay to help retain adhesive.
   f. Apply suitable capping compound to each end of specimen producing smooth surfaces perpendicular to longitudinal axis of block.
   g. Remove shim stock from gap opening.
   h. Soak specimen in water at 40 degrees F, plus or minus 3 degrees F for at least 24 hours.
   i. After soaking, remove specimen, shake free water from surface and gap opening.
   j. Prepare liquid adhesive.
   k. Within 5 minutes after removing specimen from water, start flowing adhesive into crack without entrap air bubbles.
   l. Place specimen in 40 degrees F, plus or minus 3 degrees F ambient for curing within 15 minutes after removing specimen from water for bonding. Do not expose specimen to temperatures beyond 77 degrees F during the 15-minute period.
   m. Cure specimen for 72 hours, plus or minus 4 hours at 40 degrees F, plus or minus 3 degrees F.

PART 3 EXECUTION

3.01 GENERAL

A. Structurally repair cracks in structures as specified in Section 03 30 00, Cast-in-Place Concrete.

B. Cracks:

1. Repair by injection of epoxy adhesive.
2. Repair cracks where specified or as shown.

3.02 PREPARATION

A. Free cracks from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks in accordance with epoxy adhesive manufacturer's instructions.

C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of surface seal system.

D. Do not use acids and corrosives for cleaning, unless neutralized prior to injecting epoxy.

3.03 APPLICATION

A. Sealing: Apply surface seal in accordance with manufacturer's instructions to designated crack face prior to injection. Seal surface of crack to prevent escape of injection epoxy.

B. Entry Ports:

1. Establish openings for epoxy entry in surface seal along crack.
2. Determine space between entry ports equal to thickness of concrete member to allow epoxy to penetrate to the full thickness of the wall.
3. Provide a means to prevent concrete dusts and fines from contaminating the crack or ports when drilling.
4. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
   a. Cracks extend entirely through wall.
   b. Backfill of walls on one side.
   c. Difficult to excavate behind wall to seal both crack surfaces.
5. Core drill to verify epoxy depth where only one side of wall is exposed.

C. Epoxy Injection:

1. Store epoxy at minimum of 70 degrees F.
2. Start injection into each crack at lowest elevation entry port.
3. Continue injection at first port until adhesive begins to flow out of port at next highest elevation.
4. Plug first port and start injection at second port until adhesive flows from next port.
5. Inject entire crack with same sequence.

D. Finishing:

1. Cure epoxy adhesive after cracks have been completely filled to allow surface seal removal without draining or runback of epoxy material from cracks.
2. Remove surface seal from cured injection adhesive.
3. Finish crack face flush with adjacent concrete.
4. Indentations or protrusions caused by placement of entry ports are not acceptable.
5. Remove surface seal material and injection adhesive runs and spills from concrete surfaces.

3.04 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter and mix two adhesive components, and inject mixture into crack.

B. Pumps:

1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.
2. Primary injection pumps for each material of different mix ratio, including a standby backup pump of similar ratio.
3. Capable of immediate compensation for changes in resins.
4. Do not use batch mix pumps.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed adhesive at pressures up to 200 psi, plus or minus 5 percent, and able to maintain pressure.

D. Automatic Shutoff Control: Provide sensors on both Component A and B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance: Maintain epoxy adhesive manufacturer’s prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 160 psi.

F. Ratio/Pressure Check Device:

1. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.
2. Pressure gauge capable of sensing pressure behind each valve.

3.05 FIELD QUALITY CONTROL

A. Epoxy Adhesive Two Component Ratio Tests:

1. Disconnect mixing head and pump two adhesive components simultaneously through ratio check device.
2. Adjust discharge pressure to 160 psi for both adhesive components.
3. Simultaneously discharge both adhesive components into separate calibrated containers.
4. Compare amounts simultaneously discharged into calibrated containers during same time period to determine mix ratio.
5. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.
6. Run ratio test for each injection unit at beginning and end of each injection work day, and when injection work has stopped for more than 1 hour.
7. Document and maintain complete accurate records of, ratios and pressure checks.

B. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect two adhesive component delivery lines to pressure check device.
2. Pressure Check Device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure test for each injection equipment unit:
   a. Beginning and end of each injection work day.
   b. When injection work is stopped for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

C. Crack Injection Tests:

1. Initial Cores:
   a. 4-inch diameter for full crack depth taken from Engineer selected locations.

b. Take three cores in first 100 linear feet of crack repaired and one core sample for each 500 linear feet thereafter.

2. Provide suitable containers for storage, curing, and transportation of test specimens.
3. Methods of Testing Cores:
   a. Penetration: Visual examination.
   b. Bond Strength/Compression Test: Concrete failure prior to adhesive failure.
4. Test Requirements:
   a. Penetration: Minimum of 90 percent of crack shall be full of epoxy adhesive.
   b. Bond Strength/Compression Test: Concrete failure before adhesive failure, or 6,500 psi with no failure of either concrete or adhesive.
5. Evaluation and Acceptance of Tests:
   a. If initial cores pass tests as specified, epoxy adhesive injection Work at area represented by cores will be accepted.
   b. If initial cores fail either by lack of penetration or bond strength, crack repair Work shall not proceed further until areas represented by cores are reinjected or repaired and retested for acceptance.
   c. Obtain verifying core samples, number and location as selected by Engineer, after rework of areas represented by failed initial cores is complete.
6. Core Hole Repair:
   a. Correct Work as result of testing upon notification from Engineer.
   b. Refill initial and verifying core holes with an epoxy grout tamped and rodded in-place to form a dense fill.
   c. Finish surface to blend with adjacent concrete.

END OF SECTION

SECTION 04 10 00
MORTAR AND MASONRY GROUT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes mortar and grout for masonry.

B. Related Sections: Section 04 30 00, Unit Masonry System.

1.02 REFERENCES

A. The following is a list of standards which many be referenced in this Section:

1. ASTM International (ASTM):
   a. C91, Standard Specification for Masonry Cement.
   b. C94, Standard Specification for Ready-Mixed Concrete.
   c. C144, Standard Specification for Aggregate for Masonry Mortar.
   d. C150, Standard Specification for Portland Cement.
   e. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   f. C270, Standard Specification for Mortar for Unit Masonry.
   g. C404, Standard Specification for Aggregates for Masonry Grout.
   h. C476, Standard Specification for Grout for Masonry.
   i. C1357, Standard Test Methods for Evaluating Masonry Bond Strength.
   j. E514, Standard Test Method for Water Penetration and Leakage through Masonry.

1.03 SUBMITTALS

A. Include design mix, required environmental conditions, and admixture limitations.

B. Submit two samples of mortar illustrating mortar color and color range.

C. Submit resteel shop drawings for all reinforced concrete on project.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland Cement: ASTM C150, Type I, gray color.

B. Masonry Cement: ASTM C91, gray color.

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

D. Hydrated Lime: ASTM C207, Type S.

E. Grout Coarse Aggregate: ASTM C404.

F. Water: Clean and potable.

G. Bonding Agent: Latex type.

H. Integral Water-Repellent Admixture:

1. Description: An integral liquid polymeric admixture for mixing with mortar mix, which cross links and becomes permanently locked into mortar to provide resistance to water penetration.
2. Physical Properties:
   a. Water Permeance: ASTM E514, achieves Class E rating with no water visible on back of wall above flashing at end of 72 hours, and no more than 25 percent of wall area above flashing damp at end of 3 days, and no leaks (a leak is a flow of water from flashing at a rate equal to or greater than 0.0132 gallons per hour) through wall at end of 1 day.
   b. Flexural Bond Strength of Masonry: No decrease in masonry flexural bond strength shall occur as a result of adding integral water-repellent CMU and mortar admixtures when compared to a control CMU and mortar (containing no admixtures) tested according to ASTM C1357.
   c. Water Mixability: Fully dispersible in water.
   d. Specific Gravity: Minimum 1.0.
3. Manufacturers and Products:
   a. Grace Construction Products; Dry-Block.
   b. ACM Chemistries, Inc.; RainBloc.
   c. Axim Concrete Technologies; Intrapel NS.

2.02 MORTAR COLOR

A. Mortar Color: Mineral oxide pigment; color as selected by Owner.

2.03 MORTAR MIXES

A. Mortar for Load Bearing Walls and Partitions, and Non-Load Bearing Walls and Partitions, and Reinforced Masonry: ASTM C270, Type S using the Proportion Specification and the following proportions by volume:

Mortar	Portland Cement	Type S Masonry Cement	Hydrated Lime	Sand
Cement-lime	1	--	3/8	3-1/8 to 4-1/8
Masonry cement	--	1	--	2-1/4 to 3

2.04 MORTAR MIXING

A. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use. Air content shall not exceed 14 percent.

B. Maintain sand uniformly damp immediately before the mixing process.

C. Add mortar color and admixtures in accordance with manufacturer's instructions. Provide uniformity of mix and coloration.

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

E. If water is lost by evaporation, re-temper only within 2 hours of mixing.

F. Use mortar within 2 hours after mixing at temperatures above 90 degrees F, or 2-1/2 hours at temperatures under 50 degrees F.

2.05 GROUT MIXES

A. Bond Beams Lintels: 3,000 psi strength at 28 days; 8 to 10 inches slump; pre-mixed type in accordance with ASTM C94.

B. Reinforced Masonry: 3,000 psi strength at 28 days; 8 to 10 inches slump; pre-mixed type in accordance with ASTM C94.

2.06 GROUT MIXING

A. Mix large quantity grout in accordance with ASTM C94 (Transit Mix).

B. Thoroughly mix grout ingredients for small quantities needed for immediate use in accordance with ASTM C476 (site mix).

C. Add admixtures in accordance with manufacturer's instructions; mix uniformly.

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

PART 3 EXECUTION

3.01 EXAMINATION

A. Request inspection of spaces to be grouted.

3.02 PREPARATION

A. Apply bonding agent to existing concrete surfaces.

B. Plug clean-out holes with brick or block masonry units. Brace masonry for wet grout pressure.

3.03 INSTALLATION

A. See Section 04 30 00, Unit Masonry System.

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

C. Do not install grout in lifts greater than 16 inches without consolidating grout by rodding.

D. Do not displace reinforcement while placing grout.

E. Remove excess mortar from grout spaces.

END OF SECTION

SECTION 04 30 00
UNIT MASONRY SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes concrete masonry units, brick, reinforcement, anchorage, and accessories.

B. Related Sections: Section 04 10 00, Mortar and Masonry Grout.

C. Reinforcement, anchorage, and accessories.

1.02 REFERENCES

A. The following is a list of standards which many be referenced in this Section:

1. ASTM International (ASTM):
   a. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. A951/A951M, Standard Specification for Steel Wire for Masonry Joint Reinforcement.
   d. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   e. C140/C140M, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   f. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   g. C1314, Standard Test Methods for Compressive Strength of Masonry Prisms.
   h. C1357, Standard Test Methods for Evaluating Masonry Bond Strength.
   i. D2000, Standard Classification System for Rubber Products in Automotive Applications.
   j. D2287, Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
   k. E96, Standard Test Methods for Water Vapor Transmission of Materials.
   l. E514, Standard Test Method for Water Penetration and Leakage through Masonry.

1.03 SUBMITTALS

A. Submit samples showing manufacturer's standard custom colors for color selection.

B. Submit manufacturer's certification that products and materials meet or exceed specified requirements.

C. Submit four samples of block units to illustrate color, texture and extremes of color range for block units other than standard CMU.

1.04 REGULATORY REQUIREMENTS

A. Conform to applicable building and safety code for requirements for masonry construction.

1.05 DEFINITIONS

A. Grout Pour Height: The total height of masonry to be grouted prior to erection of additional masonry. A grout pour consists of one or more grout lifts.

B. Grout Lift: An increment of grout height within a total grout pour. A grout pour consists of one or more grout lifts.

1.06 DESIGN REQUIREMENTS

A. Compressive strength of masonry, f'm, shall be 1,500 psi.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Cold Weather Construction:

1. Implement the following requirements when:
   a. The ambient temperature falls below 40 degrees F, or;
   b. The temperature of masonry units is below 40 degrees F.
2. Do not lay masonry units having a temperature below 20 degrees F. Remove visible ice on masonry units before the unit is laid in the masonry.
3. Heat mortar sand or mixing water to produce mortar temperatures between 40 degrees F and 120 degrees F at the time of mixing. Maintain mortar above freezing until used in masonry.
4. When mean daily temperature is between 32 degrees F.

B. Hot Weather Construction: Implement approved, hot weather procedures and comply with the following provisions:

1. Preparation: Prior to conducting masonry work:
   a. When the ambient air temperature exceeds 100 degrees F, or exceeds 90 degrees F with a wind velocity greater than 8 mph:
      1) Maintain sand piles in a damp, loose condition.
      2) Provide necessary conditions and equipment to produce mortar having a temperature below 120 degrees F.
   b. When the ambient temperature exceeds 115 degrees F, or exceeds 105 degrees F with a wind velocity greater than 8 mph, implement the requirements of 1.a above and shade materials and mixing equipment from direct sunlight.
2. Construction: While masonry work is in progress:
   a. When the ambient air temperature exceeds 100 degrees F, or exceeds 90 degrees F with a wind velocity greater than 8 mph:
      1) Maintain temperature of mortar and grout below 120 degrees F.
      2) Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar ingredients or mortar.
      3) Maintain mortar consistency by re-tempering with cool water.
      4) Use mortar within 2 hours of initial mixing.
   b. When the ambient temperature exceeds 115 degrees F, or exceeds 105 degrees F with a wind velocity greater than 8 mph, implement the requirements of paragraph B.2.a above and use cool mixing water for mortar and grout. Ice is permitted in the mixing water prior to use. Do not permit ice in the mixing water when added to the other mortar or grout materials.
3. Protection: When the mean daily temperature exceeds 100 degrees F, or exceeds 90 degrees F with a wind velocity greater than 8 mph, fog-spray all newly constructed masonry until damp, at least three times a day until the masonry is 3 days old.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS (CMU)

A. Standard CMU at Building Shell: Hollow load bearing block units, except where indicated on Drawings to provide solid load bearing block units, ASTM C90, normal weight.

B. Split Face, Integral Color CMU at Retaining Wall: Hollow load bearing block units, except where indicated on Drawings to provide solid load bearing block units, ASTM C90, normal weight. Color similar to Trentwyth (Oldcastle Architectural) Trendstone Colors, MW Bone or as selected from manufacturer's standard colors and textures.

C. Integral Water-Repellent Admixture:

1. Description: An integral liquid polymeric admixture mixed with concrete during production of CMU, which cross links and becomes permanently locked into the CMU to provide resistance to water penetration.
2. Physical Properties:
   a. Water Permeance: ASTM E514, achieves Class E rating with no water visible on back of wall above flashing at end of 72 hours, not more than 25 percent of wall area above flashing damp at end of 3 days, and no leaks (a leak is a flow of water from flashing at a rate equal to or greater than 0.0132 gallons per hour) through wall at end of 1 day.
   b. Water Vapor Transmission: ASTM E96, passes.
   c. Flexural Bond Strength of Masonry: No decrease in masonry flexural bond strength shall occur as a result of adding integral water-repellent CMU and mortar admixtures when compared to a control CMU and mortar (containing no admixtures) tested according to ASTM C1357.
   d. CMU Sampling and Testing: ASTM C140, surpasses normal and medium weight CMU compressive for strength, absorption, weight, moisture content, and dimensional stability.
   e. Compressive Strength of Masonry Prisms: A maximum 5 percent decrease in compressive strength of prisms shall occur as a result of adding integral water-repellent CMU and mortar admixtures when compared to a control CMU and mortar (containing no admixtures) tested according to ASTM C1314.
   f. Water Mixability: Fully dispersible in water.
   g. Specific Gravity: Minimum 1.0.
   h. Manufacturers and Products:
      1) Grace Construction Products; Dry-Block.
      2) ACM Chemistries, Inc.; RainBloc.
      3) Axim Concrete Technologies; Intrapel NS.

D. Size and Shape: Nominal face size 8 inches by 16 inches, thickness as indicated. Provide special units for 90 degree corners, bond beams, and lintels. Standard open ended units are acceptable.

2.02 REINFORCEMENT

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade, deformed billet bars, uncoated finish.

2.03 MORTAR AND GROUT

A. Mortar and Grout: See Section 04 10 00, Mortar and Masonry Grout.

2.04 FLASHINGS

A. Copper/Fabric Flashings: 5 ounces per square foot sheet, copper-bonded on both sides to asphalt- coated glass fabric; York Copper Fabric Flashing manufactured by York Manufacturing, Inc., or as approved.

B. Lap Sealant: Asphalt mastic as instructed by manufacturer.

2.05 ACCESSORIES

A. Preformed Control Joints: Rubber conforming to ASTM D2000 or polyvinyl chloride conforming to ASTM D2287. Provide with corner and tee accessories, cement-fused joints, sized for thickness of wall.

1. Manufacturer:
   a. Hohman & Barnard, Inc.
   b. Or as approved.

B. Joint Filler: Closed-cell polyurethane or rubber; oversized 50 percent to joint width.

C. Weeps: Pre-formed plastic tube or pipe, 4-inch nominal diameter minimum.

1. Manufacturer and Product:
   a. Hohman & Barnard, Inc., Model 341.
   b. Or as approved.

D. Joint Sealant: Follow Section 07 92 00, Joint Sealants.

E. Cleaning Solution: Nonacidic, not harmful to masonry work or adjacent materials.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive Work.

B. Verify items provided by other Sections of Work are properly sized and located.

C. Verify that built-in items are in proper location and ready for roughing into masonry work.

3.02 PREPARATION

A. Direct and coordinate placement of metal anchors supplied to other Sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

C. Provide temporary covers and enclosures if cold weather conditions (less than 35 degrees F) exist.

3.03 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Concrete Masonry Units:

1. Bond: Running.
2. Coursing: One unit and one mortar joint to equal 8 inches.
3. Mortar Joints: Concave.

3.04 PLACING AND BONDING

A. Lay hollow masonry units with face shell bedding on head and bed joints.

B. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.

C. Remove excess mortar as Work progresses.

D. Interlock intersections and external corners.

E. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

F. Perform jobsite cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

G. Cut mortar joints flush where rigid insulation is scheduled, cement parging is required, resilient base is scheduled, cavity insulation vapor barrier adhesive is applied, or bitumen damp-proofing is applied.

H. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.05 WEEPS

A. Install weeps in wall where indicated on Drawings.

3.06 CAVITY WALL

A. Do not permit mortar to drop or accumulate into cavity air space or to plug weeps.

3.07 MASONRY FLASHINGS

A. Extend flashings horizontally at foundation walls, above ledge or shelf angles and lintels, at bottom of walls, and where otherwise shown. Finish flush with exterior surface.

B. Turn flashing up minimum 8 inches and bed into mortar joint of masonry backup.

C. Lap end joints minimum 6 inches and seal water-tight.

D. Turn flashing, fold, and seal at corners, bends, and interruptions.

3.08 GROUTED COMPONENTS

A. Reinforce bond beam with two No. 5 bars 1 inch from bottom web.

B. Lap splices minimum 48 bar diameters.

C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.

D. Place and consolidate grout fill without displacing reinforcing.

E. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening, and 16 inches below bearing elevation.

3.09 REINFORCED MASONRY

A. Lay masonry units with core cells vertically aligned and cavities between wythes clear of mortar and unobstructed.

B. Place mortar in masonry unit bed joints back 1/4 inch from edge of unit grout spaces, bevel back and upward. Permit mortar to cure 24 hours before placing grout.

C. Reinforce masonry unit cores and cavities with reinforcement bars and grout as indicated.

D. Retain vertical reinforcement in position at top and bottom of cells and at intervals not exceeding 192 bar diameters.

E. Do not wet masonry unit surfaces in contact with grout prior to grout placement.

F. Grout spaces less than 2 inches in width with fine grout using low lift grouting techniques. Grout spaces 2 inches or greater in width with coarse grout using high or low lift grouting techniques.

G. When grouting is stopped for more than 1 hour, terminate grout 1-1/2 inches below top of upper masonry unit to form a positive key for subsequent grout placement.

H. The maximum grout lift height shall be 5 feet.

I. Consolidate grout pours 12 inches or less in height by mechanical vibration.

J. Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.

K. Maximum grout pour height shall be determined by the minimum grout space dimensions (dimensions shall ignore presence of reinforcement):

Grout Type	Minimum Grout Space Dimensions for Grouting Cells of Hollow Units (Inch by Inch)	Maximum Grout Pour Height (Feet)
Fine	1-1/2 by 2	1
Fine	2 by 3	5
Fine	2-1/2 by 3	12
Fine	3 by 3	24
Coarse	1-1/2 by 3	1
Coarse	2-1/2 by 3	5
Coarse	3 by 3	12
Coarse	3 by 4	24

3.10 CONTROL JOINTS

A. Do not continue horizontal joint reinforcement through control joints.

B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

3.11 BUILT-IN WORK

A. As Work progresses, install built-in metal door frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, plates, and other items to be built in the Work and furnished by other Sections.

B. Install built-in items plumb and level.

C. Bed anchors of metal door frames in adjacent mortar joints. Fill frame voids solid with grout.

D. Do not build in organic materials subject to deterioration.

3.12 TOLERANCES

A. Maximum Variation from Unit to Adjacent Unit: 1/16 inch.

B. Maximum Variation from Plane of Wall: 1/4 inch in 10 feet, 3/8 inch in 20 feet; 1/2 inch maximum.

C. Maximum Variation from Plumb: 1/4 inch in 10 feet, 3/8 inch in 20 feet; 1/2 inch maximum.

D. Maximum Variation from Level Coursing: 1/8 inch in 3 feet and 1/4 inch in 10 feet; 1/2 inch maximum.

E. Maximum Variation of Mortar Joint Thickness:

1. Bed: Plus or minus 1/8 inch.
2. Head: Minus 1/4 inch, plus 3/8 inch.

F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.13 CUTTING AND FITTING

A. Cut and fit for chases, pipes, conduit, sleeves, grounds, and other items as required. Coordinate with other Sections of Work to provide correct size, shape, and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.14 CLEANING

A. Remove excess mortar and mortar smears as Work progresses.

B. Replace defective mortar. Match adjacent Work.

C. Clean soiled surfaces with cleaning solution appropriate for the type of stain or soil.

D. Use nonmetallic tools in cleaning operations.

3.15 PROTECTION OF FINISHED WORK

A. Without damaging completed Work, provide protective boards at exposed external corners which may be damaged by construction activities.

END OF SECTION

SECTION 05 05 23
WELDING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. BPVC SEC V, Nondestructive Examination.
   b. BPVC SEC IX, Welding and Brazing Qualifications.
2. American Society of Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.
3. ASTM International (ASTM): A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
4. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   b. A3.0, Standard Welding Terms and Definitions.
   c. D1.1/D1.1M, Structural Welding Code - Steel.
   d. D1.2/D1.2M, Structural Welding Code - Aluminum.
   e. D1.3/1.3M, Structural Welding Code - Sheet Steel.
   f. D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
   g. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
   h. QC1, Standard for AWS Certification of Welding Inspectors.

1.02 DEFINITIONS

A. CJP: Complete Joint Penetration.

B. CWI: Certified Welding Inspector.

C. MT: Magnetic Particle Testing.

D. NDE: Nondestructive Examination.

E. NDT: Nondestructive Testing.

F. PJP: Partial Joint Penetration.

G. PQR: Procedure Qualification Record.

H. PT: Liquid Penetrant Testing.

I. RT: Radiographic Testing.

J. UT: Ultrasonic Testing.

K. VT: Visual Testing.

L. WPQ: Welder/Welding Operator Performance Qualification.

M. WPS: Welding Procedure Specification.

1.03 SUBMITTALS

A. Shop Drawings:

1. Shop and field WPSs and PQRs.
2. NDT procedure specifications prepared in accordance with ASME BPVC SEC V.
3. Welding Data (Shop and Field): Submit welding data together with shop drawings as a complete package.
    a. Show on Shop Drawings or a weld map complete information regarding base metal specification designation, location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tails of combined welding and NDE symbols as indicated in AWS A2.4.
    b. Distinguish between shop and field welds.
    c. Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for welds.
    d. For pipe fittings, provide a joint weld beveling diagram. Refer to AWS D1.1/D1.1M, Annex P Local Dihedral Angle that can be used to calculate bevels for weld joint details of intersecting pipes.
    e. Welding and NDE symbols shall be in accordance with AWS A2.4.
    f. Welding terms and definitions shall be in accordance with AWS A3.0.

B. Informational Submittals:

1. WPQs.
2. CWI credentials.
3. Testing agency personnel credentials.
4. CWI reports.
5. Welding Documentation: Submit on forms in referenced welding codes.

1.04 QUALIFICATIONS

A. WPSs: In accordance with AWS D1.1/D1.1M (Annex N Forms) for shop or field welding; or ASME BPVC SEC IX (Forms QW-482 and QW-483) for shop welding only.

B. WPQs: In accordance with AWS D1.1/D1.1M (Annex N Forms); or ASME BPVC SEC IX (Form QW-484).

C. CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.

D. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.

1.05 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, Submittals required in this section shall be submitted and approved prior to commencement of welding operations.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. CWI shall be present whenever shop welding is performed. CWI shall perform inspection, as necessary, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verifying conformance of specified job material and proper storage.
2. Monitoring conformance with approved WPS.
3. Monitoring conformance of WPQ.
4. Inspecting weld joint fit-up and performing in-process inspection.
5. Providing 100 percent visual inspection of welds.
6. Supervising nondestructive testing personnel and evaluating test results.
7. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

PART 3 EXECUTION

3.01 GENERAL

A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in attached Article References.

B. Welding procedure specifications for pressure piping shall be qualified for notch toughness by limiting heat input. Charpy testing of weld metal and heat-affected zone shall be done as a part of the welding procedure qualification. Full-size specimens shall be charpy tested in accordance with ASTM A370 at a test temperature of 30 degrees F. The minimum average energy of the test coupons shall not be less than 25 foot-pounds.

3.02 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

A. Weld Inspection Criteria:

1. Selection of welds to be tested, unless 100 percent NDT as specified herein, shall be as agreed upon between Engineer and Contractor.
2. Unless otherwise specified, perform NDT of welds at a frequency as shown below and in accordance with referenced welding codes as follows. Perform UT on CJP groove welds that cannot be readily radiographed. In case there is a conflict, higher frequency level of NDT shall apply.
   a. CJP Groove, Butt Joint Welds: 10 percent random RT.
   b. All other CJP Groove Welds: 10 percent random UT.
   c. Fillet Welds and PJP Groove Welds: 50 percent random PT or MT.
   d. All Welds: 100 percent VT.
3. Weld Acceptance:
   a. VT:
      1) Structural Pipe and Tubing: AWS D1.1/D1.1M, Paragraph 6.9, Visual Inspection, Tubular Connections.
      2) All Other Structural Steel: AWS D1.1/D1.1M, Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.
      3) Stud Connections: AWS D1.1/D1.1M, Paragraph 7.8.1.
   b. UT: Perform on CJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.13.3, Class R Indications.
   c. RT: Perform on CJP butt joint welds in accordance with AWS D1.1/D1.1M, Paragraph 6.12.1.

d. PT or MT:
   1) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.10.
   2) Acceptance shall be in accordance with VT standards specified above.

3.03 FIELD QUALITY CONTROL

A. CWI shall be present whenever field welding is performed. CWI shall perform inspection, as necessary, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verify conformance of specified job material and proper storage.
2. Monitor conformance with approved WPS.
3. Monitor conformance of WPQ.
4. Inspect weld joint fit-up and perform in-process inspection.
5. Provide 100 percent visual inspection of all welds.
6. Supervise nondestructive testing personnel and evaluating test results.
7. Maintain records and prepare report confirming results of inspection and testing comply with the Work.

3.04 WELD DEFECT REPAIR

A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Galvanizers Association (AGA): Quality Assurance Manual.
2. American Institute of Steel Construction (AISC):
   a. 303, Code of Standard Practices for Steel Buildings and Bridges.
   b. 325, Steel Construction Manual.
   c. 341, Seismic Provisions for Structural Steel Buildings.
   d. 360, Specification for Structural Steel Buildings.
   e. AISC Quality Certification Program.
   f. AISC Erector Certification Program.
3. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code—Steel.
4. ASTM International (ASTM):
   a. A6/A6M, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   b. A36/A36M, Standard Specification for Carbon Structural Steel.
   c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   d. A123/123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   e. A143/A143M, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   f. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   g. A307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   h. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   i. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
   j. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
   k. A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.

l. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
m. A563, Standard Specification for Carbons and Alloy Steel Nuts.
n. A572/A572M, Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel.
o. A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
p. A992/A992M, Standard Specification for Structural Steel Shapes.
q. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
r. F436, Standard Specification for Hardened Steel Washers.
s. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
t. F1852, Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

5. Occupational Safety and Health Administration (OSHA).
6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using ASTM A325 or ASTM A490 Bolts.

1.02 SUBMITTALS

A. Action Submittals:

1. Provide Shop Drawing details showing:
   a. Erection plans.
   b. Members, including piece numbers, sizes, grades, dimensions, cambers, and connection details.
   c. Anchor bolt layouts.
   d. Hardened washer details.
   e. Joint details for complete penetration welds.
2. Product specifications, including primer and other coatings.
3. Designation of the members and connections that are part of the seismic load resisting system (SLRS).
4. Connection material specifications.
5. Location of demand critical shop welds.
6. Locations and dimensions of protected zones.
7. Gusset plates drawn to scale when they are detailed to accommodate inelastic rotation.
8. Welding requirements as specified in AISC 341 Appendix W, Section W2.2.

B. Informational Submittals:

1. Schedule for submittal of shop and erection drawings.
2. Name and address of manufacturer(s).
3. Mill Certificates of tests made in accordance with ASTM A6/A6M.
4. Manufacturers' testing procedures and standards.
5. Preparation and installation or application instructions, as appropriate.
6. Proposed method to resolve misalignment between anchor bolts and bolt holes in steel members.
7. Provide ICC-ES or other similar building code organization recommendations regarding safe allowable design loads for expansion anchors.
8. High-Strength Bolts (Plain Noncoated and Hot-Dip Galvanized):
    a. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed) that products meet specified chemical and mechanical requirements.
    b. Manufacturer's inspection test report results for production lot(s) furnished, to include:
        1) Tensile strength.
        2) Yield strength.
        3) Reduction of area.
        4) Elongation and hardness.
    c. Certified Mill Test Reports for Bolts and Nuts:
        1) Name and address of manufacturer.
        2) Bolts correctly marked.
        3) Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.
9. Direct Tension Indicators (DTIs): Manufacturer's test report meeting requirements of ASTM F959.
10. Tension Control (TC) Bolts: Manufacturer's test report meeting requirements of ASTM A325 and ASTM F1852.
11. Welding Procedures, Qualifications, and Inspection Reports: As specified in Section 05 05 23, Welding.
12. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer with description of material processed and ASTM standard used for coating.
13. AISC Quality Certification: AISC certificate showing name and address of certified firm, effective date, and category of certification; or, for erectors, documentation of similar project experience to include Project name, location, date of completion, and name and phone number of Owner's contact person.
14. Charpy V-notch test results.

15. Nondestructive Testing (NDT) report.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Welding qualifications as specified in Section 05 05 23, Welding.
2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of AGA's Quality Assurance Manual.

B. Certifications:

1. Mill identification marks, heat number, size of section, and length in accordance with ASTM A6/A6M.
2. AISC Quality Certification for Fabricator: Standard for Steel Building Structures (STD).

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.

B. Storage:

1. Protect structural steel members and packaged materials from corrosion and deterioration.
2. Store in dry area and not in direct contact with ground.
3. Protect fasteners from dirt and moisture. Do not remove lubricant from bolts and nuts.

C. Handle materials to avoid distortion or damage to members or supporting structures.

PART 2 PRODUCTS

2.01 MATERIALS

A. Rolled Plates, Shapes except W-Shapes and Bars: ASTM A36/A36M or A572/A572M, Grade 50, unless indicated otherwise.

B. W-Shapes: ASTM A992/A992M, unless indicated otherwise on Drawings.

C. Steel Pipe: ASTM A53/A53M, Grade B.

D. Round Hollow Structural Sections (HSS): ASTM A500/A500M, Grade B (Fy equals 42 ksi).

E. Square and Rectangular Hollow Structural Sections (HSS): ASTM A500/A500M, Grade B (Fy equals 46 ksi).

F. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon, such as plates over 1.5 inches thick for ASTM A36/A36M and ASTM A572/A572M steels, limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.

2.02 FASTENERS

A. Anchor Bolts: As specified in Section 05 50 00, Metal Fabrications.

B. High-Strength Bolts:

1. ASTM A325 or ASTM A490, as required for fit, bolt Type 1, plain uncoated.
2. Bolt Length and Thread Length: As required for connection type shown, with hardened washers as required.

C. Direct Tension Indicators (DTIs) or Load Indicator Washers:

1. ASTM F959, coating type to match bolt finish.
2. Type A325 or A490, to match bolt type.
3. Manufacturers and Products:
    a. TurnaSure LLC, Langhorne, PA; DTIs.
    b. Applied Bolting Technology Products, Ludlow, VT; DTIs, regular or Squirter type.

D. Tension Control (TC) Bolts:

1. High-strength, ASTM A325 and ASTM F1852.
2. Manufacturers:
    a. LeJeune Bolt Company, Burnsville, MN.
    b. Nucor Fastener, Saint Joe, IN.
    c. Haydon Bolts, Philadelphia, PA.
    d. Vermont Fasteners Manufacturing, Swanton, VT.

E. Nuts: ASTM A563, type to match bolt type and finish.

F. Hardened Steel Flat and Beveled Washers: ASTM F436, type to match bolt finish.

G. Welded Shear Studs: As specified in Section 05 50 00, Metal Fabrications.

2.03 ANCILLARY MATERIALS

A. Surface Preparation and Primer: As specified in Section 09 90 00, Painting and Coating.

B. Grout: As specified in Section 03 62 00, Nonshrink Grouting.

2.04 FABRICATION

A. General:

1. Fabricate as shown and in accordance with AISC 360 and AISC 303.
2. Columns shall be full length members without splices, unless shown otherwise or approved by Engineer.
3. Mark and match mark materials for field assembly.
4. Complete assembly, including bolting and welding of units, before start of finishing operations.
5. Fabricate to agree with field measurements.
6. Sheared and flame-cut edges shall be free from rough corners and projections.

B. Connections:

1. Shop Connections: Weld or bolt as shown on Drawings.
2. Meet requirements of AISC 325 for bolted double-angle shear connections, unless indicated otherwise.
3. Meet OSHA requirements for one independent bolt at beams framing in to column web connections.
4. Provide oversized holes for anchor bolts in column baseplate in accordance with AISC 325, unless indicated otherwise.

C. Welded Construction:

1. As specified in Section 05 05 23, Welding.
2. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.

D. Preheating of Heavy Shapes and Plates:

1. For ASTM A6/A6M, steel shapes and plates thicker than 2 inches.
2. Minimum Preheat Temperature:
   a. Groove Weld Splices: 350 degrees F.

E. Interface with Other Work:

1. Holes:
   a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members shall be approved by Engineer.
   b. No flame-cut holes are permitted without prior approval of Engineer.
2. Weld threaded nuts to framing members, and other specialty items to receive other Work.

2.05 FINISHES

A. Shop Paint Primer:

1. Surface Preparation and painting as specified in Section 09 90 00, Painting and Coating, for all members not indicated otherwise on Drawings.
2. Do not shop prime the following surfaces, unless indicated otherwise:
   a. Faying surfaces of slip critical bolted connections.
   b. Within 2 inches of field-welded connections.
   c. Steel members to be completely encased in reinforced concrete or coated with cementitious fireproofing.
3. Apply shop primer to top flange surfaces of composite steel beams, unless indicated otherwise.
4. Shop primer for steel members to be coated with intumescent fireproofing shall be compatible with specified fireproofing.

B. Galvanizing:

1. Fabricate steel members to be galvanized, as indicated on drawings, in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of steel.
2. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.

3. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in galvanizing operation.
4. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
5. Hot-dip galvanize ASTM A325 bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop-assemble bolts, nuts, and washers with special lubricant and test in accordance with ASTM A325 and ASTM A563.
6. Mechanically zinc coat tension-control (TC) bolts, nuts, and washers in accordance with ASTM F1852 and ASTM B695, Class 50.
7. Galvanize components of bolted assemblies separately before assembly.

C. Slip Critical Bolted Connections:

1. Mask faying surfaces of slip critical (SC) bolted connections to be shop painted as specified in Section 09 90 00, Painting and Coating.
2. Roughen galvanized faying surfaces with hand wire brushing.

D. Fully Tensioned Bolted Connections:

1. Provide Class A faying surface. Mask faying surfaces of fully tensioned (FT) bolted connections to be shop painted as specified in Section 09 90 00, Painting and Coating.
2. Exclude threads from shear plane, unless approved by Engineer.

2.06 SOURCE QUALITY CONTROL

A. Charpy V-notch test for ASTM A6/A6M shapes with flanges 1-1/2 inches thick and thicker, or built up cross section consisting of plates with thickness exceeding 2 inches, in accordance with the following:

1. ASTM A6/A6M, Supplementary Requirement S30.
   a. Minimum average value of 20 foot-pounds absorbed energy at 70 degrees F.
   b. Tested in alternate core location.
2. Charpy V-notch test for ASTM A6/A6M shapes with flanges 2 inches thick and thicker, in accordance with the following:
   a. ASTM A6/A6M, Supplementary Requirement S30.
   b. Minimum average value of 20 foot-pounds absorbed energy at 70 degrees F.
   c. Tested in the alternate core location.

B. Welding:

1. Visually inspect fabrication welds in accordance with AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. An independent testing agency will be retained by Owner to perform the following inspection and testing of fabrication welds as specified in Section 05 05 23, Welding.
   a. Groove welds:
      1) Radiographic (RT) or ultrasonic (UT) testing for 10 percent of randomly selected welds, unless otherwise indicated.
      2) Use RT only for butt joint groove welds.
   b. Fillet Welds Larger than 5/16-inch: Liquid penetrant (PT) or magnetic particle (MT) for 10 percent of randomly selected welds, unless otherwise indicated.
   c. All Welds: 100 percent visually inspected (VT).
3. Repair and retest defective welds as specified in Section 05 05 23, Welding.

C. Special inspection of fabrication process and shop welding will be provided by Owner at his option.

PART 3 EXECUTION

3.01 ERECTION

A. General:

1. Meet requirements of AISC 360 and AISC 303, with exceptions as specified.
2. Install Contractor-designed temporary construction bracing to provide necessary support until components are in place and construction is complete.
3. Provide additional field connection material as required by AISC 303.
4. Splice members only where indicated and accepted on Shop Drawings.

B. Field Assembly:

1. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.
2. Set structural frames accurately to lines and elevations shown.
3. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.

4. Level and plumb individual members of structure within tolerances shown in AISC 303.
5. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.
6. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.

C. Setting Baseplates and Bearing Plates:

1. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces.
2. Clean bottom surface of baseplates and bearing plates.
3. Set loose and attached baseplates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices. Use leveling plates where indicated.
4. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout. Weld plate washer to baseplate where indicated.
5. Grout Under Baseplate: As specified in Section 03 62 00, Nonshrink Grouting, prior to placing loads on structure.

D. Anchor Bolts:

1. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in-place work.
2. Provide templates and other devices for presetting bolts and other anchors to accurate locations.
3. Projection of anchor bolts beyond face of concrete and threaded length shall be adequate to allow for full engagement of threads of hold-down nuts, adjustment of leveling nuts, washer thicknesses, and construction tolerances, unless indicated otherwise.
    a. Placement Tolerances: As required by AISC 303, unless indicated otherwise.
    b. Embedded anchor bolts shall not vary from dimensions shown on Drawings by more than the following:
        1) Center to Center of any Two Bolts Within an Anchor Group: 1/8 inch.
        2) Center to Center of Adjacent Anchor Bolt Groups: 1/4 inch.
        3) Variation from Perpendicular to Theoretical Bearing Surface: 1:50.

E. Connections:

1. High-Strength Bolted:
   a. Tighten in accordance with RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.
   b. Hardened Washers:
      1) Provide at locations required by Washer Requirements section of RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts, to include slip critical connections using slotted or oversized holes or ASTM A490 bolts.
      2) Use beveled style and extra thickness where required by RCSC Specification.
      3) Use square or rectangular beveled washers at inner flange surfaces of American Standard beams and channels.
      4) Do not substitute DTIs for hardened flat washers required at slotted and oversize holes.
         a) For bearing-type connections not fully tensioned (N, X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.
      5) Fully tensioned bolted.
   c. Use DTIs or TC bolts at slip critical (SC) and fully tensioned (FT) bearing-type connections.
   d. DTIs:
      1) Position within bolted assembly in accordance with ASTM F959.
      2) Install bolts, with DTIs plus hardened washers as required, in holes of assembly and tighten until plies are in firm contact and fasteners are uniformly snug tight.
   e. Final tightening bolts begin at most rigid part of bolted connection and progress toward free edges until final twist off of TC bolts or until DTIs have been compressed to an average gap equal to or less than shown in ASTM F959, Table 2.
2. Welded:
   a. As specified in Section 05 05 23, Welding.
   b. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.

3.02 MISFITS

A. At Bolted Connections:

1. Immediately notify Engineer for approval of one of the following methods of correction:
   a. Ream holes that must be enlarged to admit bolts and use oversized bolts.
   b. Plug weld misaligned holes and redrill holes to admit standard size bolts.
   c. Drill additional holes in connection, conforming to AISC for bolt spacing and end and edge distances, and add additional bolts.
   d. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.
      1) Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

B. At Anchor Bolts:

1. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved Shop Drawing.
2. Do not flame cut to enlarge holes without prior approval of Engineer.

C. Gas Cutting:

1. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.
2. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by Engineer.
3. Finish flame-cut sections equivalent to sheared and punched appearance.

3.03 REPAIR AND CLEANING

A. Clean shop primer from field welds, bolted connections, and abraded areas immediately after erection.

B. Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.

C. Remove weld back-up bars and grind smooth where indicated on Drawings.

D. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application and as specified in Section 09 90 00, Painting and Coating.

E. Hot-Dip Galvanized Coating Repair:

1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

3.04 FIELD QUALITY CONTROL

A. High-Strength Bolted Connections:

1. An independent testing agency will be retained by Owner to perform the following inspection and testing in accordance with the RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts:
   a. Marking identification and conformance to ASTM standards.
   b. Alignment of bolt holes.
   c. Placement, type, and thickness of hardened washers.
   d. Tightening of bolts.

B. Bearing-Type Connections Not Fully Tensioned (N, X): Snug tight condition with plies of joint in firm contact.

1. Fully Tensioned (FT) Bearing and Slip Critical (SC) Connections:
   a. Conduct preinstallation test.
   b. Monitor installation and tightening of DTIs or TC bolts.
   c. Monitor condition of faying surfaces for slip critical connections.
2. Preinstallation Test:
   a. Conduct test in accordance with Specification for Structural Joints Using ASTM A325 or ASTM A490 bolts prior to using bolt tension measuring device.
   b. Select representative sample of not less than three bolts of each diameter, length, and grade.
   c. Include DTIs and flat hardened washers as required to match actual connection assembly.
3. Nondestructive Testing (NDT): Inspect bolted connections and perform corrections as required to meet code acceptance criteria per RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

4. Defective Connections: Correct and reinspect defective and improperly tightened high-strength bolted connections. Retest fully tensioned bolts as necessary to demonstrate compliance of completed work.

C. Welded Connections:

1. Visually inspect field welds in accordance with AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. An independent testing agency shall be retained by Contractor and approved by Engineer to perform the following inspection and testing of field welds as specified in Section 05 05 23, Welding.
   a. Groove Welds:
      1) Radiographic (RT) or ultrasonic (UT) testing for 10 percent of randomly selected welds, unless otherwise indicated.
      2) Use RT only for butt joint groove welds.
   b. Fillet Welds Larger Than 5/16 Inch: Liquid penetrant (PT) or magnetic particle (MT) for 10 percent of randomly selected welds, unless otherwise indicated.
   c. All Welds: 100 percent visually inspected (VT).
3. Repair and retest defective welds as specified in Section 05 05 23, Welding.

D. Special inspection will be provided by Owner as indicated on Drawings or as selection at Owner's option.

END OF SECTION

SECTION 05 21 19
OPEN WEB STEEL JOIST FRAMING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Institute of Steel Construction (AISC):
   a. Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design.
   b. Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts.
   c. Code of Standard Practice for Steel Buildings and Bridges.
2. American Welding Society (AWS): D1.1, Structural Welding Code - Steel.
3. Steel Joist Institute (SJI):
   a. Standard Specifications and Load Tables:
      1) Open-Web Steel Joists, K-Series.
      2) Long Span Steel Joists, LH-Series, and Deep Long Span Steel Joists, DLH-Series.
      3) Super Longspan Steel Joists, SLH-Series.
      4) Joist Girders.
   b. Recommended Code of Standard Practice for Steel Joists and Joist Girders.

1.02 SUBMITTALS

A. Action Submittals:

1. Plan view layout of joists and bridging identifying joist coding.
2. Elevation view of each type of joist showing configuration, chord and web member sizes, panel point dimensions, chord extensions and camber.
3. Connection and bearing details.
4. Special joist reinforcing and connections for supported items, such as monorails and mechanical equipment.
5. Bridging member locations, sizes and connection details.
6. All shop drawings shall bear State of California Registered Professional Engineer’s stamp and signature.
7. Complete design, including stress and deflection calculations, for joists, joist members, and connections for design load and equipment weight as

indicated, plus any construction loads applied by Contractor's operations.

8. Calculations shall include check of joist chord bending stresses for concentrated loads applied between panel points.
9. All structural calculations shall bear State of California Registered Professional Engineer's stamp and signature.
10. Procedure for handling, erection, and bracing of steel joists.

B. Informational Submittals:

1. Joist manufacturer's installation requirements.
2. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding.

1.03 QUALITY ASSURANCE

A. General: Design and fabricate steel joists, bridging, attachments, headers and other supplementary framing to meet requirements of SJI Standard Specifications and Load Tables.

B. Certification: SJI Membership, with certification for joist types as indicated on Drawings.

C. Qualifications for Field Welding: As specified in Section 05 05 23, Welding.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Protect joist paint system from abrasion at steel bands and other joists.

C. Store joists and bridging off ground on wood sleepers.

D. Support joists so there is no danger of tipping, sliding, rolling, shifting or material damage.

PART 2 PRODUCTS

2.01 STEEL JOISTS AND BRIDGING

A. Provide type of joist, chord configuration, and depth as indicated on Drawings.

B. Design and Manufacture:

1. In accordance with the applicable SJI Standard Specifications.
2. Chord Members: Rolled double angle sections only.
3. Provide the following where indicated, in accordance with SJI Standard Specifications and Load Tables:
   a. Fabricate to achieve end bearing of:
      1) 2-1/2 inches on steel.
      2) 4 inches minimum on masonry.
   b. Bottom chord bracing and end anchorage for uplift design criteria.
   c. Ceiling extension to within 1 inch of finished wall surface, unless otherwise indicated.
   d. Provide bottom and top chord extensions as indicated on drawings.
   e. Bottom chord extension and stabilizer plates for joist girders.
   f. Full camber, unless otherwise indicated.

C. Joist Bridging:

1. In accordance with applicable SJI Standard Specifications for type of joist.
2. Furnish bridging of minimum size and type as indicated.
3. Provide anchorage connection to walls and girders at bridging lines as indicated.

D. Bolts, Nuts and Washers: ASTM A325 bolts, ASTM A563 nuts.

E. Anchor Bolts: Specified in Section 05 50 00, Metal Fabrications.

F. Structural Steel for Supplementary Framing and Joist Leg Extensions: ASTM A36.

G. Welding Materials: AWS D1.1; type required for materials being welded.

2.02 FINISH

A. Joists shall be shop-painted in accordance with the manufacturer's standard practice.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel joists.

3.02 INSTALLATION

A. Erection: As a minimum, follow SJI Standard specifications, recommendations and approved shop drawings.

B. Allow for erection loads. Provide sufficient temporary bracing to maintain framing safe, plumb, and in true alignment. As a minimum, follow SJI recommendations.

C. Coordinate placement of anchors in masonry construction for securing bearing plates or angles.

D. After joist alignment and installation of framing, field-weld joist seat to bearing plates.

E. Position and field-weld joist chord extensions and wall attachments as detailed. Coordinate placement of anchors in masonry construction for securing bearing plates or angles.

F. Frame roof openings greater than 18 inches with supplementary framing as indicated.

G. Do not permit erection of decking until joists are braced, temporarily bridged, and secured or until completion of erection and installation of permanent bridging and bracing.

H. Do not field-cut or alter structural members without approval of joist manufacturer.

I. Welded Connections: As specified in Section 05 05 23, Welding.

J. High-Strength Bolted Connections: Install as specified in Section 05 12 00, Structural Steel Framing.

3.03 TOUCHUP PAINTING

A. Immediately following erection, remove debris from completed installation.

B. Clean field welds, bolted connections, rust spots, and abraded areas.

C. Repair damaged painted and galvanized surfaces as specified in Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY CONTROL

A. Welding:

1. An independent testing agency will be retained by Owner to visually inspect field welded connections in accordance with AWS D1.1, Table 6.1, and as specified in Section 05 05 23, Welding.
2. Repair defective welds as specified in Section 05 05 23, Welding.

B. High-Strength Bolted Connections:

1. An independent testing agency will be retained by Owner to perform inspection and testing in accordance with the AISC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.
2. Inspect and test as specified in Section 05 12 00, Structural Steel Framing.

C. Special inspection will be provided by Owner where indicated on Drawings or as elected by Owner because of observed workmanship.

END OF SECTION

SECTION 05 31 00
STEEL DECKING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Iron and Steel Institute (AISI): Specifications for the Design of Cold Formed Steel Structural Members.
2. American Welding Society (AWS): D1.3, Structural Welding Code - Sheet Steel.
3. ASTM International (ASTM):
   a. A611, Standard Specification for Structural Steel (SS), Sheet, Carbon, Cold-Rolled.
   b. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   c. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   d. A924, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
4. Factory Mutual (FM):
   a. Factory Mutual Approval Guide.
   b. FM Research Corporation (FMRC): Approval Requirements for Steel Roof Deck Construction.
5. International Code Council Evaluation Service, Inc. (ICC-ES): Evaluation Reports for Deck Fasteners.
6. Steel Deck Institute (SDI):
   a. Design Manual for Composite Decks, Form Decks and Roof Decks.
   b. Diaphragm Design Manual.
7. Underwriters Laboratories, Inc. (UL): Fire Resistance Directory.

1.02 SUBMITTALS

A. Action Submittals:

1. Plan view layout of decking showing type and section properties of deck panels, reinforcing channels, pans, special jointing, and accessories.
2. Location of openings, deck laps, and deck attachment details.
3. Location of temporary shoring for placement of concrete topping.

B. Informational Submittals:

1. Decking manufacturer's installation requirements.
2. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding.
3. Manufacturer's Certificate of Compliance.

1.03 QUALITY ASSURANCE

A. General: For metal decking section properties, meet requirements of AISI Specifications for Design of Cold-Formed Steel Structural Members.

B. FM Requirements:

1. Steel Roof Deck: Listed in Factory Mutual "Approval Guide" for Class 1 fire rating and Class 1-90 wind uplift rating.
2. Mechanical Fasteners: Packing containers shall show name of manufacturer and product and FMRC approval mark.

C. Qualifications for Field Welding: As specified in Section 05 05 23, Welding.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store deck bundles on platforms or pallets, with one end elevated to provide drainage.

C. Protect bundles against condensation with a ventilated waterproof covering.

D. Stack bundles so there is no danger of tipping, sliding, rolling, shifting or material damage.

PART 2 PRODUCTS

2.01 METAL DECKING

A. Provide metal deck as shown in the following schedule:

Steel Deck Schedule								
Type	**Depth (in)**	**Panel Width (in)**	**Design Thickness (in)**	**Min. Yield Strength Fy (ksi)**	**Min. (+) S (in^3/ft)**	**Min. I (in^4/ft)**	**Minimum Diaphragm Shear Capacity (lbs/ft)**	**Finish**
Roof Deck	1-1/2	36	0.0478	33	0.23	0.20	400	Prime painted

B. Materials and Finishes:

1. Galvanized Deck:
   a. Sheet steel for galvanized deck and accessories shall conform to ASTM A653 Structural Quality Grade 33 or higher, as shown in Steel Deck Schedule.
   b. Galvanizing shall conform to ASTM A924 with coating class of G60 or G90 as defined in ASTM A653 and as shown in Steel Deck Schedule.

C. Manufacturers:

1. Vulcraft Division of Nucor Co., Brigham City, UT.
2. BHP Steel Building Products, USA, Inc., West Sacramento, CA.
3. Verco Manufacturing, Inc., Phoenix, AZ.
4. United Steel Deck, Inc., Summit, NJ.

2.02 ACCESSORIES

A. Provide pour stops, column closures, end closures, cover plates, girder fillers, ridge and valley plates, eave strips, finish strips, reinforcing channels, and other accessories as required for complete installation.

B. Accessories shall be minimum 18-gauge, except edge forms shall be sized as required by the deck manufacturer, unless shown otherwise on Drawings.

2.03 MECHANICAL FASTENERS

A. Self-Drilling Screws:

1. Self-drilling, self-tapping screws with hexagonal washer head and corrosion-resistant finish.
2. Manufacturers and Products:
   a. ITW Buildex, Itasca, IL; ICH Traxx Self-Drilling Fasteners with Climaseal Coating and Autotraxx Standup Installation Tool.
   b. Hilti, Inc., Tulsa, OK; Kwik-Pro HWH Self-Drilling Screws with Kwik-Cote Treatment and Kwik-Tapper Screwdriver.

B. Powder Driven Fasteners:

1. Knurled shank, minimum 1/2-inch-diameter steel washer, corrosion-resistant coating.
2. Pin diameter and length to suit deck type and flange thickness of steel support member.
3. Manufacturers and Products:
   a. ITW Buildex, Itasca, IL; Buildex BX14 pins with yellow dichromate galvanizing and BX900 Installation Tool.
   b. Hilti, Inc., Tulsa, OK; ENP-series fasteners with electroplated zinc coating and DX-750 Installation Tool.

2.04 SHEAR CONNECTORS FOR COMPOSITE DECK

A. Welded Headed Anchor Studs: Size and spacing as indicated on Drawings and as specified in Section 05 50 00, Metal Fabrications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions prior to beginning Work.

B. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel deck.

3.02 INSTALLATION

A. Erect metal deck in accordance with SDI Manual manufacturer's instructions.

B. Locate deck bundles to prevent overloading of support framing members.

C. Install at right angles to supporting members in a three span minimum lay-up, unless shown otherwise, and in accordance with Specification and manufacturer's installation recommendation.

D. Bearing on Steel Supports: 1-1/2 inches, minimum.

E. Bearing on masonry support surfaces with 4 inch minimum bearing. Align and level.

F. Endlaps: Minimum of 2 inches and located over supports.

G. Do not stretch sidelaps.

H. Install sheet steel closures and angle flashings to close openings between deck and walls, columns, and openings.

I. Closure Plates:

1. Install closure and cover plate accessories as recommended by the metal deck manufacturer, unless shown otherwise on Drawings.
   a. Floor Deck and Form Closures:
      1) Fasten column closures, cell closures, and zee-closures to deck to provide tight fitting closures at open ends of ribs and sides of decking.
      2) Fasten cell closures at changes of direction of deck units unless otherwise indicated.

J. Holes and Openings:

1. Cut and fit around roof openings and other work projecting through or adjacent to decking.
2. Locate holes and openings as shown to clear structural framing and bracing members.
3. Reinforce steel deck openings from 6 to 18 inches in size with 2 by 2 by 1/4 inch steel angles. Place framing angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and fusion-weld to deck at each flute.
4. For openings larger than 12 inches across, reinforce roof deck with framing as shown on Drawings.

K. Install 6 inch minimum wide sheet steel cover plates, of same thickness as deck, where deck changes direction. Fusion-weld or mechanically attach 12 inches on center maximum.

L. Protect deck areas from heavy concentrated loads or wheel traffic with planking or other approved means.

M. Install temporary shoring, if required, to meet strength and deflection limitations, before placing any concrete topping on deck panels.

N. Completed Deck: Free from buckles and irregularities, and in accordance with FM and UL requirements.

3.03 DECK ATTACHMENT

A. Fasten panels as shown on Drawings.

B. If not called for on drawings, fasten deck to steel support members at ends and intermediate supports with 1/2 inch diameter fusion welds through weld washers at 12 inches on center maximum, parallel with the deck flute and at every support.

C. Welded Connections: Weld deck sidelaps, attachments to framing, and accessories in accordance with AWS D1.3 and as specified in Section 05 05 23, Welding.

D. Mechanical Fasteners:

1. Self-Drilling Screws:
   a. Install screws in accordance with manufacturer's written instructions and with special installation tool. Do not over-torque.
   b. Remove and redrive screws at sidelaps where upper sheet is not drawn tightly against lower sheet.
2. Powder Driven Fasteners:
   a. Install fasteners in accordance with manufacturer's written instructions and with special installation tool.
   b. Minimum Sidelap Edge Distance: 3/8 inch.
   c. Minimum End/End Lap Distance: 1 inch.
   d. Head Projection: As specified by manufacturer for correct penetration into flange of steel support member.

3.04 TOUCHUP PAINTING

A. Immediately following erection, remove unused deck edge trimmings, screws, fasteners, welding washers, butt ends of welding rods, and debris from completed installation.

B. Clean field welds, bolted connections, rust spots, and abraded areas.

C. Repair damaged painted surfaces as specified in Section 09 90 00, Painting and Coating.

D. Repair damaged galvanized surfaces with zinc-rich spray paint in accordance with ASTM A780; color to match galvanized deck.

E. Use magnetic gauge to determine that thickness of repair is equal to or greater than base painted or galvanized coating.

3.05 FIELD QUALITY CONTROL

A. An independent testing agency will be retained by Owner to perform following inspections.

1. Welded Connections: Visually inspect in accordance with AWS D1.3, Section 7, and as specified in Section 05 05 23, Welding.
2. Mechanical Fasteners: Visually inspect, in accordance with manufacturer's instructions, for each type of fastener.

B. Repair or replace defective welds and fasteners.

C. Special inspection will be provided by Owner where indicated on Drawings or as elected by Owner based on observations of workmanship.

D. Welded Shear Studs: Inspect and test as specified in Section 05 50 00, Metal Fabrications.

END OF SECTION

SECTION 05 41 00
STRUCTURAL METAL STUD FRAMING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Iron and Steel Institute (AISI):
   a. Specification for the Design of Cold-Formed Steel Structural Members.
   b. Cold-Formed Steel Design Manual.
   c. Design Guide for Cold-Formed Steel Trusses.
   d. Fasteners for Residential Steel Framing.
2. American Welding Society, Inc. (AWS):
   a. C1.1, Recommended Practices for Resistance Welding.
   b. C1.3, Recommended Practices for Resistance Welding Coated Low Carbon Steels.
   c. D1.3, Structural Welding Code-Sheet Steel.
3. ASTM International (ASTM):
   a. A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
   b. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Structural Tubing in Rounds and Shapes.
   c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   d. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   e. 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.
   f. C955, Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
4. Center for Cold-Formed Steel Structures (CCFSS): Technical Bulletin, Vol. 2, No. 1, February 1993, Screw Connections.
5. International Code Council (ICC): Evaluation Reports for Cold-Formed Steel Framing and Fasteners.

1.02 SUBMITTALS

A. Action Submittals:

1. Plan and elevation views of all metal framing systems, including location and framing of all openings.
2. Material specifications, member sizes, and properties.
3. Details of track, web stiffeners, stud bracing, blocking, bridging, and other members as required to provide a complete installation.
4. Details of connections including welding, mechanical fasteners, and accessory items.
5. Installation and erection instructions, including sequence of operations and requirements for temporary bracing and bridging.

B. Informational Submittals:

1. Manufacturer’s installation requirements.
2. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding.
3. Operation manuals for mechanical fastener installation tools.

1.03 QUALITY ASSURANCE

A. General: For member section properties, meet requirements of AISI, Specification for the Design of Cold-Formed Steel Structural Members.

B. Qualifications for Welding: As specified in Section 05 05 23, Welding.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver to Site in bundles marked with name of manufacturer, section type, thickness, grade of material, and length.

B. Store bundles on wood blocking, flat and off ground, to keep clean and to prevent any damage or permanent distortion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide size and type of members as indicated on Drawings.

B. Sheet Steel: ASTM A653/A653M, with G-60 galvanized coating.

C. Cold-Formed Members and Accessories: ASTM C955.

D. Dimensions and Properties: Calculate section properties in accordance with AISI Cold-Formed Steel Design Manual.

2.02 STUDS AND JOISTS

A. Material:

1. ASTM A653/A653M, Structural Steel (SS) Grade 33, or High-Strength Low-Alloy Steel (HSLAS), Type A or B, Grade 50.
2. Section: Type, size, and thickness as indicated on Drawings.
3. Flanges: Stiffened with return lip.
4. Webs:
   a. Studs: Punched.
   b. Joists: Unpunched, unless indicated otherwise on Drawings.

B. Accessories:

1. Track: Size as required to fit over studs, same thickness as stud material, unpunched.
2. Blocking, Bridging, and Fire Stops: Same depth as studs or joists, 0.0566-inch minimum design thickness, unpunched.
3. Bracing Straps, Angle Bracing, Clip Angles: Size and thickness as indicated on Drawings.
4. Mounting Plates: 0.0566-inch minimum design thickness by 8 inches by 18 inches.
5. Accessories shall be from same manufacturer as studs and joists.

C. Manufacturers and Products:

1. AMS, Los Angeles, CA; Angeles Metal Systems.
2. Clark Steel, Middleton, OH; Steel Framing Systems.
3. Dale Industries; Dearborn, MI; Dale/Incor Steel Framing.
4. Dietrich Industries, Pittsburgh, PA; Lightgauge Metal Framing Products.
5. Knorr Steel Framing Systems, Salem, OR; Light Gauge Steel Framing.
6. Marino/Ware, South Plainfield, NJ; Stud-Rite Lightweight Steel Framing Systems.
7. Unimast Incorporated, Schiller Park, IL; Steel Framing Systems.

2.03 MECHANICAL FASTENERS

A. Self-Drilling Screws:

1. Self-drilling, self-tapping screws with hexagonal washer head and corrosion-resistant finish.
2. Manufacturers and Products:
   a. ITW Buildex, Itasca, IL; ICH Traxx Self-Drilling Fasteners with Climaseal Coating and Autotraxx Standup Installation Tool.
   b. Hilti, Inc., Tulsa, OK; Kwik-Pro HWH Self-Drilling Screws with Kwik-Cote Treatment and Kwik-Tapper Screwdriver.

B. Powder-Driven Fasteners:

1. Knurled shank, minimum 1/2-inch-diameter steel washer, corrosion-resistant coating.
2. Pin diameter and length to suit deck type and flange thickness of steel support member.
3. Manufacturers and Products:
   a. ITW Buildex, Itasca, IL; Buildex BX14 pins with yellow dichromate galvanizing and BX900 Installation Tool.
   b. Hilti, Inc., Tulsa, OK; ENP-series fasteners with electroplated zinc coating and DX-750 Installation Tool.

2.04 CONCRETE ANCHORS

A. Drilled anchors, size and type as shown on Drawings and as specified in Section 05 50 00, Metal Fabrications.

2.05 PREFABRICATION

A. Structural wall framing panels may be prefabricated prior to erection.

B. Prefabricated assemblies shall be not more than 1/8 inch out of square within length of assembly and shall be braced against racking. Use jig templates for layout and fabrication.

C. Protect prefabricated panels from damage during handling.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all prefabricated assemblies and repair any damage.

B. Examine bearing support surfaces for compliance with requirements for installation tolerances and other conditions affecting performance of metal framing systems.

C. Provide smooth level bearing surfaces for bottom track of load-bearing walls.

D. Clean all member and bearing surfaces that will be in contact after assembly.

3.02 INSTALLATION

A. General:

1. Install framing systems as indicated on Drawings, complete and in accordance with manufacturer's recommendations.
2. Provide temporary bracing for support of all construction loads until framing system is installed complete with sheathing or decking.
3. Install framing in true line, plumb, level, and in proper alignment.
4. Cut ends of framing members with saw or shear to bear uniformly against abutting members. Flame cutting is not permitted.
5. All structural framing members shall be full-length without splices, unless indicated otherwise.
6. Fasten members together in accordance with AISI, Cold-Formed Steel Design Manual, Part IV, Connections. Wire tying is not permitted.

B. Stud Bearing Walls:

1. Secure bottom track to floor slab with concrete anchors as indicated on Drawings.
2. Seat studs squarely and firmly within track before securing with fasteners. Gap between end of stud and track shall be less than 1/16 inch.
3. Install studs with spacing as shown and not more than 2 inches from abutting walls.
4. Provide double studs at jambs of openings wider than stud spacing.
5. Provide triple studs at corners and at jambs of openings wider than 48 inches, unless indicated otherwise.
6. Track shall be continuous. Center splices between studs and splice with stud section full length between studs.
7. Frame wall penetrations for pipes and ducts larger than stud spacing to avoid cutting structural members.
8. Fire stop stud walls and partitions with unpunched blocking full width of stud at midpoint or where required for nailers, in conformance with applicable building code.
9. Provide blocking for support of mechanical items.

10. Do not remove the web knockouts within 10 inches of either end of load-bearing studs.
11. Provide bracing straps with gusset plates and anchor holddown assemblies where indicated on Drawings.
12. Tolerances:
    a. Stud Plumbness: 1/8 inch in 10 feet.
    b. Stud Spacing: Plus or minus 1/8 inch.

C. Joists:

1. Position joists directly over bearing studs and attach to track.
2. Joists shall be one-piece within a single span. For multiple spans, lap joists and splice as shown on Drawings.
3. Immediately install bridging and solid blocking to support joists. Maximum spacing of bridging shall be 5 feet.
4. Install web stiffeners where indicated.
5. Web Penetrations:
    a. Drilled holes for other trades shall be limited to the middle 1/3 of the joist depth within the middle 1/3 of the span, unless indicated otherwise. Minimum spacing between drilled holes shall be 1-1/2 times the joist depth. Notching of joist flanges and flame cutting of holes are not permitted.
6. Tolerances:
    a. Joist Spacing: Plus or minus 1/8 inch.
    b. Joist Levelness: Plus or minus 1/8 inch in 10 feet.

3.03 FASTENERS

A. Self-Drilling Screws:

1. Install in accordance with manufacturer’s written instructions and with special installation tool.
2. Screw type, diameter, and length shall be in accordance with AISI, Fasteners for Residential Steel Framing, minimum two screws per connection unless indicated otherwise.
3. Use clamp to hold members together. Drive screw from lighter to heavier gauge, to allow plies to be pulled together without stripping metal. Do not over torque. A minimum of three exposed threads shall extend through steel.
4. Minimum screw spacing, end distance, and edge distance shall be 3 diameters.

B. Powder-Driven Fasteners:

1. Use only for connecting cold-formed steel to structural steel members, unless indicated otherwise.
2. Install in accordance with manufacturer's written instructions and with special installation tool.

C. Welded Connections:

1. Welding shall not be used for material thinner than 0.0451 inch.
2. Weld framing members and accessories in accordance with AWS D1.3.
3. Resistance welding for prefabricated framing shall be in accordance with AWS C1.1 and AWS C1.3.
4. Repair galvanized surfaces damaged by welding with zinc-rich spray paint in accordance with ASTM A780.

D. Concrete Anchors: Install in accordance with Section 05 50 00, Metal Fabrications.

3.04 FIELD QUALITY CONTROL

A. An independent testing agency will be retained by Owner to perform following inspections.

1. Welded Connections: Visually inspect in accordance with AWS D1.3, Section 7, and as specified in Section 05 05 23, Welding.
2. Mechanical Fasteners: Visually inspect, in accordance with manufacturer's instructions, for each type of fastener.

B. Repair or replace defective welds and fasteners.

C. Special inspection will be provided by Owner where indicated on Drawings or at election of Owner due to observation of workmanship.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 REFERENCES

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

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Galvanizers Association (AGA):
3. Inspection of Hot-Dip Galvanized Steel Products.
4. Quality Assurance Manual.
5. American Iron and Steel Institute (AISI): Stainless Steel Types.
6. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
7. American National Standards Institute (ANSI).
8. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
9. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.2/D1.2M, Structural Welding Code - Aluminum.
   c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
10. ASTM International (ASTM):
    a. A36/A36M, Standard Specification for Carbon Structural Steel.
    b. A48/A48M, Specification for Gray Iron Castings.
    c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
    e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
    g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
k. A276, Standard Specification for Stainless Steel Bars and Shapes.
l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
p. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
q. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
r. A489, Standard Specification for Carbon Steel Lifting Eyes.
s. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
t. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
u. A563, Standard Specification for Carbon and Alloy Steel Nuts.
v. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
w. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
x. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
y. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
z. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
aa. A992/A992M, Standard Specification for Structural Steel Shapes.
bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

cc. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
dd. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ee. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
ff. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
gg. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
hh. F436, Standard Specification for Hardened Steel Washers.
ii. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
jj. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
kk. F594, Standard Specification for Stainless Steel Nuts.
ll. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
mm. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

11. International Code Council Evaluation Service (ICC-ES):
    a. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
    b. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
    c. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
    d. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
    e. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
12. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
13. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910.27, Fixed Ladders.
    b. 29 CFR 1926.105, Safety Nets.
    c. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.
14. Specialty Steel Industry of North America (SSINA):
    a. Specifications for Stainless Steel.
    b. Design Guidelines for the Selection and Use of Stainless Steel.
    c. Stainless Steel Fabrication.
    d. Stainless Steel Fasteners.

1.02 DEFINITIONS

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

B. Concrete Anchor: Post-installed concrete anchors listed in this specification.

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

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

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

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

G. Masonry Anchor: Post-installed masonry anchors listed in this specification.

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

1.03 SUBMITTALS

A. Action Submittals:

1. Provide Shop Drawing details showing:
   a. Metal fabrications, including member piece numbers, sizes, grades, dimensions, welding, fasteners, and connection details.
   b. Anchor bolt layouts.
   c. Product specifications, including primer and other coatings
   d. Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.
2. Access Hatches with Solid Lid Covers:
   a. Provide design calculations and shop drawings, signed and sealed by a Professional Engineer licensed in California, proving access hatches and solid lid covers meet loading capacities specified.

3. Samples: Color samples of abrasive stair nosings.

B. Informational Submittals:

1. Concrete and Masonry Post-Installed Anchors:
   a. Manufacturer's product description and printed installation instructions.
   b. Current ICC-ES Report for each type of post-installed anchor to be used.
   c. Adhesive Anchor Installer Certification.
2. U-Channel Concrete Inserts:
   a. Manufacturer's product description.
   b. Allowable load tables.
3. Ladders: Letter of certification that ladder meets OSHA 29 CFR 1910.27 requirements.
4. Passivation method for stainless steel members.
5. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Adhesive Anchor Installer: Trained to install adhesive anchors in accordance with manufacturer's printed installation instructions.
2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Insofar as practical, factory assemble specified items. Assemblies, because of necessity, have to be shipped unassembled shall be packaged and tagged in manner that will protect materials from damage and will facilitate identification and field assembly.

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

C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.

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

E. Store adhesives anchors at service temperature ranges recommended by manufacturer.

1.06 SPECIAL GUARANTEE

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

1.07 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following extra materials:

Item	Quantity
Neoprene Gasket	Two for each location requiring neoprene gaskets.
Neoprene Gasket Adhesive	One kit (manufacturer's recommended) for each location requiring neoprene gaskets.

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements (to be completed).

PART 2 PRODUCTS

2.01 GENERAL

A. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over 1.5 inches thick for ASTM A36/A36M steel), limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.

B. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M
Steel Pipe	A53/A53M, Type E or S, Grade B

Item	ASTM Reference
Hollow Structural Sections (HSS)	A500/A500M, Grade B
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Condition CW
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 36, with weldability supplement S1
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Aluminum Plates and Structural Shapes	B209 and B308/B308M, Alloy 6061-T6
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48/A48M, Class 35

C. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast-In-Place Anchor Bolts:

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

B. Anchor Bolt Sleeves:

1. Plastic:
   a. Single unit construction with corrugated sleeve.
   b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
   c. Material: High-density polyethylene.
   d. Manufacturer: Sinco Products, Inc., Middletown, CT, (800) 243-6753.
2. Fabricated Steel: ASTM A36/A36M.

2.03 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchors:

1. AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of this section.
2. Current ICC-ES Report indicating acceptance per IBC 2012 for anchors at structural applications in cracked concrete.
3. Anchors shall be suitable for long-term loads, as well as for wind and seismic loads.
4. Acceptable for use in potable water structures by EPA and local health agencies or NSF 61.
5. Torque-Controlled Expansion Anchors (Wedge Anchors):
   a. Wedge anchors used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC193 for cracked concrete.
   b. Manufacturers and Products:
      1) ITW Ramset/Red Head, Addison, IL; Trubolt+ Wedge Anchor (ESR-2427).

2) Hilti, Inc., Tulsa, OK; Kwik-Bolt–TZ (KB-TZ) Anchors (ESR-1917).
3) Powers Fasteners, Brewster , NY; Power-Stud +SD2 or +SD1 Anchors (ESR-2502 and ESR-2818).
4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt Anchors (ESR-1771).

6. Displacement-Controlled Expansion Anchors (Drop-in Anchors):
   a. Self-drilling anchors, snap-off or flush type, zinc-plated.
   b. Nondrilling Anchors: Flush type for use with zinc-plated or stainless steel bolt, or stud type with projecting threaded stud.
   c. Manufacturers and Products:
      1) ITW Ramset/Red Head, Addison, IL; Multi-Set II Drop-In and Self Drill Anchor.
      2) Hilti, Inc., Tulsa, OK; Hilti HDI Drop-In Anchor.
      3) Powers Fasteners, Brewster, NY; Steel Drop-In Anchor.
      4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Drop-In Anchor.
7. Light-Duty Torque Controlled Expansion Anchors (Sleeve Anchors):
   a. Manufacturers and Products:
      1) ITW Ramset/Red Head, Addison, IL; Dynabolt Hex Nut Sleeve Anchor.
      2) Powers Fasteners, Brewster, NY; Lok-Bolt AS.
      3) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Sleeve-All Hex Head Anchor.
      4) Wej-It Corp., Tulsa, OK; Wej-It Sleeve Anchor.
8. Heavy-Duty Torque Controlled Expansion Anchors (Sleeve Anchors):
   a. Manufacturers and Products:
      1) Powers Fasteners, Brewster, NY; Power-Bolt+ Anchor.
      2) Hilti, Inc., Tulsa, OK; HSL-3 Heavy Duty Sleeve Anchor.

B. Adhesive Anchors (Epoxy Anchors):

1. If approved by Engineer, adhesive anchors used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report, indicating acceptance per IBC 2012, that demonstrates compliance with ICC-ES AC308 for cracked concrete.
2. Threaded Rod:
   a. ASTM F593 stainless steel threaded rod, diameter as shown on Drawings.
   b. Length as required, to provide minimum depth of embedment.
   c. Clean and free of grease, oil, or other deleterious material.
   d. For hollow-unit masonry, provide galvanized or stainless steel wire cloth screen tube to fit threaded rod.

3. Adhesive:
   a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
   b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
   c. Mixed Adhesive: Nonsag light paste consistency with ability to remain in 1-inch diameter overhead drilled hole without runout.
   d. Meet requirements of ASTM C881/C881M.
4. Packaging and Storage:
   a. Disposable, self-contained cartridge system capable of dispensing both components in proper mixing ratio and fitting into manually or pneumatically operated caulking gun.
   b. Store adhesive cartridges and adhesive components on pallets or shelving in covered storage area.
   c. Container Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
   d. Dispose of when:
      1) Shelf life has expired.
      2) Stored other than in accordance with manufacturer's instructions.
5. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 SD (ESR-2322).
   b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors(ESR-2508).
   c. Powers Fasteners, Brewster NY, PE1000+ Adhesive anchoring system (ESR-2583).

C. Adhesive Threaded Inserts:

1. Stainless steel, internally threaded inserts.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500-SD adhesive.

2.04 POST-INSTALLED MASONRY ANCHORS

A. General: AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of this section.

B. Current ICC Evaluation Report indicating acceptance per IBC 2012 for anchors at structural applications in masonry.

C. Manufacturers and Products:

1. Hilti, Inc., Tulsa, OK;Kwik-Bolt-3 (KB-3) (ESR-1385), for grout-filled masonry.
2. Powers Fasteners, Brewster NY, T308+ Epoxy Adhesive Anchoring System in Unreinforced Masonry (ESR-3149), Power-Stud+ SD1 (ESR-2966) for grout-filled masonry, Wedgebolt+ (ESR-1678) for grout-filled masonry.

2.05 STUD SHEAR CONNECTORS

A. Headed anchor studs (HAS), or threaded anchor studs (TAS),or stud shear connectors, as indicated on Drawings.

1. Carbon Steel: ASTM A108, Standard Quality Grades 1010 through 1020, inclusive either semikilled or killed aluminum or silicon dioxidation, unless indicated otherwise.
2. Stainless Steel: ASTM F593, AISI Type 316, Condition CW, where indicated.

B. Manufacturers:

1. Nelson Stud Welding, FabriSteel Co., Elyria, OH.
2. Stud Welding Associates, Inc., Elyria, OH.

2.06 PIPE SLEEVES

A. As specified in Section 40 50 10, Underground Piping.

2.07 STEEL LINTELS AND SHELF ANGLES

A. ASTM A992/992M for Steel Wide Flange Shapes and ASTM A36/A36M for all other structural shapes and plates.

B. Hot-dip galvanize after fabrication in accordance with ASTM A123/A123M.

2.08 EMBEDDED STEEL SUPPORT FRAMES FOR FLOOR PLATE AND GRATING

A. Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.

B. Welded anchors for stainless steel support frames shall also be stainless steel.

2.09 U-CHANNEL CONCRETE INSERTS

A. Rolled ASTM A240/A240M, AISI Type 316 stainless steel, 0.105-inch-thick, 1-5/8 inches wide by 1-3/8 inches deep, with stainless steel anchors at 10-inch maximum spacing, Styrofoam fillers, and end caps.

B. Nut and Bolt Hardware: Type 316 stainless steel, 5/8-inch minimum diameter, unless indicated otherwise. Manufacturer's standard to match insert.

C. Manufacturers and Products:

1. Power-Strut, Wayne, MI; PS 349 Series.
2. B-Line Systems, Inc., Highland, IL; B32 Series.
3. Halfen Anchoring Systems, Converse, TX; Channel Type 4141HTA.

2.10 ABRASIVE NOSING FOR STAIRS

A. Unless otherwise shown on Drawings, furnish flush type abrasive nosings on stairs.

B. Nosing Components:

1. Homogeneous epoxy abrasive, with minimum 50 percent aluminum oxide content, formed and cured upon an extruded aluminum base.
2. Epoxy abrasive shall extend over and form curved front edge of nosing.
3. Base of Nosing: Extruded aluminum alloy, 6063-T5, heat-treated.

C. Anchoring System: Double-set anchors consisting of two rows of integrally extruded anchors.

D. Size: 3 inches wide by 1/4 inch to 3/8 inch thick by length as shown.

E. Color: Selected by Engineer from manufacturer's standard color range.

F. Manufacturers and Products:

1. Wooster Products, Inc., Wooster, OH; Spectra Type WP3J.
2. American Safety Tread Co., Inc., Helena, AL; Type BF-311D, and Type 801.

2.11 FLOOR PLATE

A. Material:

1. Galvanized Steel: Carbon steel, ASTM A786/A786M, commercial grade, hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
2. Stainless Steel: ASTM A793, AISI Type 304.
3. Aluminum: ASTM B632/B632M, Alloy 6061-T6.

B. Minimum Thickness:

1. Steel: 1/4 inch, unless shown otherwise on Drawings.
2. Aluminum: 3/8 inch, unless shown otherwise on Drawings.

C. Surface shall be raised-lug pattern or diamond tread, unless shown otherwise on Drawings.

D. Slip-Resistant Surface:

1. Provide where indicated on Drawings.
2. Manufacturers and Products:
   a. IKG/Borden, Clark, NJ; MEBAC 2.
   b. W.S. Molnar Co., Detroit, MI; SLIPNOT Grade 2–Medium.

2.12 EXTRUDED FLOOR PLATE

A. Extruded Deck Plate:

1. Minimum Section Height: As shown on Drawings.
2. Minimum Section Width: 12 inches.
3. Manufacturer and Product: Alcoa Building Products, Inc., Sidney, OH; Standard Diamondback.

B. Extruded Tread Plate:

1. Minimum Section Height: 0.360 inch, plus serrations.
2. Section Width: 12 inches.
3. Accessories: Edgebands, tongue-and-groove attachment.
4. Manufacturer and Product: Alcoa Building Products, Inc., Sidney, OH; Standard Diamondback.

2.13 TRENCH GRATING

A. Load Capacity: HS-20 (intended for highway traffic) wheel loading capacity.

B. Manufacturer and Products:

1. Neenah Foundry, Neenah, WI; R-4999-HX and R-4999-DX.
2. Or as approved.

2.14 ACCESS HATCHES WITH SOLID LID COVERS

A. Load Capacity: HS-20 (intended for highway traffic) wheel loading capacity.

B. Solid lid cover manufacturer to provide design calculations and shop drawings, signed and sealed by a Professional Engineer licensed in California, proving access hatches and solid lid covers meet loading capacities specified.

C. Frames and Solid Cover Lids: Water-Tight Frames and Covers, with Type A heavy duty solid cover, or as approved, complete with a gasket seal, and recessed bronze or stainless steel cap screws or hex head machine screws or four recessed locking devices with stainless steel hex head bolts, and no open pickhole. Provide minimum total weight of 375 pounds, machined bearing surfaces, frame with continuous anchor flange embedded in precast concrete vault walls and/or top slab. Utilize structural angles and other structural shapes, made from same material as heavy duty solid lid cover, to stiffen solid lid cover to meet loading capacities required.

D. Provide gaskets and cover plates (between adjacent steel plates forming solid lid cover) to make total solid lid cover at water-tight as possible. Cover plates shall utilize countersunk mechanical fasteners to cover plate below.

E. Provide countersunk lifting attachment points in solid lid covers to allow for removal (with the use of crane or other piece of heavy equipment) of each individual steel plate sections making up the solid lid cover.

F. Manufacturers:

1. Neenah Foundry, Neenah, WI.
2. East Joran Group, Inc., East Jordan, MI.

2.15 VAULT ACCESS DOORS AND HATCHES

A. Load Capacity: 300 psf, for parkway and pedestrian traffic where indicated on Drawings, with maximum deflection of 1/150th of span. Provide HS-20 wheel loading capacity where indicated on Drawings.

B. Component Fabrication:

1. Access Door Leaf(s): 1/4-inch minimum thickness aluminum diamond pattern plate with aluminum angle stiffeners as needed for loading capacity requirements. Provide stainless steel safety chain and attachments for end of double-leaf door assembly when open.
2. Channel Frame: 1/4-inch-thick extruded aluminum trough frame with continuous anchor flange around perimeter. Weld 1-1/2-inch diameter drain coupling, and drain pipe, to frame trough at front right corner, unless indicated otherwise on Drawings.
3. Safety Grate (if indicated on Drawings): Aluminum or fiberglass grating (as shown on drawings) with 300 psf live load capacity, permanent hinging system that locks grate in 90-degree position, and opening arm with vinyl grip handle and locking device.

C. Door Hardware:

1. Hinges: Heavy-duty brass or stainless steel with stainless steel pins through-bolted to cover plate with tamper-proof stainless steel bolts flush with top of cover and to outside leg of channel frame with stainless steel bolts and locknuts.
2. Lifting Mechanism: Stainless steel compression lift springs enclosed in telescoping vertical housing or stainless steel torsion lift springs.
3. Hold-Open Arm:
   a. Stainless steel.
   b. Locks automatically in open position (at 90 degree position).
   c. Disengages with slight pull on vinyl grip with one hand.
   d. Door can be easily closed with one hand by pulling forward and down on vinyl grip.
4. Snap Lock:
   a. Stainless steel snap lock mounted on bottom of door leaf with removable topside key wrench and inside fixed lever handle.
   b. Threaded plug for flush outside surface with key wrench removed.

D. Aluminum shall be mill finished with protective coating applied to surfaces to be in contact with concrete, as specified in Section 09 90 00, Painting and Coating.

E. Manufacturers and Products:

1. Bilco Co., New Haven, CT; J Series.
2. Nystrom Products Co., Minneapolis, MN; FG Series.
3. U.S.F. Fabrication, Hialeah, FL; T Series.

4. ITT Flygt Corporation, Trumbull, CT; FDRN Series.
5. Thompson Fabricating Co., Birmingham, AL; TE Series.
6. Halliday Products, Orlando, FL; WS Series.

2.16 HATCH SAFETY NET

A. General:

1. Conforms to ASSE A10.11 and OSHA CFR Part 1926.105.
2. Size to fit hatch opening where indicated.

B. Components and Accessories:

1. Rails and Slide Rings: Aluminum 6061-T6 extruded rails and aluminum-alloy 713.0 slide rings.
2. Corner Hooks and Eyebolts: AISI Type 316 stainless steel.
3. Netting: Polyester, 5-inch by 5-inch net openings; 5,000 pounds minimum breaking strength.
4. Bolts, Nuts, and Concrete Anchors: AISI Type 316 stainless steel.

C. Manufacturer and Product: Safe Approach Inc., Auburn, ME; Hatch Net 121.

2.17 LADDERS

A. Fabricate ladders with rails, rungs, landings, and cages to meet applicable requirements of OSHA, CFR Part 1910.27, and ALI A14.3.

1. Concentrated load of 200 pounds loads imposed by persons occupying ladder shall be considered to be concentrated at such points as will cause maximum stress in structural member being considered.
2. Weight of ladder and attached appurtenances together with live load shall be considered in design of rails and fastenings.
3. Self-closing gates at landings.

B. Flat Bar Ladder:

1. Punch rails, pass rungs through rails, and weld on outside.
2. Weld brackets to ladder for fastening ladder to wall.
3. Hot-dip galvanize steel after fabrication in accordance with ASTM A123/A123M and ASTM A385/A385M.

C. Aluminum Pre-engineered Pipe Ladder:

1. Rungs:
   a. Aluminum extrusions of Alloy 6063-T6.
   b. Nonslip grip surface, 1-inch wide flat top, and semicircular bottom with mill finish.
2. Side Rails: ASTM B429/B429M, Alloy 6063-T6, 1-1/2 inches, Schedule 40 pipe with anodized finish, AA M32-C22-A41.
3. Ladder Attachments and Cage Assembly Fasteners: Stainless steel.
4. Welded, pop riveted, or glued construction is not acceptable.
5. Fabricate to longest length as practical but not to exceed 24 feet.
6. Furnish support attachments to side rails at 6 feet maximum spacing.
7. Manufacturer: Thompson Fabricating Co. Inc., Tarrant, AL.

D. Ladder Safety Post:

1. Telescoping tubular, spring balanced and automatically locking in raised position, with release lever for unlocking.
2. Post: Hot-dip galvanized steel in accordance with ASTM A123/A123M Stainless steel, AISI Type 316 or aluminum (match ladder material).
3. Spring Mechanism: Stainless steel.
4. Furnish dissimilar metal protective coatings at connections.
5. Manufacturer and Product: Bilco Co., New Haven, CT; “Ladder Up” to fit ladder rungs.

2.18 SAFETY CLIMB DEVICE

A. General:

1. Conforms to ALI A14.3 and OSHA CFR Part 1910.27.
2. Belt and harness shall withstand minimum drop test of 250 pounds in 6-foot free fall.
3. Fall Prevention System Material: Aluminum 6061-T6 or Hot-dip galvanized steel in accordance with ASTM A123/A123M (match ladder material).

B. Components and Accessories:

1. Main Components: Sleeve or trolley, safety harness, and carrier or climbing rail.
2. Ladder rung clamps with aluminum or hot-dip galvanized steel (match ladder material) mounting brackets and hardware.
3. Removable extension kit with tiedown rod or trolley gate, mandrel, and carrier rail for ladders under manholes and hatches.

C. Manufacturers and Products:

1. Miller Equipment, Franklin, PA; Sure Track Rail System.
2. TS Products, St. Charles, IL; TS Safety Rail System.

2.19 LADDER CLIMB PREVENTION SHIELD

A. Eight feet long with angled sides to within 2 inches of wall when closed.

B. Furnish dissimilar metals protective coatings at bolted connections.

C. Manufacturer and Product: North Safety Products, Specialty Products Division, Toronto, Ontario, Canada; Ladder Gate 770-000-001.

2.20 FALL ARREST ANCHORS

A. General:

1. Conforms to OSHA CFR Part 1926.502.
2. Minimum Breaking Strength: 5,000 pounds.
3. Material: Stainless steel, AISI Type 304.

B. Components and Accessories:

1. Forged combination eye and base assembly with headed anchor bolt, backer plate, lock washer, and nut.
2. Suitable for embedment in concrete wall or slab.

C. Manufacturers and Products:

1. Thaler Metal Industries, Buffalo, NY; FARA Wall Anchor.
2. Rose Manufacturing Company, Pittsburgh, PA; Anchorage Connector.

2.21 FABRICATED UNITS

A. Filter Screens: Type 304 stainless steel, 200 mesh, 0.0021 wire diameter in accordance with ASTM E2016, PSW weave type.

B. Overflow Pipe and Accessories:

1. Use steel pipe and fabricate flared section at top of overflow of steel plate, weld seams, and grind smooth.
2. Flange at Base:
   a. Standard 125-pound steel ring flange drilled 125-pound ANSI Standard.

b. Flange: Parallel to upper edge of fitting so lip can be installed in horizontal plane with pipe vertical.
c. Grind upper lip smooth.

3. Fabricate supporting brackets of structural shapes and flat bar stock, as shown.
4. Bolts: Hot-dip galvanized steel machine bolts with hexagon nuts in accordance with ASTM A153/A153M.
5. Hot-dip galvanize assembly after fabrication in accordance with ASTM A123/A123M.
6. Coat interior with coal-tar enamel as specified in Section 09 90 00, Painting and Coating.

C. T-Handled Operating Wrenches: Galvanized operating wrenches, 4 foot total length, No. A-2461 as manufactured by Mueller.

D. Valve Operator Access Box: Cast iron, 8 inches by 4 inches, as manufactured by Zurn; No. ZN-1930-K.

E. Wire Mesh Screen:

1. Fabricate frame of aluminum shapes and flat bar stock.
2. Wire Mesh: Woven of 14-gauge aluminum wire, three openings per inch, stretched taut over frame before bolts are tightened down.

2.22 CASTINGS

A. Frame and Cover for manholes as specified in Section 33 05 13, Manholes.

B. Meter Box Manhole: Nonslip surface and handle, as manufactured by Olympic Foundry Co.; 5823B.

C. Floor Boxes:

1. Cast iron, except as otherwise shown.
2. Depth: Equal to slab thickness where installed.
3. Diameter: As shown.
4. Manufacturers and Products:
   a. Neenah Foundry, Neenah, WI; R 7506.
   b. Mueller, Decatur, IL; No. A-27010.
   c. Olympic Foundry Co., Seattle, WA; No. 5680.

2.23 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

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

B. Neoprene Gasket:

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

2.24 FABRICATION

A. General:

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

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be Hot-dip Galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 and 0.25 percent.
3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer's instructions.
7. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.

7. Galvanized steel sheets in accordance with ASTM A653/A653M.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

F. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.

G. Watertight Seal: Where required or shown, furnish neoprene gasket of a type that is satisfactory for use in Contact with water containing micro levels of solvent. Cover full bearing surfaces.

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

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

2.25 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

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

B. Hot-Dip Galvanizing:

1. An independent testing agency will be retained by Owner to inspect and test hot-dip galvanized fabricated items in accordance with ASTM A123/A123M and ASTM A153/A153M.
2. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123/A123M and ASTM A153/A153M.
3. Reject and retest nonconforming articles in accordance with ASTM A123/A123M and ASTM A153/A153M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

A. General:

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

B. Aluminum:

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

C. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

3.02 CAST-IN-PLACE ANCHOR BOLTS

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

B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long with hex head at embedded end, unless otherwise shown.

3.03 CONCRETE AND MASONRY POST-INSTALLED ANCHORS

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

B. Install in accordance with manufacturer's instructions.

C. Provide minimum embedment, edge distance, and spacing as follows, unless indicated otherwise by anchor manufacturer's instructions or shown otherwise on Drawings:

Anchor Type	Minimum Embedment (Bolt Diameters)	Minimum Edge Distance (Bolt Diameters)	Minimum Spacing (Bolt Diameters)
Expansion	9	6	12
Undercut	9	12	16
Adhesive	9	9	13.5

D. Use only drill type and bit type and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air per manufacturer's printed installation instructions.

E. For undercut anchors, use special undercutting drill bit and rotary hammer drill and apply final torque as recommended by anchor manufacturer.

F. When embedded steel or rebar is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than 10 degrees to clear obstruction, notify Engineer for direction on how to proceed.

G. Adhesive Anchors:

1. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F, unless cold temperature adhesives, compliant with ACI 308 are used. Refer to the respective ICC-ES report and manufacturer's printed installation instructions.
2. Remove water from hole with oil-free compressed air. Damp or water filled holes may be allowed only if approved in manufacturer's printed installation instructions and ICC-ES report.
3. For hollow-unit masonry, install screen tube in accordance with manufacturer's printed installation instructions.
4. Do not disturb anchor during recommended curing time.

5. Do not exceed maximum torque as specified in manufacturer's printed installation instructions.

H. Prestressed Concrete: Do not use post-installed anchors in prestressed or post-tensioned concrete members without Engineer's prior approval, unless specifically shown on Drawings. If Engineer approves anchor installation all prestressed tendons in vicinity of anchors must be located prior to drilling.

3.04 ABRASIVE NOSINGS

A. Provide abrasive nosings on concrete steps not being supplied or coated with another type of nosing or nonskid material.

3.05 VAULT ACCESS DOORS AND HATCHES, ACCESS HATCHES WITH SOLID LID COVERS, AND TRENCH GRATING

A. Install vault access doors and hatches, access hatches with solid lid covers, and trench grating in accordance with manufacturer's instructions.

B. Accurately position prior to placing concrete, such that covers are flush with floor surface.

C. Protect from damage resulting from concrete placement. Thoroughly clean exposed surfaces of concrete spillage to obtain a clean, uniform appearance.

D. Route drain pipe to exterior face of concrete or as shown on Drawings.

3.06 SAFETY CLIMB DEVICE SYSTEM

A. Provide for each ladder where unbroken height between levels exceeds 20 feet, or at lesser height where indicated on Drawings.

B. Install in accordance with manufacturer's instructions.

C. Furnish additional accessories required to complete system for each ladder.

D. Furnish one harness for each ladder equipped with safety climb device.

E. Furnish pivot section at platforms, landings, and roofs.

F. When installed to required height, fall prevention system shall be rigid and an integral part of the structure.

3.07 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:

1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
3. Allow coating to dry before installation of the material.
4. Protect coated surfaces during installation.
5. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

B. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

C. Stainless Steel:

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

3.08 PAINTING

A. Painted Galvanized Surfaces: Prepare as specified in Section 09 90 00, Painting and Coating.

B. Repair of Damaged Hot-Dip Galvanized Coating:

1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.

4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

C. Field Painting of Shop Primed Surfaces: Prepare surfaces and field finish in accordance with Section 09 90 00, Painting and Coating.

3.09 FIELD QUALITY CONTROL

A. Owner-Furnished Quality Assurance:

1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on Drawings.
2. Contractor responsibilities and related information on special inspection and testing are included in Section 01 45 33, Special Inspection and Testing (to be completed).

B. Contractor-Furnished Quality Control:

1. Inspection and testing required in Section 01 45 16.13, Contractor Quality Control (to be completed).
2. Certificate of Compliance per Section 01 43 33, Manufacturer's Field Services (to be completed), for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01 61 00, Common Product Requirements and Section 01 88 15, Anchorage and Bracing (to be completed).

C. Stud Shear Connectors:

1. At start of each production period, conduct the following test to determine proper generator, control unit, and stud welding gun settings, in accordance with AWS D1.1/D1.1M, Chapter 7:
   a. Weld two test studs and visually inspect for full 360-degree flash.
   b. Bend test studs 30 degrees from vertical for headed anchor studs (HAS). Torque test threaded anchor studs (TAS) studs per AWS D1.1/D1.1M, Section 7.6.6.2.
   c. Test studs will be acceptable if there is no failure of welds.
   d. If weld fails, repeat test until two consecutive test studs test to be satisfactory.
2. During production, if visual inspection reveals weld does not exhibit full 360-degree flash or that stud has been repaired by welding, conduct the following test in accordance with AWS D1.1/D1.1M, Chapter 7:
   a. Bend HAS studs or stud shear connectors approximately 15 degrees from vertical, away from missing portion of flash. For TAS studs, torque test per AWS D1.1/D1.1M, Section 7.6.6.2.

b. Studs meeting this test without exhibiting cracks in weld will be considered acceptable and left in bent position.
c. Replace studs failing test.

3. Special inspection shall be provided by Owner where indicated on Drawings.

3.10 FASTENER SCHEDULE

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

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating	See Section 09 90 00, Painting and Coating
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating
3. Drilled Anchors for Metal Components to Cast-in-Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment)		
Interior Dry Areas	Zinc-plated or stainless steel wedge or expansion anchors	Use zinc-plated undercut anchors for overhead and ceiling installations.

Service Use and Location	Product	Remarks
Submerged, Exterior, Interior Wet, and Corrosive Areas	Adhesive stainless steel anchors	Use stainless steel undercut anchors for overhead and ceiling installations.
4. Anchors in Grout-Filled Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Hot-dip galvanized steel headed anchor bolts, zinc-plated or stainless steel sleeve anchors, or stainless steel adhesive anchors	
5. Anchors in Hollow Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Zinc-plated or stainless steel sleeve anchors, or stainless steel adhesive anchors with screen tube	
6. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.
7. Connections for Steel Fabrications and Wood Components		
Exterior and Interior Wet and Dry Areas	Hot-dip galvanized carbon steel bolted connections	
8. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
9. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on stainless steel threads.

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

END OF SECTION

SECTION 05 52 00
METAL RAILINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. Aluminum Association, Incorporated (AA): DAF45, Designation System for Aluminum Finishes.
2. American Iron and Steel Institute (AISI).
3. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   e. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   f. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   g. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   h. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
   i. E985, Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
4. International Code Council (ICC): International Building Code (IBC).
5. Occupational Safety and Health Act (OSHA): 29 CFR 1910, Code of Federal Regulations.

1.02 DEFINITIONS

A. Handrails: Synonymous with terms; i.e., guardrail system, railing system, ramp-rail system, and stair-rail system. Handrails are comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.

B. ICC Evaluation Services Report for concrete anchor manufacturers.

C. Special Inspection: As governed by the ICC IBC.

D. Toeboards: Vertical barrier at floor level usually erected on handrails along exposed edges of floor or wall openings, platforms, ramps, or stairs to prevent miscellaneous items from falling through.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Indicate handrail profiles, sizes, connections, anchorage, size and type of fasteners, and accessories. Project-specific scale plans and elevations of handrails.
   b. Manufacturer's literature and catalog data of handrail and components.
   c. Design Data: Calculations or test data using design performance loads and include the following:
      1) Bending stress in, and deflection of, posts in accordance with ASTM E985.
      2) Stress in post base connection.
      3) Calculation of anchorage forces and comparison of these forces to ICC IBC recommendations regarding safe allowable design loads of anchorages.
      4) For concrete anchor spacings less than 12 anchor diameters and edge distances less than six anchor diameters, make reduction in allowable pullout and shear values. Provide independent laboratory inspection service for ICC Evaluation Services Report values with Special Inspection.
2. Samples:
   a. Railing sections, 6 inches long showing different connections and proposed finish.
   b. Each fitting including wall brackets, castings, toeboard fittings, and rail expansion joints.

B. Informational Submittals:

1. Manufacturer's assembly and installation instructions.
2. Special Inspection:
   a. Manufacturer's instructions for Special Inspection of concrete anchors.

b. Special Inspection report in accordance with Article Tests and Inspections.

C. Manufacturer's Certificate of Proper Installation in accordance with General Conditions (to be completed).

1. Manufacturer's written recommendations describing procedures for maintaining handrails including cleaning materials, application methods, and precautions to be taken in the use of cleaning materials.
2. Test Reports: Test data may supplement load calculations providing data covers the complete handrail system, including anchorage:
   a. Test data for handrail and components showing load and deflection due to load, in enough detail to prove handrail is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR 1910, using design loads specified. Include test data for the following:
      1) Railing and post connections.
      2) Railing wall connections.
      3) Post and base connections.
      4) Railing expansion joint connections.
      5) Railing gate assembly, including latch and gate stop. Both gate latch and stop to support required loads applied, independent of each other.
   b. Deflection Criteria: In accordance with ASTM E985 and design loads specified.
   c. Aluminum Rail Piping: Test data showing yield strength of pipe as-delivered equals or exceeds values specified in this section.
   d. Concrete Anchors: Calculations and test data for review prior to use, on anchors other than those specified.

1.04 QUALITY ASSURANCE

A. Qualifications: Calculations required for design data stamped by a registered civil or structural engineer licensed in the state where the Project will be constructed.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Handrails adequately packaged and wrapped to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping until railing is completely installed.

B. Aluminum Handrails:

1. Shop assemble into practical modules of lengths not exceeding 24 feet for shipment.
2. Deliver toeboards loose for field assembly.
3. Deliver clear anodized handrail pipe and posts with protective plastic wrap.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Thermal Movements: Allow for thermal movement resulting from the following maximum range in ambient temperature in design, fabrication, and installation of handrails to prevent buckling, opening up of joints, over stressing of components, connections and other detrimental effects. Base design calculation on actual surface temperatures of materials due to both solar heat gain and night time sky heat loss. Temperature change is difference between high or low temperature and installation temperature.

1. Temperature Change Range: 100 degrees F, material surfaces.

PART 2 PRODUCTS

2.01 DESIGN PERFORMANCE

A. Structural Performance of Handrails: Design, test, fabricate, and install handrails to withstand the following structural loads without exceeding allowable design working stress or allowable deflection. Apply each load to produce maximum stress and deflection in each of the respective components comprising handrails.

1. Top Rail of Handrails: Capable of withstanding the following load cases applied:
   a. Concentrated load of 200 pounds applied at any point and in any direction in accordance with ICC IBC.
   b. Uniform load of 50 pounds per linear foot applied in any direction in accordance with ICC IBC.
   c. Concentrated load need not be assumed to act concurrently with uniform loads in accordance with ICC IBC.
2. In-Fill Area of Railing Systems:
   a. Capable of withstanding a horizontally applied normal load of 50 pounds applied to 1 square foot at any point in the system including panels, intermediate rails, balusters, and openings and space between railings.
   b. Horizontal concentrated load need not be assumed to act concurrently with loads on top rails of handrails.

3. Mid-rails with corner returns to withstand a 300-pound concentrated vertical load applied at any point or direction without damage and loosening of pipe, fittings, or attachment hardware.
4. Concrete Anchors for Handrail Wall Brackets: Anchors with a strength required by calculations with concrete strength assumed at 4,000 psi and in conformance with ICC IBC.
5. Concrete Anchors: In accordance with ICC IBC for size, length, embedment, spacing, and edge distance to match required loads shown in calculations.

2.02 ALUMINUM HANDRAILS

A. General:

1. Furnish pre-engineered and prefabricated three picket handrails.
2. Pop rivets and glued railing construction not permitted.

B. Manufacturers:

1. Thompson Fabricating Co., Birmingham, AL.
2. Moultrie Manufacturing, Moultrie, GA; Wesrail II.

C. Rails, Posts, and Formed Elbows: Extruded Alloy 6105-T5 or 6061-T6, minimum tensile strength of 38,000 psi and minimum yield strength of 35,000 psi.

1. Miscellaneous Aluminum Parts: 6063-T6 or 6061-T6 extruded aluminum of adequate strength for all loads.
2. Post and Railing: Nominal 1-1/2 inch diameter.
   a. Rails: 1.900-inch outside diameter by 0.145-inch wall thickness, Schedule 40.
   b. Posts: 1.900-inch outside diameter by 0.200-inch wall thickness, Schedule 80.
   c. Solid dowel interconnectors of 6105-T5 or 6061-T6 aluminum.

D. Fittings:

1. Handrail and Post Fittings: Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements. Fittings shall match color of pipe in handrails. Sand cast parts not permitted.
2. Concrete Top Mount Post Base:
   a. Four holes in base for concrete anchors. For narrow walls or curbs, furnish two holes in base for concrete anchors with required edge distance.

b. Manufacturers and Products:
   1) Thompson Fabricating Co.; Part No. TBF-3.4 and Part No. TBF-3.2 for narrow walls and curbs.
   2) Moultrie Manufacturing Co.; Part No. WII4HB and WII2HB for narrow walls and curbs.

3. Concrete Side Mounted Handrail Bracket: Extruded aluminum, Alloy 6063-T6 with four holes for bolts or concrete anchors.
   a. Manufacturers and Products:
      1) Thompson Fabricating Co.; Part No. TSM-1.5.
      2) Moultrie Manufacturing Co.; Part No. WIISMB.
4. Concrete Anchors for Securing Bases and Brackets to Concrete: Type 304 or Type 316 stainless steel 1/2-inch concrete anchors.
5. Handrail Connections for Metal Stairway Stringers:
   a. Extruded aluminum bracket, Alloy 6063-T6.
   b. Brackets bolts 1/2-inch diameter Type 304 or Type 316 stainless steel bolts.
   c. Offset Adjustable Stair Fitting:
      1) Thompson Fabricating Co.; Part No. ASF of cast Al-mag.
      2) Moultrie Manufacturing Co.; Standard and custom elbow angles, Part No. W51XXX (numbers vary based on angle).
   d. Additional Offset Adjustable Fitting for Picket Railing System: Thompson Fabricating Co.; Part No. APF of cast Al-mag.
   e. Base Connection:
      1) Manufacturers and Products:
         a) Thompson Fabricating Co.; Part Nos. SMB-2 or SMB-3, ASF, APF.
         b) Moultrie Manufacturing Co.; Part No. WIISMBEXT.
6. Handrail Connections for Metal Beams:
   a. Extruded aluminum bracket, Alloy 6063-T6.
   b. Bracket bolts 1/2-inch diameter Type 304 stainless steel bolts.
   c. Manufacturers and Products:
      1) Thompson Fabricating Co.; Part Nos. SMB-2 or SMB-3. Use Part No. TSM-1.5 if bracket is attached to flat side of channel.
      2) Moultrie Manufacturing Co.; Part No. WIISMBEXT. Use Part No. WIISMB if bracket is attached to flat side of channel.
7. Handrail Wall Brackets: Adjustable wall fitting, with provision for three 3/8-inch Type 304 stainless steel bolts or concrete anchors.
   a. Manufacturers and Products:
      1) Thompson Fabricating Co.; Part No. AWF cast Al-mag aluminum bracket.
      2) Moultrie Manufacturing Co.; Part No. W41100.

8. Miscellaneous Rail to Post Fittings:
   a. Aluminum Tee Fittings:
      1) Manufacturers and Products:
         a) Thompson Fabricating Co.; Part Nos. TF-1 and TX-1.
         b) Moultrie Manufacturing Co.; Part Nos. WIIT40, WIIT40/05, WIIT80, and WIIT80/05.
   b. Aluminum Ell Fittings:
      1) Manufacturers and Products:
         a) Thompson Fabricating Co.; Part Nos. TE-1, TE-2, and TE-3.
         b) Moultrie Manufacturing Co.; Part No. 51900.
   c. Aluminum Splice Lock:
      1) Manufacturers and Products:
         a) Thompson Fabricating Co.; Part No. SL-1.
         b) Moultrie Manufacturing Co.; Part No. WIIS40.
   d. Aluminum Expansion Joint Splice:
      1) Manufacturers and Products:
         a) Thompson Fabricating Co.; Part No. ES-1.
         b) Moultrie Manufacturing Co.; Part No. WII40, omit set screws on one side.
   e. Formed Aluminum Wall Flange:
      1) Manufacturers and Products:
         a) Thompson Fabricating Co.; Part No. CF-2.
         b) Moultrie Manufacturing Co.; Part No. 41250.
9. Handrail Gate: 6063-T6, 6105-T5, or 6061-T6 extruded aluminum.
   a. Hardware Manufacturers and Products:
      1) Julius Blum & Co., Inc., Carlstadt, NJ; No. 782/3 gate hinges with springs, and No. 784 gate latch and stop.
      2) CraneVeyor Corp., South El Monte, CA; No. C4370b gate hinges with spring, No. C4369 gate latch, and No. C4368 gate stop.
      3) Thompson Fabricating Co., Birmingham, AL.
      4) Moultrie Manufacturing Co., Moultrie, GA; Part No. W60006.
10. In-Fill Area Picket and Attachments:
   a. 1/2-inch Schedule 40 aluminum pipe (picket). Alloy 6105, 6063, or 6061.
   b. Extruded aluminum 1-1/2-inch by 7/8-inch by 1/8-inch channel. Alloy 6105, 6063, or 6061.
   c. Fittings for Offset Stair Railings:
      1) Cast Al-mag Adjustable Picket Fitting Manufacturer and Product: Thompson Fabricating Co.; Part No. APF.
      2) Cast Al-mag Adjustable Stair Fitting Manufacturer and Product: Thompson Fabricating Co.; Part No. ASF.

d. Furnish neoprene plug for each end of the picket.

11. Toeboards and Accessories:
    a. Material: Molded or extruded 6063 or 6061 aluminum.
        1) Manufacturers and Products:
            a) Thompson Fabricating Co.
            b) Moultrie Manufacturing Co.; Part No. WIIKP20.
    b. Castings for Handrails:
        1) Cast Al-mag with sufficient strength to meet load and test requirements.
        2) Anodizable grade finish with excellent resistance to corrosion when subject to exposure of sodium chloride solution intermittent spray and immersion.

E. Concrete Embedded Metal Anchorages: In accordance with Section 05 50 00, Metal Fabrications.

F. Finishes:

1. Handrail Pipe and Post: In accordance with AA DAF45, designation AA-M32-C22-A41.
2. Cast Fittings and Toeboards: In accordance with AA DAF45, designation AA-M10-C22-A41.

2.03 GALVANIZED STEEL HANDRAILS

A. Pipe: Hot-dip galvanized carbon steel, ASTM A53/A53M, Type E or S, Grade B; or ASTM A501, 1-1/2-inch NPS with 1.900-inch outside diameter and a minimum 0.145-inch wall thickness for rails and a minimum of 0.200-inch wall thickness for posts.

B. Fittings:

1. Anchor Bolts and Fasteners: Stainless steel.
2. Handrail Post Bolted Baseplate Connector: Baseplate, carbon steel ASTM A36/A36M.
    a. Insert: Minimum wall thickness of 0.200 inch or from solid rod in accordance with ASTM A36/A36M.
3. Handrail Wall Brackets: Malleable iron, round top, and galvanized.
    a. Manufacturers and Products:
        1) R & B Wagner; No. 1765.
        2) Julius Blum; No. 1382.

4. Handrail Gate: As specified for galvanized steel piping.
   a. Gate Hardware Manufacturers and Products: Type 304 stainless steel:
      1) Julius Blum & Co., Inc., Carlstadt, NJ; Connectorail System, No. 782/3 gate hinges with spring, and No. 784 gate latch and stop.
      2) Craneveyor Corp., South El Monte, CA; No. C4370b gate hinges with spring, No. C4369 gate latch, and No. C4368 gate stop.
5. Handrail Picket Panels and Clamps:
   a. Solid bar steel meeting minimum requirements specified for piping.
   b. Fasteners: Stainless steel.
6. Toeboards and Accessories:
   a. ASTM A36/A36M steel.
   b. Fasteners: Stainless steel.

C. Concrete Embedded Metal Anchorages: In accordance with Section 05 50 00, Metal Fabrications.

D. Fasteners: Stainless steel.

2.04 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

A. Locknuts, Washers, and Screws:

1. Elastic Locknuts, Steel Flat Washers, RHMS Round Head Machine Screws: Type A 304 or Type A316 stainless steel.
2. Flat Washers: Molded nylon.
3. Manufacturer: McMaster-Carr Supply Co., Los Angeles, CA.

B. Bolts and Nuts for Bolting Handrail to Metal Beams: ASTM A193/A193M and ASTM A194/A194M, Type A 316 stainless steel with minimum yield strength for bolts of 95,000 psi, unless otherwise shown.

C. Concrete Anchors:

1. Stainless steel Type 304 or Type 316.
2. Use ICC IBC approved values for size, length, embedment, spacing, and edge distance to match required loads shown in calculations.

D. Epoxy Anchors: Heavy-duty 1/2-inch diameter, for exterior use only in accordance with Section 05 50 00, Metal Fabrications, as an alternative to mechanical concrete anchors. Design and provide the number required. Do not use where fire or elevated temperatures above 110 degrees F exist.

2.05 FABRICATION OF ALUMINUM HANDRAILS

A. Shop Assembly:

1. Post Spacing: Maximum 6-foot horizontal spacing.
2. Railing Posts Bolted to Metal or Concrete:
   a. In lieu of field cutting, provide approved fitting with sufficient post overlap, containing provisions for vertical adjustment.
   b. Field fit-up is required.
3. Free of burrs, nicks, and sharp edges when fabrication is complete.
4. Welding is not permitted.

B. Shop/Factory Finishing:

1. Use same alloy for uniform appearance throughout fabrication for railings.
2. Handrail and Post Fittings: Match fittings with color of pipe in handrail.
3. Sand cast parts not permitted.

C. Tolerances:

1. Shop assemble rails, posts, and formed elbows with a close tolerance for tight fit.
2. Fit dowels tightly inside posts.

2.06 FABRICATION OF GALVANIZED STEEL HANDRAILS

A. Shop Assembly:

1. Alternate Post to Baseplate Connection:
   a. Field measure elevation of concrete at each post location and determine exact post length so baseplate is on concrete surface without shims or grout. Rails shall be in straight alignment when all rails to posts and posts to baseplates are welded.
   b. Grind welds prior to hot-dip galvanizing of railing sections.
2. Handrail Post Bolted to Metal or Concrete:
   a. Field fit-up is required.
   b. Field measure and weld post to baseplate as an alternative to field cutting.
3. Remove burrs from cut edges.
4. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with finished surfaces smooth.
5. Cover exposed ends of steel pipe by welding 3/16-inch thick steel plate in place or use prefabricated fittings.

6. Welding:
   a. Thoroughly fuse without undercutting or overlap.
   b. Remove splatter, grind exposed welds to blend, and contour surfaces to match those adjacent.
7. Furnish explosion prevention holes at closed ends of pipes.
8. Form and assemble joints exposed to weather to prevent water and moisture from penetrating.

B. Shop/Factory Finishing: Hot-dip galvanize all components in accordance with ASTM A123/A123M after fabrication.

C. Tolerances:

1. Cut pipe square within 2 degrees and to lengths within 1/8 inch.
2. Welding: Miter and cope intersections of posts and rails within 2 degrees, fit to within 0.020 inch, and perform continuous welds around joints.
3. Repair of Defective Work: Remove stains and replace defective Work.

PART 3 EXECUTION

3.01 GENERAL

A. Provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on the actual structure. Install railing with a base that provides plus or minus 1/4-inch vertical adjustment inside the base fitting. If adjustment is required in the field and exceeds plus or minus 1/4-inch, reduce post length not to exceed beyond bottom of lowest set-screw or bolt in base fitting.

B. Field fabrication of aluminum railing systems not permitted.

C. Modification to structure not permitted where handrail is attached.

D. Mount handrails only on completed walls. Do not support handrails temporarily by means not satisfying structural performance requirements.

3.02 HANDRAIL INSTALLATION

A. Assembly and Installation: Perform in accordance with manufacturer’s written recommendations for installation.

B. Protection from Entrapped Water:

1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
2. Posts mounted in concrete, bends and elbows occurring at low points, drill weep holes of 1/4-inch diameter at lowest possible elevations, one hole per post or rail. Drill hole in the plane of the rail.

C. Expansion Joints:

1. Maximum intervals of 54 feet on center and at structural joints.
2. Slip joint with internal sleeve extending 2 inches beyond each side of joint. Provide 1/2-inch slip joint gap to allow for expansion.
3. Fasten to one side using 3/8-inch diameter set-screw. Place set-screw at bottom of pipe.
4. Locate joints within 12 inches of posts. Locate expansion joints in rails that span expansion joints in structural walls and floors supporting the posts.

D. Setting Posts:

1. Embedded:
   a. Clean dust and foreign matter from sleeves or blockouts.
   b. Moisten interior of hole and surrounding surface with clean water. Fill hole with nonshrink grout prior to installing post.
   c. Brace railing until grout sets.
   d. Posts installed outside and exposed to freezing temperatures, drill weep hole through post approximately 1/2 inch above level of grout inside post and in plane of rail to prevent entrapment and freezing of water inside post.
2. Surface Mounted:
   a. Bolt post baseplate connectors firmly in place.
   b. Shims, wedges, grout, and similar devices for handrail post alignment not permitted.

E. Posts and Rails:

1. Set posts plumb and aligned to within 1/8 inch in 12 feet.
2. Set rails horizontal or parallel to slope of steps to within 1/8 inch in 12 feet.
3. Install posts and rails in same plane. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.
4. Support 1-1/2-inch rails directly above stairway stringers with offset fittings.

F. Handrail Wall Brackets:

1. Support wall rails on brackets spaced maximum 6 feet on centers for steel and 5 feet for aluminum as measured on the horizontal projection.
2. Install wall anchor backplates on solid blocking in stud walls.

G. Toeboard:

1. Provide at all handrails except where 4-inch or higher concrete curbs are installed or at gates.
2. Accurately measure in field for correct length, after handrail post installation, cut and secure to posts.
3. Dimension between bottom of toeboard and walking surface not to exceed 1/4 inch.
4. Aluminum Toeboards: Provide expansion and contraction connections between each post.
5. Steel Toeboards: Between each post cut toeboard and provide slotted holes for expansion and contraction.

H. Railing Gate: Install in accordance with manufacturer's installation instructions.

3.03 FIELD FINISHING

A. Corrosion Protection: Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces as specified in Section 09 90 00, Painting and Coating.

1. Treatment of Field Welds for Galvanized Steel Railings: Touch up welds by application of two coats high-zinc dust content paint to dry film thickness of 2 mils.

3.04 TESTS AND INSPECTIONS

A. Perform Special Inspection for anchors where ICC Evaluation Services Reports require them for anchor strength value used.

B. Provide an independent test laboratory to perform Special Inspection.

3.05 CLEANING

A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.

B. Do not use acid solution, steel wool, or other harsh abrasive.

C. If stain remains after washing, restore in accordance with manufacturer's recommendations, or replace stained handrails.

END OF SECTION

SECTION 05 53 00
METAL GRATINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A510, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
   c. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   d. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   e. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
3. National Association of Architectural Metal Manufacturers (NAAMM):
   a. MBG 531, Metal Bar Grating Manual.
   b. MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Grating:
      1) Provide span and deflection tables.
      2) Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
   b. Grating Anchorage: Show details of anchorage to supports to prevent displacement from traffic impact.
   c. Product data for grating, grating clips, anchors, accessories, and other manufactured products specified herein.
   d. Manufacturer’s specifications, including coatings, surface treatment, and finishes.

e. Samples: Two Samples of grating approximately 4 inches by 8 inches, showing at least four crossbars each and four bearing bars each. One Sample will be retained at Site to be used as a basis for acceptance or rejection of grating installed.

B. Informational Submittals:

1. Special handling and storage requirements.
2. Installation instructions.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Insofar as is practical, factory assemble items.

B. Package and clearly tag parts and assemblies that are, due to necessity, shipped unassembled.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Alabama Metal Industries Corporation (AMICO), Birmingham, AL.
2. IKG Industries, Houston, TX.
3. Ohio Gratings, Inc., Canton, OH.
1. Seidelhuber Metal Products, Inc., South San Francisco, CA.

2.02 GRATING MATERIALS

A. Aluminum: Provide alloy and temper as designated below.

1. Bearing Bars and Banding: ASTM B221 alloy 6061-T6 or 6063-T6.
2. Swaged Crossbar Rods: ASTM B221 alloy 6061 or 6063, or ASTM B210 alloy 3003.
3. Finish: Mill.

2.03 METAL BAR GRATING

A. General Requirements:

1. Maximum Service Load:
   a. Light Duty (Type A): 100 psf uniformly distributed load.
2. Maximum Deflection: Span/240 or 1/4 inch, whichever is less.

3. Bearing Bar Spacing:
   a. Light Duty: 1-3/16 inch maximum, center-to-center.
4. Cross Bar Spacing: 4 inches maximum, center-to-center. For aluminum I-bar grating with depths greater than 2 inches, provide cross bars at 2 inches maximum, center-to-center.
5. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 531 or as shown on Drawings.

B. Grating Materials: Aluminum, pressure-locked rectangular bar grating fabricated by pressing crossbars between rectangular bearing bars.

C. Surface:

1. Slip resistant, consisting of an applied abrasive finish of aluminum-oxide aggregate.
2. When surface of bars is serrated provide 1/4-inch deeper bearing bars than shown on Drawings to maintain specified load carrying capacity of grating.

D. Stair Treads:

1. Material and Type: Same as grating material and grating type as furnished for connecting walkway or work surface.
2. Nosings: Integral ribbing and serrated edge on one long axis of tread, or nonslip abrasive on each tread along one long edge.
3. Carrier Plate or Angle: Furnish at each end for connection to stair stringers.

2.04 ACCESSORIES

A. Embedded Frames: As indicated on Drawings and as specified in Section 05 50 00, Metal Fabrications.

B. Grating Clamps:

1. Use at flanged beam and bolted angle frame supports.
2. Removable from above grating walkway surface.
3. Provide hat bracket, recessed bolt, and bottom clamp of same material as grating.
4. Manufacturers and Products:
   a. Direct Metals Company, LLC, Kennesaw, GA; Grating Clamp.
   b. Grating Fasteners, Inc., Harvey, LA; G-Clip.

C. Anchor Stud and Saddle Clip:

1. Use at embedded angle frame supports with stud anchor and nut recessed below top of grating surface.
2. Removable from above grating walkway surface.
3. Provide Type 316 stainless steel welded threaded stud anchor, nut, washer, and saddle clip.
4. Manufacturers and Products:
   a. Welded Stud Anchor:
      1) Nelson Stud Welding, Inc., Elyria, OH.
      2) Stud Welding Associates, Inc. Elyria, OH.
   b. Saddle Clip:
      1) Direct Metals Company, LLC, Kennesaw, GA; Saddle Clip.
      2) Grating Fasteners, Inc., Harvey, LA; Saddle Clip.
      3) Struct-Fast, Inc., Baltimore, MD; Gratefast.

2.05 FABRICATION

A. General:

1. In accordance with NAAMM MBG 531 or NAAMM MBG 532.
2. Do not weld aluminum grating.
3. Conceal fastenings where practical.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Cutouts:
   a. Fabricate in grating sections for penetrations indicated.
   b. Arrange to permit grating removal without disturbing items penetrating grating.
   c. Edge band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
6. Do not notch bearing bars at supports to maintain elevation.
7. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
8. Section Length: Sufficient to prevent section from falling through clear opening when oriented in the span direction and one end is touching either the concrete or the vertical leg of grating support.
9. Minimum Bearing: 1 inch for grating depth up to 2-1/4 inches and 2 inches for grating depth greater than 2-1/4 inches.
10. Banding and Toe Plates: Same material as grating and welded to bearing bars in accordance with requirements of NAAMM MBG 531 and NAAMM MBG 532.

B. Metal Bar Grating: A single grating section shall be not less than 1.5 feet or greater than 3 feet in width, or weigh more than 150 pounds.

C. Supports:

1. Same material as grating, except that supports which are to be embedded in concrete shall be Type 316 stainless steel, unless part of an extruded aluminum system.
2. Coordinate dimensions and fabrication with grating to be supported.
3. Coordinate dimensions with increased depth due to serrations.

PART 3 EXECUTION

3.01 PREPARATION

A. Electrolytic Protection:

1. Protect aluminum surfaces in contact with dissimilar metals, or embedded or in contact with masonry, grout, or concrete as specified in Section 09 90 00, Painting and Coating.
2. Allow paint to dry before installation of material.

3.02 INSTALLATION

A. Until grating sections are securely fastened in place, area shall be appropriately barricaded or flagged to alert people working in the area of potential fall hazard.

B. Install manufactured products in accordance with manufacturer’s recommendations.

C. Install supports such that grating sections have a solid bearing on both ends, and that grating sections will not rock or wobble under design loads.

D. Install grating supports plumb and level as applicable.

E. Install sections of welded frames with anchors to straight plane without offsets.

F. Field locate and install fasteners to fit grating layout.

G. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.

H. Each grating or plank section shall be easily removable and replaceable.

I. Completed installation shall be rigid and neat in appearance.

J. Protect painted and galvanized surfaces during installation.

K. Repair damaged coatings as specified in Section 09 90 00, Painting and Coating.

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.01 REFERENCES

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

1. American Forest and Paper Association (AF&PA): 2, National Design Specification for Wood Construction.
2. American Hardboard Association (AHA): A135.4, Basic Hardboard.
3. American Institute of Timber Construction (AITC): 112, Standard for Tongue-and-Groove Heavy Timber Roof Decking.
4. American Lumber Standards Committee's Board of Review (ALSC).
5. American Wood Preservers' Association (AWPA):
   a. U1, User Specification for Treated Wood.
   b. M4, Standard for the Care of Preservative-Treated Wood Products.
6. APA - The Engineered Wood Association (APA):
   a. PRP-108, Performance Standards and Qualification Policy for Structural-Use Panels (Form E445).
   b. Form B445, APA Quality Assurance Policies for Structural-Use Panels Qualified to PRP-108.
7. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   d. C1177/C1177M, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
   e. C1396/C1396M, Standard Specification for Gypsum Board.
   f. D226/D226M, Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   g. D3498, Standard Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems.
   h. D5456, Standard Specification for Evaluation of Structural Composite Lumber Products.

i. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
j. F1667, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

8. Composite Panel Association (CPA): A208.1, Standard for Particleboard.
9. International Code Council (ICC):
   a. ESR-1539, Power-Driven Staples and Nails.
   b. International Building Code (IBC).
10. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
11. Southern Pine Inspection Bureau (SPIB): 1003, Grading Rules.
12. Underwriters Laboratories, Inc. (UL): 723, Standard for Safety Test for Surface Burning Characteristics of Building Materials.
13. U.S. Department of Commerce—Voluntary Product Standard (DOC):
    a. PS 1, Structural Plywood.
    b. PS 2, Performance Standard for Wood-Based Structural-Use Panels.
    c. PS 20, American Softwood Lumber Standard.
14. Western Wood Products Association (WWPA): G5, Western Lumber Grading Rules.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data: Indicate component materials and dimensions, and include construction and application details for the following:
   a. Underlayment.
   b. Sheathing.
   c. Metal framing anchors.
   d. Construction adhesives.
   e. Construction panel thickness where not shown.
   f. APA product reports in accordance with 2012 IBC, Section 104.11 for structural composite lumber.

B. Informational Submittals:

1. ICC Evaluation Service Reports, including the following as a minimum:
   a. Connections and Fasteners.
   b. Wood Treatment.
   c. Nails.
   d. Wood Framing.

e. Structural Panels.
f. Shear Wall Panels.

2. Wood treatment manufacturer's instructions for handling, storing, installation, and finishing of treated material.
3. Material Certificates: Showing species and grade selected for dimension lumber for each use.
   a. Material certificates for dimensional lumber in compliance with allowable unit stresses. Show species and grade selected for each use as well as design values approved by the ALSC's Board of Review.
   b. For each type of preservative-treated wood product, include certification by treatment plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
   c. For waterborne-treated products include statement that moisture content of treated materials was reduced to levels indicated prior to shipment to Site.
4. Material test reports from testing laboratory showing and interpreting test results in accordance with test methods UL 723, NFPA 255, and ASTM E84, relative to fire-retardant treated wood products.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Upon delivery to Site, immediately place materials in area protected from weather. Do not store seasoned materials in wet or damp areas.

B. Protect sheet materials from breaking corners and damaging surfaces while unloading.

C. Store materials a minimum of 6 inches above ground on framework or blocking and cover with waterproof covering, providing for adequate air circulation and ventilation. Store sheet materials flat, not on edge.

D. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

E. Store materials for which maximum moisture content is specified in areas where humidity can be controlled.

PART 2 PRODUCTS

2.01 GENERAL

A. Lumber Standards:

1. In accordance with DOC PS 20 and applicable grading rules and wood species certified by ALSC.
2. Design values for wood members equal to those published in supplement to AF&PA 2.
3. Stamp or brand each unexposed piece of lumber with grade, species, and moisture content at time of mill surfacing.
4. Furnish exposed lumber pieces with grade stamps applied to ends or back of each piece. If completely exposed, and permitted by local building jurisdiction, omit grade stamps entirely.

B. Lumber sizes shown on Drawings are nominal, unless shown otherwise. Provide actual sizes as required by DOC PS 20 for use.

C. Dressed lumber S4S, unless shown otherwise on Drawings.

D. Moisture content of lumber not to exceed 19 percent, unless otherwise specified and marked “DRY.”

E. Each plywood panel identified with designated grade trademark of APA.

2.02 LUMBER

A. Lumber grade shall be as noted on Drawings.

2.03 CONSTRUCTION PANELS

A. Plywood:

1. General:
   a. Where construction panels are shown on Drawings for the following concealed types of applications, provide APA Performance-Rated Panels complying with requirements designated under each application for grade designation, span rating, exposure durability classification, and thickness.
   b. Construction Panel Standards: Comply with DOC PS 1 for plywood construction panels and for products not manufactured under DOC PS 1 provisions, in accordance with APA PRP-108 and APA Form B445.

c. Trademark: Each construction panel factory-marked with APA trademark evidencing compliance with grade requirements.

2. Wall Sheathing: APA rated plywood sheathing.
   a. Exposure Durability Classification: EXTERIOR.
   b. Span Rating: 24/16.
3. Roof Sheathing: APA rated plywood sheathing.
   a. Exposure Durability Classification: EXTERIOR.
   b. Span Rating: 24/16.

2.04 PRESERVATIVE WOOD TREATMENT BY PRESSURE PROCESS

A. Where lumber or plywood is indicated as preservative-treated wood, in accordance with AWPA U1 and AWPA M4, mark and grade each treated item in accordance with SPIB 1003 or WWPA G5.

1. Kiln-dry after treatment to maximum moisture content of 19 percent.
2. Treat wood in contact with roofing or flashing.
3. Treat wood in contact with masonry or concrete.
4. Treat wood less than 18 inches above grade.

B. Aboveground Materials:

1. Pressure treat items with waterborne preservatives to a minimum retention of 0.25 per cubic foot.
2. Interior Use: After treatment, kiln-dry lumber and plywood to maximum moisture content of 19 percent and 15 percent respectively.
3. Treat the following items:
   a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
   c. Wood framing members less than 18 inches above grade.
   d. Wood floor plates installed over concrete slabs directly in contact with earth.

C. Materials in Contact with Ground or Freshwater: Pressure treat in accordance with applicable AWPA U1.

D. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces to comply with AWPA M4. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

2.05 FIRE-RETARDANT TREATED WOOD

A. Pressure treat lumber and plywood with fire-retardant chemicals in accordance with applicable AWPA U1 and AWPA M4 standard for species, product, preservative and end use to ensure flame-spread rating not higher than 25 with no evidence of significant progressive combustion when tested for 30 minutes duration under UL 723 and ASTM E84.

B. Treated lumber and plywood labeled and tested by Underwriters Laboratories, Inc. shall show performance rating.

2.06 HARDWARE

A. Fasteners and connectors in contact with preservative-treated or fire-retardant-treated wood shall be hot-dipped zinc-coated galvanized steel or stainless steel in accordance with ASTM A153/A153M.

B. Conform to ASTM F1667.

C. Nails:

1. Conform to ASTM F1667.
2. Steel common nails or alternatives listed in rough carpentry section of General Structural Notes found on Drawings.
3. Use hot-dipped zinc-coated nails wherever exposed.
4. Use deformed shank nails for fastening underlayment.

D. Staples: Conform to ASTM F1667, galvanized where exposed.

E. Power Driven Fasteners: Conform to ICC ESR-1539.

F. Bolts and Screws: Conform to ASTM A307, galvanized where exposed.

G. Framing Anchors, Joist, and Beam Hangers:

1. Manufacturers:
   a. United Steel Products, Gibraltar Industries, Montgomery, MN.
   b. KC Metal Products, San Jose, CA.
   c. Simpson Strong-Tie Co., Pleasanton, CA.
   d. Cleveland Steel Specialty Co., Bedford Heights, OH.

H. Metal Cross Bridging:

1. Manufacturers and Products:
   a. Cleveland Steel Specialty Co., Bedford Heights, OH; zinc-coated steel compression bridging.
   b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; galvanized NC/NCA bridging.

I. Structural Framing Connectors:

1. Manufacturers:
   a. Simpson Strong-Tie Co, Inc. Pleasanton, CA; hot-dip galvanized.
   b. United Steel Products Company; hot-dip galvanized.

2.07 MISCELLANEOUS

A. Construction Adhesives: Elastomeric glue conforming to ASTM D3498 for gluing subfloor to joists.

B. Roofing Felt: Asphalt-saturated organic felt conforming to ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify surfaces to receive rough carpentry materials are prepared to exact grades and dimensions.

3.02 GENERAL

A. Lay out, cut, fit, and install rough carpentry items. Anchor sufficiently to ensure rigidity and permanence.

B. Install items accurate to dimension, true to line, level, and square unless shown otherwise on Drawings. Provide for installation and support of other Work.

C. Discard units of material with defects that impair quality of rough carpentry construction and that are too small to use in fabricating rough carpentry with minimum joints or optimum joint arrangement.

D. Countersink nail heads on exposed carpentry work and fill holes.

E. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.

F. Field cuts and holes in pressure-treated lumber and timber shall be field treated with preservative in accordance with AWPA M4.

G. Holes shall be 1/16 inch larger than nominal bolt diameter, except holes for cast-in-place anchor bolts shall be 3/16 inch larger than nominal bolt diameter. Tight holes requiring forcible driving of bolts shall be enlarged by reaming.

H. Provide washers under bolt heads and nuts bearing on wood.

3.03 INSTALLATION

A. Sills and Plates: Set level and flush with outside face of foundation or as shown Drawings.

B. Stud Framing:

1. Plates and Stud Members:
   a. Provide single bottom plate and double top plates for load-bearing partitions, 2 inches thick by width of stud. Lap top plates at corners. Splice top plate two stud spaces from lower top plate.
   b. Provide single bottom plate and single top plate for nonload-bearing partitions, 2 inches thick by width of studs.
   c. Provide studs in continuous lengths without splice.
   d. End nail studs to bottom plate and end nail to lower top plate. Tilt up and anchor into place.
   e. Face-nail upper top plate to lower top plate.
   f. Nail bottom plate to wood construction.
   g. Anchor bottom plate to concrete structure as shown on Drawings.
   h. Triple studs at corners and partition intersections.
   i. Partition parallel with joists, locate two joists directly below studs.
   j. Frame openings with double studs and headers for openings less than 4 feet; triple studs and headers for openings 4 feet and greater.
2. Headers: In bearing and exterior walls, provide headers over openings. Maximum span:
   a. Spans to 3 Feet 6 Inches: Two 2 by 4.
   b. Spans to 4 Feet 6 Inches: Two 2 by 6.
   c. Spans to 6 Feet 0 Inch: Two 2 by 8.

d. Spans to 8 Feet 0 Inch: Two 2 by 10, braced.

3. Blocking:
   a. Install in continuous, staggered horizontal row where shown on Drawings or required by code.
   b. Locate blocking to facilitate installation of finishing materials, fixtures, specialty items, hardware, and trim.

C. Joist Framing:

1. Install with crown edge up.
2. Support ends of each member minimum 1-1/2 inches of bearing on wood or metal. Support ends of each member minimum 3 inches of bearing on masonry.
3. Lap members framing from opposite sides of beams, girders, or partitions, minimum 4 inches, or tie opposing members together by toenailing or metal connectors.
4. Anchor joists bearing on masonry as shown on Drawings.
5. Provide solid blocking between joists under door posts.
   a. Notches: Do not notch in middle third of joists. Notches in top or bottom of joists, maximum of 1/6 depth of member. Notched ends, maximum of 1/3 depth of member.
   b. Bored Holes: Maximum 1/3 depth of member, 2 inches minimum distance to top or bottom of joists.
   c. Bridging: Where nominal depth-to-thickness ratio of joists exceeds four, install bridging at 8-foot intervals.
   d. Metal Cross Bridging: Install with two 8d nails in each end, leaving a space between members, minimum of 1/8 inch.

D. Rafters:

1. Notch to fit exterior wall plates and toenail to plates.
2. Double rafters at opening in roof framing to provide headers and trimmers, and support with metal hangers.
3. At ridge, place rafters directly opposite each other and nail to ridge member or support with metal hangers.
4. At valleys, bevel ends of rafters for bearing against valley rafters.
5. At hips, bevel ends of rafters for bearing against hip rafters.

E. Beams and Girders:

1. Install with crown edge up.
2. Provide bearing at ends of each member minimum 4 inches.

3. Nail built-up beams or girders with two rows of 20d nails spaced maximum of 2 feet 8 inches on center, locating one row near top edge and other near bottom edge of member.
4. Where girders and beams are not continuous, splice together as shown on Drawings.
5. Where beams or girders are framed into pockets of exterior concrete or masonry walls, provide minimum of 1-inch air space between sides and ends of wood members and concrete or masonry wall.

F. Miscellaneous Framing:

1. Fire Stops:
   a. Stud Walls: 2 inches thick by depth of member blocking at each floor level and top story ceiling level, so placed that the maximum dimension of any concealed space is not over 10 feet.
   b. Floor and Ceiling Framing: 2 inches thick by depth of wood member blocking, fitted to fill openings from one space to another to prevent drafts.
   c. Chimneys and Fireplaces: Keep wood framing minimum of 2 inches from outside face of masonry and 4 inches from fireplace back wall.
2. Framing for Mechanical Work:
   a. Frame members for passage of pipes and ducts to avoid cutting structural members.
   b. Do not cut, notch, or bore framing members for passage of pipes or conduits without concurrence of Engineer. Reinforce framing members where damaged by cutting.

G. Roof Sheathing:

1. Install plywood panels with face grain perpendicular to supports, using panel continuous over two or more spans, with end joints staggered between panels and locate over supports.
2. Allow minimum space of 1/16 inch between end joints and 1/8 inch at edge joints for expansion and contraction of panels.
3. Support edge joints by use of ply clips or lumber blocking, unless noted otherwise on Drawings.
4. Unless noted otherwise on Drawings, minimum nailing shall be 6 inches on center along panel edges and 12 inches on center at intermediate supports.
5. Unless noted otherwise on Drawings, use 8d common nails for panels 3/4-inch thick and less, and 10d nails for greater thickness. See rough

carpentry section of General Structural Notes found on Drawings for alternate fastener and spacing options.

H. Wall Sheathing:

1. Allow minimum 1/16 inch space at end joints and 1/8 inch at edge joints, doubling these spacings in wet or humid conditions.
2. Unless noted otherwise on Drawings, minimum nailing shall be 6 inches on center along panel edges and 12 inches on center at intermediate supports.
3. Unless noted otherwise on Drawings, use 6d common nails for panels and 1/2-inch thick and less, and 8d nails for greater thickness. See rough carpentry section of General Structural Notes found on Drawings for alternate fastener and spacing options.
4. Place an air infiltration barrier horizontally over wall sheathing, weather lap edges, and ends.

3.04 PRESERVATIVE-TREATED WOOD PRODUCTS

A. Provide preservative-treated wood for framing, blocking, furring, nailing strips built into exterior masonry walls, wood in contact with concrete or masonry and in conjunction with gravel stops, and built-up roofing.

B. Apply two brush coats of same preservative used in original treatment to sawed or cut surfaces of treated lumber.

3.05 FIRE-RETARDANT TREATED WOOD

A. Provide fire-retardant treated lumber and plywood where indicated on Drawings.

END OF SECTION

SECTION 06 18 00
GLUED-LAMINATED CONSTRUCTION

PART 1 GENERAL

1.01 REFERENCES

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

1. American Institute of Timber Construction (AITC):
   a. 117, Standard Specification for Structural Glued Laminated Timber of Softwood Species, Design Requirements.
   b. A190.1, Wood Products - Structural Glued Laminated Timber.
2. American Lumber Standards Committee (ALSC).
3. American Wood-Preservers' Association (AWPA):
   a. C20, Structural Lumber - Fire-Retardant Treatment by Pressure Processes.
   b. C28, Standard for Preservative Treatment of Structural Glued Laminated Members and Lamination Before Gluing of Southern Pine, Coastal Douglas Fir, Hemfir and Western Hemlock by Pressure Processes.
   c. M4, Standard for the Care of Preservative-Treated Wood Products.
4. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   c. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   d. D2559, Standard Specification for Adhesives for Structural Laminated Wood Products for Use under Exterior (Wet Use) Exposure Conditions.
   e. D3737, Standard Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam).
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
5. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
6. Underwriters Laboratories, Inc. (UL): 723, Standard for Safety Test for Surface Burning Characteristics of Building Materials.
7. U.S. Department of Commerce (DOC): PS 20, American Softwood Lumber Standard.

1.02 DEFINITIONS

A. Glued Laminated (Glulam) Timber: Wood members fabricated from 2-inch nominal thickness lumber, glued face-to-face to a depth of four or more laminations.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Plan of structural glulam system with actual dimensions of each member. Large-scale details of connections, connectors, and accessories. Indicate species and laminating combination and adhesive type required for Work.
   b. Product data of the following:
      1) Lumber.
      2) Adhesives.
      3) Fabrication process.
      4) Accessories.
2. Samples: Submit 48 inches long by full width by depth of three laminations, showing range of variation expected in appearance of glulam units.

B. Informational Submittals:

1. Manufacturer’s instructions.
2. Manufacturer’s Certificate of Compliance, indicating conformance of glulam units with AITC A190.1.
3. Statements of Qualification:
   a. Manufacturer.
   b. Installer.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: AITC licensed; qualified to apply the AITC “Quality Inspected” mark.
2. Installer: Demonstrate, in writing, competence in installation of glulam units for at least 5 years.

1.05 DELIVERY AND STORAGE

A. Delivery:

1. Wrap each member with a moisture resistant paper before shipment.
2. Time delivery and installation of glulams to avoid extended onsite storage.

B. Storage:

1. Keep glued laminated structural units dry during delivery, storage, handling, and erection by maintaining factory applied protective covering in weathertight and light-proof condition. Maintain protective covering until building enclosure is completed to extent necessary for protection of interior glulam Work, and until final finishing of exterior Work is ready to proceed. Do not store glulam units in areas of either excessively high or excessively low relative humidity; comply with manufacturer's instructions.
2. Place individual or bundle wrapped units on blocks off ground with individual members separated for air circulation. Leave wrappings intact, but slit or puncture lower side to permit drainage of water which may otherwise accumulate.

PART 2 PRODUCTS

2.01 GLUED LAMINATED UNITS

A. General:

1. Comply with AITC A190.1 and ASTM D3737.
2. Factory mark each piece of glulam structural unit with an AITC Quality Inspected mark.
3. Place AITC mark on timber surfaces that will not be exposed in completed Work.

B. Lumber: Furnish members with minimum allowable working stress values for loads of normal duration of 2,400 psi in bending, 1,100 psi in tension, and 1,650 psi in compression parallel to grain and a minimum modulus of elasticity (E) of 1,700,000 psi for dry conditions of use.

C. Lumber Species: Softwood lumber or mixed species, at manufacturer's option, in compliance with requirements.

D. Lumber Species: Douglas Fir-Larch, and Southern Pine.

E. Adhesives: Conform to ASTM D2559, for exterior (wet use) exposure conditions for glulam units regardless of actual use. Comply with wet use adhesive requirements of AITC A190.1.

F. Connectors, Anchors, Accessories: Fabricated steel shapes, plates and bars, welded into assemblies of types and sizes as shown on Drawings in accordance with ASTM A36/A36M. Steel bolts in accordance with ASTM A307.

1. Coat surfaces of connectors, anchors, and accessories with hot-dip zinc coating in accordance with ASTM A153/A153M.

G. Fabrication:

1. Comply with AITC A190.1 for furnishing units; where dimensions are not completely documented, provide manufacturer's standard sizes and shapes. Shop fabricate connections and connecting hardware to greatest extent feasible, including drilling of bolt holes.
2. Appearance Grade: Architectural Grade units, complying with AITC 117.
3. End Cut Sealing: Immediately after end cutting each member to final length, apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces "flood coated" for not less than 10 minutes.
4. Seal Coat: After fabrication and sanding of each unit, and end coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit, except for treated wood where treatment has included a water repellent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide steel connectors, anchors, and accessories as necessary for a complete installation.

B. Install such that joints provide a close fit and neat appearance.

C. When hoisting members into place, use padded or non-marring slings, and protect corners with wood blocking. Handle and temporarily support members to prevent visible surface damage.

D. Adequately brace members as they are placed to maintain safe position until full stability is provided.

E. Avoid cutting glulam members during erection, to greatest extent possible. Except for fastener drilling and other minor cutting, coat cuts with end sealer. Where treated members must be cut during erection, apply a heavy brush coat of the same preservative treatment, complying with AWPA M4.

END OF SECTION

SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 REFERENCES

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

1. Architectural Woodwork Institute Quality Certification Corporation (AWI QCC): Quality Certification Program.
2. Architectural Woodwork Institute, Architectural Woodwork Manufacturers Association of Canada, Woodwork Institute (AWI, AWMAC, WI): Architectural Woodwork Standards.
3. Builders Hardware Manufacturers Association (BHMA):
   a. 156.9, Cabinet Hardware.
   b. 156.11, Cabinet Locks.
4. Federal Specifications (FS): A-A-1936, Adhesive, Contact, Neoprene Rubber.
5. Hardwood Plywood and Veneer Association (HPVA): HP-1, Hardwood and Decorative Plywood.
6. National Electrical Manufacturers' Association (NEMA): LD 3, High-Pressure Decorative Laminates (HPDL).
7. Woodwork Institute (WI): Certified Compliance Program (CCP).

1.02 DEFINITIONS

A. Trim: Includes baseboards, chair rails, interior cornices, window stools, door frames, and door and window casings.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Show details and dimensions not controlled by job conditions and required field measurements.
   b. Describe and illustrate features of design showing field measurements, construction details, dimensions, materials, and finish.
      1) Use full-size or 1/4-size scale drawings.
      2) Key to Contract Drawings.

c. Furnish manufacturer's descriptive literature of specialty items not manufactured by woodwork manufacturer.

2. Samples:
   a. Each finish to be applied by woodwork manufacturer.
   b. Casework unit complete with hardware, including locks and accessories, and top. Unit may be incorporated in the Work.

B. Informational Submittals: Proof of woodwork manufacturer qualifications.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Successful completion of comparable work on similar size project within 2 years before start of construction on this Project.
2. Quality Standards: AWI, AWMAC, WI Architectural Woodwork Standards.
3. Current member of AWI.
4. Engineer reserves right to approve woodwork manufacturer selected to furnish Work.

B. Casework and Paneling:

1. Reference to Premium, Custom, or Economy Grade: As defined in AWI, AWMAC, WI Architectural Woodwork Standards.
2. Provide Custom Grade, unless otherwise specified.

C. Cabinet Hardware: In accordance with BHMA 156.9 and BHMA 156.11.

D. Work in this section shall be accomplished under the Quality Certification Program of AWI QCC.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Defer delivery to Site until installation and storage areas are complete and dry of wet type construction, and excessive moisture has been out of building for at least 10 days.

B. Protect casework and paneling from damage and dampness. Store in weathertight, well-ventilated areas. Do not subject to extreme changes of temperature or humidity.

1.06 ENVIRONMENTAL REQUIREMENTS

A. For a minimum of 72 hours prior to installation, allow woodwork to come to equilibrium onsite in space where it is to be installed.

B. Humidity: For 24 hours before, during, and after installation, maintain relative humidity between 25 percent and 55 percent.

C. Temperature: For 24 hours before, during, and after installation, maintain ambient temperature between 65 degrees F and 75 degrees F.

PART 2 PRODUCTS

2.01 CASEWORK FINISH

A. Plastic Laminate:

1. Meet requirements of AWI, AWMAC, WI Architectural Woodwork Standards Section 10.
2. Furnish casework exposed surfaces, including top, edges, front face, and backsplashes, with plastic laminate in colors indicated in Interior Finish Schedule.

2.02 CASEWORK HARDWARE

A. Hinges: For flush overlay or reveal overlay, use pin, pivot, or European style hinge; 630 satin stainless steel finish.

1. Manufacturers:
   a. Blum, Inc.
   b. Grass America, Inc.
   c. Stanley.

B. Continuous Hinges: Stanley No. Sc 311-1/4; 630 satin stainless steel finish.

C. Locks: Sargent and Co. 1654 MKD or Schlage 46-002; 630 satin stainless steel finish keyed into building door lock system.

D. Catches: Stanley No. 46; 628 aluminum finish, magnetic.

E. Pivot Door Slides: Knape and Vogt No. 8085, medium duty.

F. Pulls: Solid stainless steel, Stanley No. 4484, Baldwin No. 4676; 630 satin stainless steel finish.

G. Drawer Slides: Knape and Vogt No. 1300 or Grant No. 336SC.

H. Heavy-Duty Drawer Slides: Knape and Vogt No. 1429 or Grant No. 4930.

I. Shelf Supports: Knape and Vogt No. 255/256 or Grant No. 120/121, nickel-plated finish.

J. Heavy-Duty Shelf Supports: Knape and Vogt slotted standard No. 82 and bracket No. 182; or Stanley No. 6783 and 6785, clear anodized aluminum finish.

K. Shelf and Rod Support: Stanley No. 7046 or Knape and Vogt No. 1194.

L. Hanging Rod with Flanges: Knape and Vogt No. 770-1 with 734 and 735, or Builders Brass Works 7770-5 with 7775-5 and 7776-5.

M. Heavy-Duty Folding Bracket: Stanley No. V772 heavy-duty folding shelf bracket.

N. Heavy-Duty Pivot Door Slides: HAWA-Turnaway 35/X3, pivot sliding door fitting.

2.03 PLASTIC LAMINATE

A. Counter Tops:

1. NEMA LD 3, Grade GP 50; solid color, standard velvet finish.
2. Color as indicated in Interior Finish Schedule.
3. Manufacturers and Products:
   a. Wilson Art; Tuf-Surf.
   b. Westinghouse; Micarta.
   c. Formica Corp.

B. General Use and Paneling: NEMA LD 3, Grade GP 38; in colors indicated in Interior Finish Schedule.

2.04 ANCILLARY MATERIALS

A. Adhesives:

1. Woodwork: Phenol-resin or resorcinol-resin.
2. Plastic Laminate: Contact cement; FS A-A-1936.

B. Woodwork Putty: Single component, acrylic latex polymer, color to match finish.

C. Hardware: Furnish fasteners and miscellaneous hardware required for assembling and anchoring woodwork, including casework.

2.05 FABRICATION

A. Moisture Content: Kiln dry lumber to an average moisture content range as follows:

1. Exterior Work: 9 percent to 15 percent.
2. Interior Work: 5 percent to 10 percent.

B. Casework Construction: AWI, AWMAC, WI Architectural Woodwork Standards Section 10, Custom Grade, Type B, Style 2 reveal overlay.

C. Casework Fronts: Plastic laminate.

D. Casework Units: Shop assembled for field installation.

E. Install concealed hinges on doors.

F. Drawer Slides: Use side-mounted, heavy-duty type.

G. Install casework hardware in accordance with manufacturer's instructions.

1. Provide items where indicated and as required for a complete installation.
2. Provide pulls and catches on casework doors unless indicated otherwise.

PART 3 EXECUTION

3.01 PREPARATION

A. Examine grounds, stripping, and blocking for cabinet attachment.

B. Do not proceed to install until conditions are acceptable to installer.

C. Verify surfaces to receive architectural woodwork items are properly prepared.

3.02 CASEWORK INSTALLATION

A. Coordinate installation of, and cut openings for mechanical, electrical, and other items that penetrate casework surfaces and tops.

B. Install casework in true alignment, level, and plumb.

C. Secure units with nails or screws to cleats that have been anchored to building structure or wall framing.

D. Install wall-hung cabinets to rigidly support cabinet weight plus normally expected weight of cabinet contents.

E. Accurately scribe and closely fit faceplates, filler strips, and trim strips to irregularities of adjacent surfaces.

F. Adhere plastic laminate as recommended by laminate manufacturer.

1. Apply with as few cross joints as possible and no longitudinal joints.
2. Scribe neatly to vertical surfaces.

G. Toe Space at Front of Cabinets: Provide by installing front face of cabinets 3 inches in front of base face.

3.03 ADJUSTING AND CLEANING

A. Adjust hardware and leave in smooth working condition.

B. Adjust doors and drawers to operate without restriction.

C. Surfaces: Clean and ready for use.

D. Staining or Discoloration of Finish: Restore to original finish or replace unit.

END OF SECTION

SECTION 07 11 00
SHEET MEMBRANE WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes elastomeric sheet membrane waterproofing; and protective covering.

B. Related Sections:

1. Section 31 23 23, Fill and Backfill.
2. Section 33 46 00, Subsurface Drainage.

1.02 SYSTEM DESCRIPTION

A. Waterproofing System: Fluid applied material to prevent moisture migration to interior.

1.03 PERFORMANCE REQUIREMENTS

A. Waterproofing System: Capable of resisting water head of 10 feet and preventing moisture migration to interior.

1.04 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed).

B. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.

C. Product Data: Submit data for surface conditioner or primer, tape, other accessories, and temperature range for application of waterproofing membrane.

D. Manufacturer's Installation Instructions: Submit special procedures and perimeter conditions requiring special attention.

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

1.05 QUALITY ASSURANCE

A. Manufacturer: Minimum 10 years' experience in the production and sales of self-adhesive sheet membrane waterproofing.

B. Installer: Minimum 3 years' experience specializing in performing the Work of this Section.

C. Perform Work in accordance with local jurisdiction requirements.

1.06 MOCKUP

A. Section 01 40 00, Quality Requirements (to be completed), for mockup.

B. Construct Mockup: 100 square feet of waterproofed panel; to represent finished work including internal and external corners, jointing, attachment method, base termination, and protective cover.

C. Locate as indicated by Engineer.

D. Incorporate accepted mockup as part of Work.

1.07 PRE-INSTALLATION MEETINGS

A. Section 01 30 00, Administrative Requirements (to be completed): Pre-installation meeting.

B. Convene minimum 1 week prior to commencing work of this section.

1.08 WARRANTY

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Product warranties and product bonds.

B. Furnish 5 year manufacturer warranty for waterproofing failing to resist penetration of water.

C. For warranty repair work, remove and replace materials concealing waterproofing.

PART 2 PRODUCTS

2.01 ELASTOMERIC SHEET MEMBRANE WATERPROOFING

A. Manufacturers and Products:

1. Tamko Water-Proofing; TW-60.
2. W.R. Grace & Co.; Conn., Bituthene System 4000.
3. W.R. Meadows, Inc.; Sealtight Mel-Rol.
4. Or as approved.

B. Membrane:

1. Self-adhesive, cold-applied composite sheet consisting of a thickness of 56 mils of rubberized asphalt and 4 mils of cross-laminated, high density polyethylene film.
2. Membrane Characteristics:

Property	Typical Value	Test Method
Thickness	60 mils	ASTM D3767 Method A
Tensile Strength, membrane, Die C	325 psi (minimum)	ASTM D412
Tensile Strength, film	5,000 psi (minimum)	ASTM D882
Elongation, ultimate failure of rubberized asphalt	300% (minimum)	ASTM D412
Peel Strength	9.0 lbs./in. width	ASTM D903
Puncture Resistance, membrane	50 lbs. (minimum)	ASTM E154
Resistance to Hydrostatic Head	231 ft. of water	ASTM D5385
Permeance	0.05 perms (maximum)	ASTM E96, Section 12 - Water Method
Water Absorption	0.1% (maximum)	ASTM D570

C. Accessories: Provide surface conditioner or primer, tape, and other accessories required for a complete and proper installation.

2.02 PROTECTIVE COVER

A. Manufacturers and Products:

1. Dow Chemical Co.; Styrofoam Brand Protection Board.
2. Tenneco Building Products; Amocor PB4 Water-Proofing Protection Board.
3. Or as approved.

B. Protection Board: 1/4-inch thick extruded polystyrene with plastic film laminate on both sides, with a minimum compressive strength of 10 psi.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.

B. Verify items which penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION

A. Protect adjacent surfaces not designated to receive waterproofing.

B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions. Do not apply waterproofing to surfaces unacceptable to manufacturer's representative.

C. Seal cracks and joints with sealant materials using depth to width ratio as instructed by sealant manufacturer.

3.03 INSTALLATION

A. Install membrane waterproofing and protective cover in accordance with manufacturer's instructions.

B. Roll out membrane. Minimize wrinkles and bubbles.

C. Remove release paper layer. Roll out on substrate with a mechanical roller to encourage full contact bond.

D. Lap sides and ends in accordance with membrane manufacturer's instructions.

E. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or moving.

F. Seal membrane and flashings to adjoining surfaces.

G. Seal items penetrating membrane and install counter flashing membrane material.

H. Extend waterproofing material from grade level and terminate on top of the footer.

I. Protect membrane from damage by adhering protection cover over membrane surface. Scribe and cut boards around projections and interruptions.

3.04 FIELD QUALITY CONTROL

A. Section 01 40 00, Quality Requirements, and Section 01 70 00, Execution and Closeout Requirements (to be completed): Field inspecting, testing, adjusting, and balancing.

3.05 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Protecting installed construction.

3.06 SCHEDULE

A. Provide Sheet Membrane Waterproofing as follows:

1. Exterior face of all TC Loop Injection and Extraction Well and Well Casing Vault exterior concrete walls.
2. Exterior face of all IRZ Injection and Extraction Well and Well Casing Vault exterior concrete walls.
3. Exterior face of all Inner Recirculation Loop Injection and Extraction Well and Well Casing Vault exterior concrete walls.
4. Retaining wall portion of buildings.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C272, Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
   b. C303, Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
   c. C549, Standard Specification for Perlite Loose Fill Insulation.
   d. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   e. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
   f. C1029, Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation.
   g. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   h. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer’s product literature identifying products proposed for use.
2. Qualifications: Written approval of proposed foam-in-place insulation installer company by insulation manufacturer

1.03 DELIVERY, STORAGE, AND HANDLING

A. On packaging clearly identify manufacturer, contents, brand name, applicable standard, and R-value.

B. Store materials off ground and keep them dry. Protect against weather, condensation, and damage.

C. Comply with manufacturer's printed recommendations.

PART 2 PRODUCTS

2.01 BATT INSULATION AND FASTENERS

A. Fiberglass or Mineral Wool Batts:

1. ASTM C665, I, with no facing, R-values as indicated on Drawings.
2. Manufacturers:
   a. CertainTeed Corp.
   b. Owens-Corning Insulating Systems.
   c. Johns Manville.
3. Insulation Value: Minimum of 3.1R per 1-inch thickness.

B. Fasteners: As recommended by insulation manufacturer.

2.02 VAPOR RETARDER

A. See Section 07 26 00, Vapor Retarders.

2.03 RIGID INSULATION

A. Extruded Polystyrene Foam:

1. ASTM C578, Type IV, 25 psi compressive strength, tongue and groove edges.
2. Flame Spread: Less than 25 when tested in accordance with ASTM E84.
3. Aged Insulation Value: Minimum of 5.0R per 1-inch thickness.
4. Thickness: As shown.
5. Manufacturers and Products:
   a. Dow Chemical Co.; Styrofoam Tongue and Groove Insulation.
   b. UC Industries; Foamular 250, tongue and groove edge treatment.

B. Adhesives and Fasteners: As recommended by insulation manufacturer.

2.04 FOAM-IN-PLACE INSULATION

A. Medium density, closed cell polyurethane spray foam insulation:

1. ASTM C1029, Type II vapor retarder.
2. Flame Spread: Less than 25 when tested in accordance with ASTM E84.
3. Thickness: As shown.
4. Aged Insulating Value: Minimum of 5.8R per 1-inch thickness.

PART 3 EXECUTION

3.01 BATT INSULATION

A. Install in accordance with manufacturer's instructions and as specified below:

1. Install in widths required by framing spacing.
2. Fit tightly in framing cavity.
3. Where electrical outlets, ducts, pipes, vents, or other utility items occur, place insulation on cold weather side of obstruction.
4. Protect installed insulation from tears and other damage until covered with finish material.
5. Remove and replace damaged material.

3.02 RIGID INSULATION

A. Install in accordance with the following:

1. Install boards in location and in thickness as shown.
2. Cut insulation with saw, knife, or other sharp tool to fit tightly around obstructions.
3. Butt insulation boards together tightly at joints, engaging tongue and groove connections firmly.
4. Where thickness required exceeds 1-1/2 inches, install two layers of boards.
5. Apply to masonry or concrete with fasteners recommended by insulation manufacturer.

3.03 FOAM-IN-PLACE INSULATION

A. Verify substrates and conditions conform to manufacturer's requirements for a warrantable installation. Beginning of work indicates acceptance of site conditions.

B. Application:

1. Coordinate required time period of segregation of application area before, during and after application with all parties before beginning of work.
2. Use only manufacturer approved personal protection, mixing, and application equipment. Employ only trained and experienced personnel to ensure a warrantable installation.

3. Apply site mixed material at rate required to produce required final insulation thickness over entire areas to be covered.

C. Repair any defects only with manufacturer approved forces, materials, and techniques.

D. Protect applied materials from damage due to weather, physical abuse or other causes through use of temporary coverings until scheduled construction is complete.

END OF SECTION

SECTION 07 26 00
VAPOR RETARDERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes sheet materials for controlling vapor diffusion through the building envelope.

1. Sheet and sealant materials to continue vapor or air retarder from wall to roof construction Vapor Barrier at interior face of wall assembly.
2. Sheet applied Vapor Retarder and associated accessories to continue air and vapor control membrane over selected exterior portions of the building envelope above grade to roof construction.
   a. Coordination of membranes applied in this Section with flashings to create an unobstructed liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration while accommodating substrate movement.

B. Related Sections:

1. Section 07 92 00, Joint Sealants.
2. Section 09 22 36, Lath and Plastering.
3. Section 09 29 00, Gypsum Board.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. Authority Having Jurisdiction (AHJ).
2. ASTM International (ASTM).
3. Green Seal (GS).
4. International Code Council – Evaluation Service (ICC-ES).
5. South Coast Air Quality Management District (SCAQMD).
6. Sealant, Waterproofing and Restoration Institute (SWRI).

B. References Standards:

1. ASTM International (ASTM):
   a. C920, Standard Specification for Elastomeric Joint Sealants.
   b. E96, Standard Test Methods for Water Vapor Transmission of Materials.

c. E2178, Standard Test Method for Air Permeance of Building Materials.

2. Green Seal (GS) 36, Aerosol Adhesives.
3. ICC-ES Evaluation Reports: AC 212, Water-resistive Coatings Used as Water-resistive Barriers over Exterior Sheathing and AC 148 Flexible Flashing Materials.
4. Sealant, Waterproofing and Restoration Institute (SWRI): Sealant and Caulking Guide Specification.
5. Mojave Desert Air Quality Management District (MDAQMD): Rule 1113, Architectural Coating Rule.

1.03 PERFORMANCE REQUIREMENTS

A. Vapor Barrier Permeance: Maximum 0.01 perm when tested in accordance with ASTM E96, Procedure A.

B. Vapor Retarder Permeance:

1. Minimum 50 perms when tested in accordance with ASTM E2178.
2. Provide materials that are in compliance with evaluation criteria set forth in ICC-ES AC148, Acceptance Criteria for Flexible Flashing Materials and ICC-ES AC212, Acceptance Criteria for Water-Resistive Coatings Used as Water-Resistive Barriers Over Exterior Sheathing.

1.04 SUBMITTALS

A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with:

1. SWRI, Sealant and Caulking Guide Specification requirements for materials and installation.
2. ICC ES Evaluations AC 212 and 148.

B. Maintain one copy of each document on site.

C. Applicator Qualifications: Manufacturer approved applicator to be experienced in applying air/water resistive vapor retarder materials similar in materials, design and extent to those indicated for the scheduled work, whose efforts has resulted in application with a record of successful in-service performance.

D. Knowledgeable in the proper use and handling of selected products.

E. Employ skilled installers who are experienced and knowledgeable in air/water-resistive retarder application, and familiar with the requirements of the specifications.

F. Regulatory Requirements: Conform to applicable code requirements for air/water resistive retarders.

G. Primary materials, including fluid (or sheet)-applied air/water-resistive retarder membrane, reinforcing fabrics, primers, and transition membranes required for a complete system shall be sourced from one manufacturer regularly engaged in production of air/water resistive retarder materials.

1.06 SEQUENCING

A. Sequence Work to permit installation of materials in conjunction with other retardant materials and seals.

B. Do not install vapor retarder until items penetrating vapor retarder are in place.

PART 2 PRODUCTS

2.01 VAPOR BARRIERS

A. Manufacturers:

1. Alumiseal Corp.
2. Fiberweb Corp.
3. Griffolyn, Reef Industries.
4. Raven Industries.

B. Components:

1. Vapor Barrier: Fire retardant reinforced three-ply laminate of two layers of linear low-density polyethylene and one high-strength non-woven cord grid. Griffolyn TX-1200 FR or approved substitution. Resistance to moisture vapor transmission to be less than 0.01 perms.
2. Sealant: Type specified in Section 07 92 00, Joint Sealants.
3. Primer and Backer Rods: Recommended by sealant manufacturer to suit application.
4. Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

5. Cleaner: Noncorrosive type; recommended by sealant manufacturer; compatible with adjacent materials.
6. Adhesive: Compatible with sheet retarder and substrate, permanently non-curing.
    a. Adhesives: Maximum volatile organic compound content in accordance with MDAQMD Rule 1113.
    b. Aerosol Adhesives: Maximum volatile organic compound content in accordance with GS 36.
7. Thinner and Cleaner for Sheet: As recommended by sheet material manufacturer.
8. Tape: Polyethylene self-adhering type, mesh reinforced, 2-inch wide, compatible with sheet material.
9. Attachments: Galvanized steel bars and anchors.

2.02 VAPOR RETARDERS

A. Manufacturer:

1. Dupont.
2. As approved.

B. Components:

1. Vapor Retarder: Spun bound polyolefin, non-woven, nonperforated, vapor retarder sheet. Basis of design is DuPont Tyvek StuccoWrap and related assembly components or approved substitution. The completed product protects the building from air and liquid water ingress (maximum less than 0.004 cfm/square foot at 1.57 pounds/square foot air pressure) and is vapor permeable (11.00 perms minimum).
2. Fasteners and washer caps.
3. Seam Tape: Similar to DuPont Tyvek Tape.
4. Primers.
5. Adhesives:
    a. Mastic (Silicone Sealant): Dow Corning 795 Silicone Building Sealant.
    b. Spray: 3M Hi-Strength 90.
6. Membrane Flashing: DuPont StraightFlash or FlexWrap.
7. High Temperature Membrane Flashing: Similar to Grace Ultra roofing underlayment.
8. Liquid Applied Membrane Flashing: DuPont Tyvek Fluid Applied Flashing, Brush Formulation.

2.03 HIGH TEMPERATURE MEMBRANE FLASHING

A. Manufacturer:

1. W.R. Grace & Co. (Grace Construction Products).
2. Approved substitution.

B. Component: Grace Ultra, constructed of butyl rubber based adhesive layer with high density cross laminated polyethylene, 30 mils total thickness.

PART 3 EXECUTION

3.01 PREPARATION

A. Remove loose or foreign matter capable of impairing adhesion from dry substrate.

B. Clean and prime substrate surfaces to receive adhesive and sealants.

C. Vapor Barrier to be installed behind interior wall sheathing at perimeter walls and at interior walls as noted.

D. Vapor Retarder to be installed on rigid insulation and wood blocking on CMU and sheathing on wood studs.

3.02 INSTALLATION

A. Vapor Barrier for Stud Framed Walls:

1. Secure sheet vapor barrier to wall framing using manufacturer’s approved adhesives.
2. Tape sheet edges at seams, perimeter and penetrations.
3. Install sheet barrier between exterior window and door frames and adjacent vapor retarder. Seal junction of vapor barrier and vapor retarder with sealant. Comply with requirements of ICC-ES evaluation reports AC 212 and AC 148.
4. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges or where compatibility with adjacent materials may be in doubt.
5. Install Work in accordance with applicable State of California standards.
6. Protect sheet vapor retarder from damage until covered. Immediately repair holes with self-adhesive repair tape.

7. Provide surface ready for installation of work of Section 09 29 00, Gypsum Board.

B. Vapor Retarder for Rigid Insulation Surface:

1. Verify substrate and surface conditions are in accordance with manufacturers required tolerance prior to installation.
2. Handle and apply material as required by product label and Material Safety Data Sheets (MSDS).
3. Prepare substrate, select materials, prime substrate, and apply materials appropriate for ambient temperature range at time of application, anticipated service temperature, and as well as specific substrate.
4. Install vapor retarder over exterior face of exterior wall substrate in accordance with manufacturer recommendations.
5. Install vapor retarder prior to installation of windows, doors and other penetrations.
6. Start vapor retarder installation at lower building corner, leaving 6 to 12 inches of sheet extended beyond corner for overlap.
7. Install vapor retarder in a horizontal manner starting at the lower portion of the wall surface with subsequent layers installed in a shingling manner to overlap lower layers. Maintain vapor retarder plumb and level.
8. Bottom of Wall Interface: Wrap vapor retarder behind rigid insulation edge blocking 2 to 3 inches. Secure to blocking with fasteners and sealant as recommended by vapor retarder manufacturer.
9. Window and Door Openings: Extend vapor retarder completely over openings.
10. Overlap Vapor Retarder:
    a. Exterior Corners: Minimum 12 inches.
    b. Seams: Minimum 6 inches.
11. Vapor Retarder Attachment: Attach vapor retarder to CMU substrate through rigid insulation. Secure using vapor retarder manufacturer recommended fasteners, space 12 to 18 inches vertically on center along stud line, and 24 inches on center maximum horizontally.
12. Seaming:
    a. Seal seams of vapor retarder with seam tape at all vertical and horizontal overlapping seams.
    b. Seal any tears or cuts as recommended by vapor retarder manufacturer.
13. Opening Preparation:
    a. Flush cut vapor retarder at edge of sheathing around full perimeter of opening.

b. Cut a head flap at 45-degree angle in the vapor retarder at window head to expose 8 inches of sheathing. Temporarily secure vapor retarder flap away from sheathing with tape.
c. Install self-adhering flashing and accessories as required for a warrantable assembly.

14. Flip down head flap and integrate metal flashing in assembly to direct liquid water away from wall penetrator as required for a warrantable assembly.
15. Cover parapets and near horizontal surfaces with high temperature membrane flashing, integrating with vapor retarding system in a shingle-like fashion, providing overlap of layers as recommended to achieve a warrantable installation.
16. Where wall penetrations are grouped to closely for effective adherence of sheet applied membrane to penetrating items and surrounding rigid insulation, blocking, and vapor retarder systems, apply brush grade detail membrane to clean and dry penetrations and sheathing. Provide 2 inches of exposed rigid insulation and blocking around penetration items as recommended to achieve a warrantable installation.
17. Provide surface ready for installation of work of Section 09 22 36, Lath and Plastering.

C. High Temperature Membrane Flashing:

1. Verify substrate and surface conditions are in accordance with manufacturers required tolerance prior to installation.
2. Handle and apply material as required by product label and Material Safety Data Sheets (MSDS).
3. Prepare substrate, select materials, prime substrate, and apply materials appropriate for ambient temperature range at time of application, anticipated service temperature, and as well as specific substrate.
4. Apply in fair weather with temperature at 40 degrees F or warmer.
5. Cut membrane into 10 to 15 foot lengths and reroll loosely.
6. Working from low point of roof, install membrane so all laps shed water. Apply in valley prior to applying to adjoining roof faces.
7. Peel back 1 to 2 feet of release liner, align the membrane and continue to peel release liner from membrane.
8. Press membrane in place with heavy hand pressure.
9. Provide side laps of 3-1/2 inches and end laps of 6 inches minimum.
10. At valley and ridge, peel the release liner, center sheet over valley or ridge, drape, and press in place. Work from center of valley or ridge outwards in each direction.
11. In any case, start at low point and work up the roof.

12. Do not install fasteners through the membrane at unsupported areas of the structural deck.
13. Repair fishmouths, tears, removed fastener holes and membrane damage with a round patch, 6 inches bigger than damage.

3.03 CLEANING AND PROTECTION

A. Remove all masking materials after installation.

B. Clean and protect completed work until covered.

C. Remove waste generated in the course of prosecution of work of this Section in accordance with AHJ regulations.

3.04 SUBMITTAL SCHEDULE

Item No.	Submittal Requirement	With Bid	As Indicated
07 26 00-01	Product Data: Submit data indicating material characteristics, performance criteria, limitations.		Prior to delivery
07 26 00-02	Provide manufacturers documentation describing physical characteristics of vapor retarder, accessory materials, and application requirements.	PDF, MS Word or MS Excel	Per Submittal Schedule
07 26 00-03	ICC-EC Evaluation Reports confirming compliance with AC 212 and AC 148.	PDF, MS Word or MS Excel	Per Submittal Schedule
07 26 00-04	Maintenance Data: Submit description of system, cleaning requirements and methods, inspection data, and parts lists.		With record documents.

END OF SECTION

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C661, Standard Test Method for Indentation Hardness of Elastomeric Type Sealants by Means of a Durometer.
   b. C834, Standard Specification for Latex Sealants.
   c. C920, Standard Specification for Elastomeric Joint Sealants.
   d. C1193, Standard Guide for Use of Joint Sealants.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Surface preparation instructions. Indicate where each product is proposed to be used.
2. Samples: Material proposed for use showing color range available.

1.03 INFORMATIONAL SUBMITTALS:

1. Installation instructions.
2. Documentation showing applicator qualifications.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).
4. Special guarantee.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum of 5 years' experience installing sealants in projects of similar scope.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Ambient Temperature: Between 40 degrees F and 80 degrees F (4 degrees C and 27 degrees C) when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.

1.06 SPECIAL GUARANTEE

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

B. Conditions: No adhesive or cohesive failure of sealant.

C. Sealed Joints: Watertight and weathertight with normal usage.

PART 2 PRODUCTS

2.01 SEALANT MATERIALS

A. Characteristics:

1. Uniform, homogeneous.
2. Free from lumps, skins, and coarse particles when mixed.
3. Nonstaining, nonbleeding.
4. Hardness of 15 minimum and 50 maximum, measured by ASTM C661 method.
5. Immersible may be substituted for nonimmersible.

B. Color: Unless specifically noted, match color of the principal wall material adjoining area of application.

C. Type 1—Silicone, Nonsag, Nonimmersible:

1. Silicone base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Capable of withstanding movement up to 50 percent of joint width.
3. Manufacturers and Products:
   a. Dow Corning Corp.; No. 790.
   b. General Electric; Silpruf.
   c. BASF; Sonneborn, Omniseal-50.

D. Type 2—Multipart Polyurethane, Self-leveling, Immersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade P, Class 25.

2. Capable of being continuously immersed in water.
3. Manufacturers and Products:
    a. BASF; Sonneborn, SL-2.
    b. Pecora Corp.; Urexspan NR-200.
    c. Tremco; THC-900/901.
    d. Sika Chemical Corp.; Sikaflex 2c SL.

E. Type 3—Multipart Polyurethane, Nonsag, Immersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products:
    a. Pecora; DynaTrol II.
    b. Tremco; Dymeric 240.
    c. BASF; Sonneborn NP-2.
    d. Sika Chemical Corp.; Sikaflex 2c NS.

F. Type 4—Multipart Polyurethane, Nonsag, Nonimmersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
2. Manufacturers and Products:
    a. BASF; Sonneborn NP-2.
    b. Pecora Corp.; Dynatrol II.
    c. Tremco; Dymeric 240.
    d. Sika Chemical Corp.; Sikaflex 2c NS.

G. Type 5—One-part Polyurethane, Immersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products for Nonsag:
    a. Sika Chemical Corp.; Sikaflex-1a.
    b. Tremco; Vulkem 116.
4. Manufacturers and Products for Self-leveling:
    a. BASF; Sonneborn, SL-1.
    b. Tremco; Vulkem 45.
    c. Sika Chemical Corp.; Sikaflex 1c SL.

H. Type 6—One-Part Polyurethane, Nonimmersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Manufacturers and Products:
   a. Pecora Corp.; Dynatrol 1 XL.
   b. Tremco; Dymonic.
   c. BASF; Sonneborn, NP-I.

I. Type 7—Multipart Polysulfide, Immersible:

1. Polysulfide base, two-component, chemical curing; ASTM C920, Type M, Grade P or NS, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products:
   a. W. R. Meadows; Deck-O-Seal Gun Grade, two-part.
   b. BASF; Sonolastic, two-part Polysulfide.

J. Type 8—One-Part Polysulfide, Nonsag, Nonimmersible:

1. Polysulfide base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 12 1/2.
2. Capable of withstanding movement up to 20 percent of joint width.
3. Manufacturer and Product: W. R. Meadows; Deck-O-Seal, one-part.

K. Type 9—One-Part Acrylic Terpolymer, Nonsag, Nonimmersible:

1. Acrylic base, single-component, solvent curing; ASTM C834 nonsag.
2. Capable of withstanding movement up to 7.5 percent of joint width; Shore “A” hardness of 55 maximum.
3. Manufacturer and Product: Tremco; Mono 555.

L. Type 10—Sanitary Sealant:

1. Silicone sealant similar to Type 1, above, formulated to resist mold growth and repeated exposure to high humidity while retaining adhesion, flexibility, and color.
2. Manufacturers and Products:
   a. Dow Corning; 786.
   b. General Electric; Sanitary Sealant SCS1700.

M. Type 11—Fire Penetration Seal:

1. Manufacturers and Products:
   a. 3M Corp.; Fire Barrier Caulk CP25 and Putty 303.
   b. General Electric; Pensil Sealant or Foam.
   c. Unifrax Corporation; Fyre Putty.
   d. Hilti USA; CP 604.

N. Type 12—One-Part Polycarbonate, Immersible:

1. Polycarbonate base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturer and Product: Pro-Seal Products, Inc.; Pro-Seal 34.

O. Type 13—Tape Sealant:

1. Compressible polyurethane foam impregnated with polybutylene or polymer-modified asphalt.
2. Color: Black.
3. Size: 3/4 inch wide by length required by expanded thickness recommended by manufacturer for particular application.
4. Manufacturers and Products:
   a. Emseal Joint Systems, Ltd.; AST—High Acrylic.
   b. Dayton Superior; Polytite Standard.
   c. PARR Technologies; PARR Sealant EP-7212-T.

2.02 BACKUP MATERIAL

A. Nongassing, extruded, closed-cell round polyurethane foam or polyethylene foam rod, compatible with sealant used, and as recommended by sealant manufacturer.

B. Size: As shown or as recommended by sealant material manufacturer. Provide for joints greater than 3/16 inch wide.

C. Manufacturers and Products:

1. Sonneborn; Sonolastic Closed-cell Backing Rod.
2. Tremco; Closed-cell Backing Rod.
3. Pecora Corporation; Green Rod.

2.03 ANCILLARY MATERIALS

A. Bond Breaker: Pressure sensitive tape as recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Primer: Nonstaining type recommended by sealant manufacturer to suit application.

2.04 PREFORMED SEALS

A. Preformed Compressible Joint Seals:

1. Widths Up to 5 Inches:
   a. BASF, Watson Bowman Acme Div.; Wabo Weatherseal II.
   b. Emseal Joint Systems Limited; Colorseal.
   c. LymTal International; Iso-flex Joint System.
2. Other Widths: Series or model recommended by seal manufacturer.

PART 3 EXECUTION

3.01 GENERAL

A. Use of more than one material for the same joint is not allowed unless approved by sealant manufacturer.

B. Install joint sealants in accordance with ASTM C1193.

C. Horizontal and Sloping Joints up to 1 Percent Maximum Slope: Use self-leveling (Grade P) joint sealant.

D. Steeper Sloped Joints, Vertical Joints, and Overhead Joints: Use nonsag (Grade NS) joint sealant.

E. Use joint sealant as required for the applicable application and as follows:

Joint Size	**Sealant Type**
Less than 1"	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 12
Less than 2"	1, 2, 3, 4, or 7
Over 2"	Follow manufacturer’s recommendation

3.02 PREPARATION

A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.

B. Surfaces to be sealed shall be clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials.

1. Mask adjacent surfaces where necessary to maintain neat edge.
2. Starting of work will be construed as acceptance of subsurfaces.
3. Apply primer to dry surfaces as recommended by sealant manufacturer.

C. Verify joint shaping materials and release tapes are compatible with sealant.

D. Examine joint dimensions and size materials to achieve required width/depth ratios.

E. Follow manufacturer’s instructions for mixing multi-component products.

3.03 INSTALLATION

A. Use joint filler to achieve required joint depths, to allow sealants to perform intended function.

1. Install backup material as recommended by sealant manufacturer.
2. Where possible, provide full length sections without splices; minimize number of splices.
3. Tape sealant may be used as joint filler if approved by sealant manufacturer.

B. Use bond breaker where recommended by sealant manufacturer.

C. Seal joints around window, door and louver frames, expansion joints, control joints, and elsewhere as indicated.

D. Joint Sealant Materials: Follow manufacturer’s recommendation and instructions, filling joint completely from back to top, without voids.

E. Joints: Tool slightly concave after sealant is installed.

1. When tooling white or light color sealant, use a water-wet tool.
2. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.

F. Tape Sealant: Compress to 50 percent of expanded thickness and install in accordance with manufacturer's instructions.

3.04 PREFORMED SEALS

A. Prepare joint surfaces clean and dry, free from oil, rust, laitance, and other foreign material.

B. Construct joints straight and parallel to each other and at proper width and depth.

C. Apply joint sealant manufacturer's approved primer and adhesive in accordance with manufacturer's instructions.

D. Install seal in accordance with manufacturer's instructions.

3.05 CLEANING

A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.

B. Replace damaged surfaces resulting from joint sealing or cleaning activities.

3.06 JOINT SEALANT SCHEDULE

A. This schedule lists the sealant types acceptable for each joint location. Use as few different sealant types as possible to meet the requirements of Project.

Joint Locations	Sealant Type(s)
Expansion/Contraction and Control Joints At:	
Concrete Walls (except water-holding and belowgrade portions of structures)	1, 3, 4, 5, 6, 7, 12
Concrete Floor Slabs (except for water-holding Structures)	2, 5
Slabs Subject to Vehicle and Pedestrian Traffic	2, 5
Masonry Walls	1, 3, 4, 5, 6, 7, 12, 13
Exterior Insulation and Finish System	4

Joint Locations	Sealant Type(s)
Material Joints At:	
Metal Door, Window, and Louver Frames (Exterior)	1, 5, 6, 8, 12
Metal Door, Window, and Louver Frames (Interior)	1, 5, 6, 8, 9
Wall Penetrations (Exterior)	1, 5, 6, 8, 12
Wall Penetrations (Interior)	1, 5, 6, 8
Floor Penetrations	5, 6, 7
Ceiling Penetrations	1, 3, 4, 5, 6, 7
Roof Penetrations	5
Sheet Metal Flashings	5, 13
Sheet Metal Roofing and Siding	5, 13
Other Joints:	
Threshold Sealant Bed	5
Between Counter Tops and Backsplashes	10
Around Plumbing Fixtures	10
Openings Around Pipes, Conduits, and Ducts Through Fire-Rated Construction	11
Concrete Form Snap-Tie Holes	1, 4, 5

END OF SECTION

SECTION 08 11 00
METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI):
   a. A250.6, Hardware on Standard Steel Doors (Reinforcement - Application).
   b. A250.8, Recommended Specification for Standard Steel Doors and Frames.
   c. A250.11, Recommended Erection Instructions for Steel Frames.
2. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   d. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
   e. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
3. Builders Hardware Manufacturers Association (BHMA): A156.115, Hardware Preparations in Standard Steel Doors and Frames.
4. National Fire Protection Association (NFPA): 80, Standard for Fire Doors and Other Opening Protectives.
5. Underwriters Laboratories, Inc. (UL): Building Materials Directory.

1.02 SUBMITTALS

A. Action Submittals: Applicable information for each type of door and frame, including:

1. Frame conditions and complete anchorage details, supplemented by suitable schedules covering doors and frames.
2. Glass and louver opening sizes and locations in doors.
3. Connections of door frames to structural steel framing concealed in frames.
4. Location and field splice joints for frames too large to ship in one piece; indicate complete instructions for making field splices.
5. Joints required to accommodate expansion joint movement.
6. Relate to door numbers used in Contract Drawings.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Properly identify each item with number used in Contract Drawings.

B. Store doors upright, in protected dry area, at least 1 inch off ground or floor and at least 1/4 inch between individual pieces.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Curries Manufacturing.
2. The Ceco Corp.
3. Fenestra Division, Marmon Group.
4. Mesker Industries, Inc.
5. Monarch Steelcraft, Ltd.
6. Overly Manufacturing Co.
7. Pioneer Industries.
8. Precision Metals, Inc.
9. Republic Steel Corp.
10. Steelcraft Manufacturing Co.
11. Trussbilt, Inc.
12. Williamsburg Steel Products Co.
13. Stiles Custom Metal, Inc.

2.02 MATERIALS

A. Basic Metal Material:

1. ASTM A1008/A1008M; sheet steel, cold-rolled, stretcher level.
2. ASTM A167, Type 316 stainless steel.

B. Hollow Metal Frames:

1. Products of hollow metal door manufacturer.
2. ANSI 250.8, except as modified herein.
3. Frames for Doors and Windows: 16 gauge for interior and 14 gauge, with thermal break, for exterior, welded type, of cross-section shown.
4. Prepare floor and wall anchors, reinforcement, and cutouts for hardware to meet requirements of BHMA A156.115 and ANSI A250.6.
5. Finished size, shape, and profile of frame members as shown.
6. Concealed fasteners or welding are preferred to through-the-face fasteners.
7. Identification: Stamp opening number, as shown on Drawings, on center hinge reinforcement of each frame.

C. Hollow Metal Doors: ANSI A250.8, except as modified herein. BHMA A156.115 and ANSI A250.6 to receive hardware specified in Door and Hardware Schedule.

1. Interior:
   a. Flush Panel Doors: 18 gauge, Level 2, Model 1.
   b. Flush end closure at top of doors.
2. Exterior:
   a. Flush Panel Doors: 16 gauge, Level 3, Model 1.
   b. Double Doors: Overlapping astragals for active leaf, except as noted or detailed otherwise.
   c. Flush end closure at top of doors.
   d. R-Value: 6.

D. Labeled Fire Doors and Frames:

1. Conform to listing requirements of Underwriters Laboratories, Inc. (UL).
2. Label each door and frame for class of rating required.
3. Overlapping astragal on active leaf of double doors.

4. Label requirements, dimensions, and type of door are indicated in Door and Hardware Schedule.
    a. Modify drawing details if required to secure label.
    b. Clearly identify modifications on Shop Drawings.
    c. Maximum temperature rise of 450 degrees F for stairway enclosures.

E. Glazing:

1. Doors: Furnish with formed flush-type glazing strips with butt corner joints to permit selection of secure side in field.
2. Glazing Arrangements: Accommodate glass of type and thickness indicated and as specified in Section 08 80 00, Glazing.

2.03 MISCELLANEOUS ITEMS

A. Filler or Transom Panels: Furnish of same construction and finish as door to include fire-resistive label and sound-retardant construction.

B. Furnish manufacturer's standard core filler, anchors, fasteners, and other ancillary items.

2.04 FACTORY FINISHING REQUIREMENTS

A. Galvanized with A60 zinc coating in accordance with ASTM A653/A653M.

B. Phosphate treat metal for paint adhesion.

C. One shop coat of baked-on rust-inhibiting prime coating compatible with finish coating as specified in Section 09 90 00, Painting and Coating.

D. Stainless Steel: ASTM A480, No. 3 or No. 4.

PART 3 EXECUTION

3.01 INSTALLATION

A. Frames:

1. Follow ANSI A250.11 and manufacturer's instructions.
    a. Maintain scheduled dimensions, hold head level, and maintain jambs plumb and square.
    b. Secure anchorages and connections to adjacent construction.

c. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb and anchors are securely attached.

B. Doors:

1. Hollow Metal Doors: ANSI A250.8.
2. Hardware: In accordance with manufacturer's templates and instructions.
   a. Adjust operable parts for correct function.
   b. Remove hardware, with exception of prime coated items, tag, box, and reinstall after finish paint work is completed.
3. Labeled Doors: NFPA Pamphlet No. 80.

3.02 FIELD PAINTING

A. Where prime coat has been damaged, sand smooth and touch up with same primer as applied at shop.

1. Remove rust before painting.
2. Touch Up: Not obvious.
3. Perform immediately after door and frame installation.

3.03 PROTECTION

A. Protect installed doors and frames against damage from other construction work.

3.04 SCHEDULES

A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements see Door and Hardware Schedule on Drawings.

END OF SECTION

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   c. A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
   d. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
3. Intertek Testing Services (Warnock Hersey Listed) (WH): Certification Listings.
4. National Association of Metal Manufacturers (NAAMM).
5. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
6. MG 1, Motors and Generators.
7. National Fire Protection Association (NFPA):
   a. 80, Standard for Fire Doors and Other Opening Protectives.
   b. 252, Standard Methods of Fire Tests of Door Assemblies.
8. Underwriters Laboratories Inc. (UL):
   a. Building Materials Directory.
   b. 10B, Standard Safety for Fire Tests of Door Assemblies.
   c. 325, Standard Safety for Door, Drapery, Gate, Louver, and Window Operators and Systems.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
2. Product Data: General construction, component connections and details, wiring diagram and electrical equipment.
3. Samples: Submit two shutter slats, 12 by 12 inch in size illustrating shape, color and finish texture.

B. Informational Submittals:

1. Third party testing documentation or manufacturer’s literature qualifying door model as meeting required developed wind pressures and impact testing for small or large missile. Miami-Dade Notice of Approval (NOA) documentation is acceptable as third party evidence of certification.
2. Manufacturer's Instructions: Indicate installation sequence and procedures, and adjustment and alignment procedures.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data (to be completed), include lubrication requirements and frequency, and periodic adjustments required.
4. Seismic Anchorage and Bracing:
   a. Drawings and product data as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
   b. Calculations as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
   c. Installer’s factory authorization.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 3 years’ documented experience.
2. Installer: Company specializing in performing work of this section approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Cookson Co.
2. Cornell Iron Works, Inc.
3. Overhead Door Co.

2.02 GENERAL

A. Wind Loads: Design door assembly to withstand wind/suction load in compliance with AHJ PSF requirements for the area, with a maximum deflection of 1/120 without damage to door or assembly components.

B. Operation: Design door assembly , including operator, to operate for not less than 10,000 cycles and 10 cycles per day.

C. Fire Rated Door Construction: Conform to one of the following:

1. NFPA 252.
2. UL 10B.

D. Products Requiring Electrical Connection: Listed and classified by UL or another testing firm acceptable to authority having jurisdiction.

E. Surface Burning Characteristics, Foam Insulation: Maximum 75/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

2.03 COMPONENTS

A. Curtain: Conform to following:

1. Slats: 2- to 3-inch-wide flat-face steel slats, gauge as required for specified performance, but in no case less than 20 gauge.
2. Perforations: Provide perforations that control insect movement and provide a minimum of 22 per cent open space when curtain is completely deployed.
3. Nominal Slat Size: 3 inches wide by required length.
4. Slat Ends: Each slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
5. Windlocks: Provide windlocks as required by windload or door size.

6. Curtain Bottom: Fitted with angles, channels, or tubes to provide reinforcement and positive contact with floor in closed position.

B. Guides:

1. Minimum 3/16 inch thick; galvanized steel conforming to ASTM A653/A653M, minimum galvanized coating designation G90 in accordance with ASTM A924/A924M stainless steel conforming to ASTM A666 Type 304 rollable temper.
2. Furnish continuous angles of profile to retain door in place; mounting brackets of same metal.

C. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension.

D. Hood Enclosure and Fascia: Square shape, minimum 24 gauge thick galvanized steel; internally reinforced to maintain rigidity and shape.

E. Hardware:

1. Locks: Furnish locks to allow doors to be secured.
   a. Manual Doors: Manufacturer's standard cylinder dead lock on inside at door jamb, key operated from interior.
2. Cylinders: Minimum six-pin cylinders Furnished under Section 08 71 00, Door Hardware, installed as part of Work of this section; doors keyed alike master keyed.
3. Handle: Inside side mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position; interior and exterior handle.
4. Weatherstripping (Exterior Assemblies): Moisture and rot proof, resilient type for complete weathertight installation.
   a. Rubber, neoprene, or vinyl water seal at hood to prevent airflow around coil on exterior doors.
   b. Weather seal sealing strip on guide to close space between guide and curtain on exterior doors.

F. Manual Operation: Manual hand chain lift unit with overhead counter balance device, requiring 25 pound nominal force to operate.

2.04 FINISHES

A. Curtain Slats: Primed and painted. Exterior paint color to match building siding color.

B. Steel Guides and Hood Enclosure: Primed and painted. Exterior portions to be painted to match building siding color.

2.05 SOURCE QUALITY CONTROL

A. Attach label from agency approved by authority having jurisdiction to identify each fire rated door.

1. Oversize Door Certification: Provide UL Certificate of Inspection or comparable certification acceptable to authorities having jurisdiction, in lieu of label for oversize door assemblies exceeding 120 square feet or 24 feet in any dimension.

B. Apply label from agency approved by authority having jurisdiction to identify each foam plastic insulation board.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

B. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

C. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

D. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07 92 00, Joint Sealants.

E. Install perimeter trim and closures.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent Work.

B. Maximum Variation from Plumb: 1/16 inch.

C. Maximum Variation from Level: 1/16 inch.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING

A. Adjust door, hardware and operating assemblies for smooth and noiseless operation.

B. Test smoke activated assemblies for proper activation.

3.05 CLEANING

A. Leave door and components clean.

B. Remove labels and visible markings.

END OF SECTION

SECTION 08 41 13
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.01 REFERENCES

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

1. The Aluminum Association, Incorporated (AA): Designation System for Aluminum Finishes.
2. American Architectural Manufacturers Association (AAMA): 800, Voluntary Specification and Test Method for Sealants.
3. ASTM International (ASTM):
   a. C509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
   b. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
   c. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen.
   d. E330, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
   e. E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

1.02 SYSTEM DESCRIPTION

A. Design Requirements:

1. Provide a thermally isolated aluminum framing system that utilizes straight-in glazing without projecting stops. Position glass near exterior of frame and provide in-swinging operable vents where shown.
2. System shall have interior flashing to provide continuous flashing to exterior through pressure relieved horizontal weep holes.
3. Face Clip Design:
   a. Engaged by pushing straight into the clip.
   b. Easily removed for deglazing.
   c. Reusable for reglazing.
4. Entrances and glass framing shall be compatible in appearance.

B. Performance Requirements: Meet requirements of Article Performance Tests.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Details of doors, framing, and anchorage to structure.
   b. Manufacturer's brochures or catalogs, specifications, recommendations, and standard details illustrating and specifying products proposed for use on this Project.
   c. Show field measurements.
   d. Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing (to be completed).
2. Samples: At least 3-inch long Samples of anodized extruded aluminum, showing probable range of variation in color.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing (to be completed).
2. Evidence of installer's qualifications.
3. Certified test reports showing compliance with specified performance tests.
4. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements (to be completed).

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Entity specializing in the installation of aluminum glazing systems, with a minimum of 3 years' experience and approved by the system manufacturer.

B. Preinstallation Meeting: Conduct to discuss and verify project requirements, substrate conditions, and manufacturer's installation instructions and warranty requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Store materials as recommended by manufacturer, in inside designated areas, free of dust and corrosive fumes, as close as possible to point of installation.

C. Prevent contaminants from contacting aluminum.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Framing systems, entrance doors, and ventilators shall be the products of a single manufacturer.

B. Materials and products specified in this section shall be products of:

1. Kawneer Co.
2. United States Aluminum Corp.
3. Tublite, Inc.

2.02 BASIC MATERIALS

A. Basic Aluminum Extrusions: 6063-T5 aluminum not less than 0.094 inch thick; door extrusions not less than 0.125 inch thick.

B. Framing Members: 4-1/2 inches in depth with thermal break and face width of 2 inches or less, similar to Kawneer Trifab 451UT, inside glazed.

C. Swing Entrance Doors:

1. Thickness: 1-3/4 inch.
2. Stile and Rail Construction:
    a. Medium (3-1/2-inch) stiles and top rails, and 12-inch bottom rail.
    b. Mechanically fastened and welded.
    c. Hook-in type glazing stops.
    d. Configuration indicated.
3. Flush Construction:
    a. Face sheets of plain unpatterned architectural quality 5005 alloy aluminum, 0.050 inch thick, interlocked with stiles and rails.
    b. Aluminum stiles and rails, mechanically fastened and welded.
    c. Core of froth-in-place urethane foam, free of chlorofluorocarbon (CFC) blowing agents.
    d. Aluminum framed vision lights.
    e. Configuration indicated.

D. Glazing Gaskets: Framing manufacturer's standard elastomeric extrusion, conforming to ASTM C509.

E. Glass and Glazing: As specified in Section 08 80 00, Glazing.

F. Concealed Fastening Devices, Reinforcements, and Other Internal Components: Of aluminum alloy, stainless steel, or corrosion-resistant plated.

G. Screws: Stainless steel, factory finished color to match aluminum finish.

H. Hardware: Door manufacturer's standard items as scheduled, and coordinated with Section 08 71 00, Door Hardware.

1. Hinges or pivots, including electrified hardware.
2. Locks.
3. Exit devices.
4. Concealed closers.
5. Pull handles.
6. Stops and holders.
7. Thresholds.
8. Weatherstripping: Head and jambs, and sweepstrip at bottom of doors.
9. Provision for electric lockset, when required by door hardware group.

I. Sealants:

1. AAMA 800, to seal metal to metal, nonworking joints.
2. Color to be compatible with adjacent materials.

J. Isolation Tape:

1. Manufacturers and Products:
   a. Tremco; 440.
   b. 3M; EC1202.
   c. Presstite; 579.6.

K. Isolation Paint: Bituminous coating conforming to ASTM D1187.

2.03 FINISH

A. Exposed Framing Members: Free of scratches and other serious surface blemishes.

B. Treatment and Color:

1. Caustic etch and anodic oxide.
2. Meet requirements of AA-M12C22A41, clear.
3. Color: Clear.

2.04 FABRICATION

A. Methods of Fabrication and Assembly: Manufacturer's discretion, unless otherwise specified.

B. Reinforcement for Surface Hardware:

1. Manufacturer's standard.
2. Coordinate with security system requirements to provide concealed applications.

C. Wind Load: Reinforce mullions as necessary to limit deflection to 1/175 of span when wind load on wall is calculated to AHJ required loads, measured in psf in addition to dead loads.

D. Assembly: As far as practicable, do fitting and assembly work in shop.

PART 3 EXECUTION

3.01 PREPARATION

A. Substrate Conditions: Verify acceptability for product installation in accordance with manufacturer's instructions.

B. Field Measurements: Verify actual opening sizes prior to fabrication.

3.02 INSTALLATION

A. In accordance with manufacturer's installation instructions.

B. Set items straight, level, square, plumb, and at proper elevations and in alignment with other work.

C. Securely anchor units to surrounding structure to resist wind loads and to withstand the normal loads imposed by the operation of the doors.

D. Fasten framing members in place using screws and backing, anchor plugs, or straps.

1. Accurately cut and fit framing and moldings to result in tightly closed flush, hairline weathertight joints.
2. No visible unfinished aluminum.
3. Provide concealed attachments and fasteners.

E. Door Operation:

1. Swing freely, and without rattle when closed.
2. Swing Type Doors: Head and jamb clearance of 3/32 inch, plus or minus 1/32 inch.

F. Coat aluminum surfaces in contact with concrete, cement plaster, or stucco with isolation paint, sealant, or isolation tape cut to neat line.

G. Seal all joints.

H. Glazing: As specified in Section 08 80 00, Glazing.

3.03 PERFORMANCE TESTS

A. Air Leakage Through Assembly: Maximum 0.06 cfm per minute per square foot of wall area at 6.24 psf, as measured in accordance with ASTM E283.

B. Resistance to Water Infiltration: No leaks in the complete system when tested in accordance with ASTM E331 at test pressure of 8 psf.

C. Performance Under Uniform Loading:

1. Test in accordance with ASTM E330 for a wind load of 30 psf.
2. Maximum Deflection: Not to exceed 1/175 of member span.
3. When Load is Removed: No permanent deformation or damage.

3.04 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for preinstallation meeting, installation assistance, inspection and certification of proper installation, and performance testing of specified equipment.

3.05 CLEANING

A. After erection, protect exposed portions from damage by machines, plaster, lime, paint, acid, cement, or other harmful compounds.

B. Remove protective materials and clean with plain water, water with soap, or household detergent.

3.06 PROTECTION

A. Protect adjacent areas and finish surfaces from damage during product installation.

3.07 SCHEDULES

A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see Door and Hardware Schedules on Drawings.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.01 REFERENCES

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

1. Builders Hardware Manufacturer's Association (BHMA):
   a. A156.1, Butts and Hinges.
   b. A156.2, Bored and Preassembled Locks and Latches.
   c. A156.3, Exit Devices.
   d. A156.4, Door Controls - Closers.
   e. A156.13, Mortise Locks & Latches.
   f. A156.16, Auxiliary Hardware.
   g. A156.18, Materials and Finishes.
2. International Code Council (ICC): A117.1, Accessible and Usable Buildings and Facilities.
3. Underwriters Laboratories, Inc. (UL): Fire Protection Equipment List.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Manufacturer's literature for each item of finish hardware required herein, clearly marked.
   b. Finish Hardware Schedule: Furnish complete and detailed schedule, show product items, numbers, and finishes for hardware for each separate opening.
   c. Special Tools: Provide listing and description of usage.

B. Informational Submittals:

1. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data (to be completed).
2. Manufacturer's Field Service Report.
3. Certification of Hardware Consultant.
4. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).

1.03 QUALITY ASSURANCE

A. Qualifications of Supplier: Recognized supplier of architectural finish hardware, with warehousing facilities, who has been furnishing hardware in vicinity of Project for not less than 5 years, and who is, or who employs, architectural hardware consultant.

B. Qualifications of Architectural Hardware Consultant (AHC): Certified by Door and Hardware Institute.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Before delivery, clearly identify and tag each item of hardware with respect to specified description and location of installation.

B. Provide secure storage for finish hardware until installation is made.

1.05 EXTRA MATERIALS

A. Special Tools: Two sets for installation and maintenance of hardware.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide end products of one manufacturer for each product in order to achieve standardization for appearance, maintenance, and replacement.

B. Finishes: BHMA A156.18.

C. Some products listed below may not be used on this Project.

2.02 FASTENERS

A. Stainless steel.

2.03 BUTT HINGES

A. BHMA A156.1.

B. Quantity per Door Leaf (Minimum):

Door Height	Hinges
Up to 5'-0"	1 pair
5'-1" to 7'-7"	1-1/2 pair
7'-8" to 10'-0"	2 pairs
10'-1" to 12'-6"	2-1/2 pairs

C. Hinge Height (Minimum):

Door Width	Hinge Height
Up to 3'-0"	4-1/2"
3'-1" to 4'-0"	5"
Over 4'-0"	6"

D. Width: Minimum for clearance of trim and 180-degree swing.

E. Exterior Hinges: Nonremovable pin.

F. Joint Tolerance: 0.012 inch maximum, gauged in CLOSED position.

G. Finish: Satin stainless steel, 630.

H. Types and Manufacturers:

No.	Type Description	Stanley	Mc-Kinney	Lawrence	BHMA
H1	Regular weight, two ball-races, full mortise, stainless steel	FBB191	TB2314	BB4101-1	A2112

I. Electric hinges are to be similar in size, finish, and function to other hinges supplied for scheduled opening.

2.04 LOCKS AND LATCH SETS

A. Cylindrical or Bored Locks: BHMA A156.2, highest grade.

1. Trim: Wrought or cold-forged metal knobs and roses.

2. Core Cylinders: Large Format Interchangeable Core (LFIC), removable; minimum of six pins.
3. Strikes: Lip dimensions to fit configuration of trim.
4. Bolt Throw: 3/4 inch minimum, on latchbolts for pair of doors.
5. Knob Backset: 3-3/4 inch.
6. Manufacturers and Products:
   a. Schlage ND Series (LFIC).
   b. Card Reader Doors: Schlage ND Series; Model ND96RDEV.

B. Tactile Warning: Knurl knob backs and lever handles for touch identification; ICC A117.1, Section 4.29.3.

C. Finish: Satin stainless steel, 630.

D. Types and Manufacturers:

No.	Type Description	Schlage	BHMA
L1	Bored, entrance lock	C53PD	F81, F82
L2	Bored latch	C10S	F75
L3	Bored, utility room lock	C80PD	F86
L4	Bored, privacy lock	C40S	F76
L5	Cabinet lock, drawer and door	46-002	E07121
L6	Bored, exit only, lock	C12D	F89
L7	Padlock	45-101	

E. Keying:

1. Lock Cylinders: Operate by master key system that allows for future expansion and integration into existing key system.
2. Keylocks: As directed by Owner.
3. Keys: Two per lock; tag with schedule information.
4. Master Keys: Four; send by registered mail to Owner/Security.
5. Furnish lock manufacturer’s removable core maximum security keying system compatible with Schlage Primus system. Verify with existing keying system.
6. Control keys: Send by registered mail to Owner/Security.

2.05 CONSTRUCTION KEY SYSTEM

A. Removable construction core system for locks.

B. See Article Manufacturer's Services under Part 3, Execution.

2.06 CONSTRUCTION KEY SYSTEM

A. Assemble permanent cylinders with construction inserts and ship with all lock sets.

B. Change Keys: Pack in separately identified envelopes and ship.

C. Construction Keys: Pack in cartons marked "packing list" and ship.

D. Construction Insert Extractor Keys, Master Keys, and Grand Master Keys: Ship by registered mail to Owner.

E. On completion of job, deliver construction keys to Owner.

2.07 CLOSERS

A. BHMA A156.4.

B. Size closers in accordance with manufacturer's standards. Mount regular arm closers on pull side of doors. Mount parallel arm closers on push side of doors. On pair of doors provide closer on active leaf only, unless noted otherwise.

C. Finish: Satin stainless steel, 630.

D. Types and Manufacturers:

No.	Type/Description	LCN	Sargent	BHMA
C1	Regular arm	4010 Series	351 Series	C02011
C2	Parallel arm	4110 Series	351-P Series	C02021
C3	Regular arm with hold-open	4010H Series	351-H Series	C02051
C4	Parallel arm with integral stop	4110 Cush-N-Stop Series	351-PS Series	C02021
C5	Parallel arm with hold-open	4110H Series	351-PH Series	C02061

No.	Type/Description	LCN	Sargent	BHMA
C6	Parallel arm with integral stop and hold-open	4110H Cush-N-Stop Series	351-PSH Series	C02061
C7	Closer furnished by door and frame manufacturer			

2.08 STOPS AND HOLDERS

A. BHMA A156.16.

B. Machine Screws: In threaded anchors at concrete or masonry.

C. Self-Tapping Screws: At stud partitions, wood, or metal mountings.

D. Metal Risers: For mounting at carpet floors.

E. Finish: Satin stainless steel, 630.

F. Types and Manufacturers for Each Leaf:

No.	Type Description	BBW or GJ	Baldwin	BHMA
S1	Floor stop	F121X	4086	L02131
S2	Wall bumper	WC9X	4031	L02241
S3	Stop or holder furnished by door manufacturer			

2.09 BOLTS

A. BHMA A156.16.

B. Finish: Satin stainless steel, 630.

C. Types and Manufacturers:

No.	Type/Description	Stanley	Lawrence	BHMA
B1	Top and bottom flush bolts	393-1/2	280	L04201

2.10 KICKPLATES

A. Solid metal, not plated. Bevel four edges.

B. Width of door leaf less than 1-1/2 inches at single leaf and less than 1 inch at pairs.

C. Finish: Satin stainless steel No. 630.

D. Types and Manufacturers: Builders Brass Works, Baldwin, or Cipco as follows:

1. K1: 10 inches high by 0.125 inch thick.

2.11 THRESHOLDS

A. Thresholds: One-piece full width of opening; extend beyond jamb where indicated.

B. Provide with stainless steel machine screws in threaded expansion anchors at concrete.

C. Finish: Mill finish aluminum, unless indicated otherwise.

D. Types and Manufacturers:

No.	Type Description	Pemko	Reese
T1	Thermal break saddle (6-1/8")	253XAFG	S473A

2.12 WEATHERSTRIP

A. Finish: Clear anodized aluminum, unless indicated otherwise.

B. Seal Types and Manufacturers:

No.	Type Description	Pemko	Reese
W1	Rubber or vinyl bulb at jambs and head, and at meeting stiles of pairs	S88D	797B
	Door shoe	222AV	DB596AF
	Rain drip	346C	R201C

2.13 SILENCERS

A. Ives, Glynn-Johnson.

B. At metal frame of each hinged door that does not have seals scheduled.

C. Three at single leaves and two at pairs.

2.14 TEMPLATES

A. Fabricate to template hardware applied to metal doors and frames.

B. Ensure that required templates are furnished to various manufacturers for fabrication purposes.

C. Templates: Make available not more than 10 days after receipt of approved Hardware Schedule.

2.15 EXIT AND FIRE DOORS

A. Exit Doors: Always openable from inside by simple turn of lever handle or push on panic bar without use of key or any special knowledge or effort, to include each leaf of door pairs.

B. Hardware for Fire Doors: Underwriters Laboratories Inc., Fire Protection Equipment List.

2.16 KEY CONTROL SYSTEM

A. System: Integrate with existing Owner’s LFIC Key Control system.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer’s written instructions.

B. Make Work neat and secure, develop full strength of components, and provide proper function.

C. Prevent marring, scratching, or otherwise damaging adjacent finishes during hardware installation.

D. Install electric hinges at the center position of opening.

E. Latchbolts:

1. Install to engage in strikes automatically, whether activated by closers or manually.
2. In no case shall additional manual pressure be required to engage latchbolt in strike.

F. Stops and Holders: Set to allow doors to open as far as possible.

G. Wall Mounted Hardware: Install over solid structural backing or solid blocking in hollow walls.

H. Thresholds:

1. Cope ends neatly to profile of jamb.
2. Set in sealant and seal ends to jambs.

I. Hardware: Adjust for easy, noise-free operation.

J. Replace damaged hardware items.

3.02 MOUNTING DIMENSIONS

A. Standard Door Hardware Locations: As recommended and published by Door and Hardware Institute, except as noted or detailed otherwise.

B. Door Silencers: Install 3 inches from top and bottom of jamb and 1 inch above strike at single doors, and 3 inches from edges of doors in head for pairs of doors.

3.03 MANUFACTURER'S SERVICES

A. Deliver permanent lock cores to Site.

B. Remove temporary construction cores and insert permanent cores.

C. Inspect each lock set to ensure permanent cores are operating satisfactorily.

D. Deliver to Owner change and control keys for permanent system.

E. Return temporary construction cores to manufacturer.

F. Furnish manufacturer's representative for the following services at Site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:

1. 2 person-days for installation assistance, inspection, and Manufacturer's Certificate of Proper Installation.
2. 2 person-days for functional and performance testing.

3.04 PROTECTION

A. Cover and protect exposed surfaces of hardware during installation and until Substantial Completion.

B. Fit, dismantle, and reinstall finish hardware as required for finish painting work.

C. Protect and prevent staining of hardware during construction in accordance with manufacturer's recommendations.

D. Remove protective measures and permanent lock cylinders installed prior to final cleaning.

3.05 DOOR AND HARDWARE SCHEDULE

A. Door and Hardware Schedule on Drawings is guide to functional requirements of each opening.

B. Provide finish hardware as scheduled. Sizes omitted shall be as recommended by manufacturer.

END OF SECTION

SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI): Z97.1, Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test.
2. ASTM International (ASTM):
   a. C509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
   b. C864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
   c. C920, Standard Specification for Elastomeric Joint Sealants.
   d. C1036, Standard Specification for Flat Glass.
   e. C1048, Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.
   f. C1115, Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.
   g. C1193, Standard Guide for Use of Joint Sealants.
   h. C1376, Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
   i. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   j. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
   k. E1300, Standard Practice for Determining Load Resistance of Glass in Buildings.
   l. E1886, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
   m. E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
3. Consumer Product Safety Commission (CPSC) Code of Federal Regulations (CFR): 16 CFR 1201, Safety Standard for Architectural Glazing Materials.

4. Glass Association of North America (GANA):
   a. Glazing Manual.
   b. Sealant Manual.
5. National Fenestration Rating Council Incorporated (NFRC):
   a. 100, Procedure for Determining Fenestration Product U-Factors.
   b. 200, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
   c. 300, Standard Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.
6. National Fire Protection Association (NFPA):
   a. 80, Safety Standard for Fire Doors and Other Opening Protectives.
   b. 252, Safety Standard Methods of Fire Tests of Door Assemblies.
   c. 257, Safety Standard on Fire Test for Window and Glass Block Assemblies.
7. Mojave Desert Air Quality Management District: MDAQMD Rule 1113 - Architectural Coatings.
8. Underwriters Laboratories Inc. (UL):
   a. Building Materials Directory.
   b. 10C, Standard for Safety for Positive Pressure Fire Tests of Door Assemblies.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Complete schedule of glass and glazing material to be used for each purpose.
   b. Indicate sizes, layout, thicknesses, and loading conditions for glass.
2. Product Data:
   a. Catalog cuts of glazing materials with inclusion of glass edge cutting procedures.
   b. Glass: Provide structural, physical, and thermal and solar optical performance characteristics, size limitations, special handling or installation requirements.
   c. Glazing Sealants, Compounds, and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors where exposed.

3. Samples:
   a. Glass: Two samples 4 by 4 inch (100 by 100 mm) in size, illustrating each glass unit, coloration and design.
   b. Glazing Materials: Submit 6 inch (150 mm) long bead of glazing sealant and gaskets, color aluminum.

B. Informational Submittals:

1. Design calculations for glass thicknesses. Signed and sealed by Professional Engineer registered in State of California.
2. Manufacturer's Certificate of Compliance for each type of glazing.
3. Details and methods of glazing for each type of glazing condition; include manufacturer's recommendations for setting, sealing materials, and installing each type of glazing.
4. Documentation declaring compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants and other glazing materials.
5. Documentation of glazer's previous experience and manufacturer's approval.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing Work of this section with minimum 3 years' documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage:

1. Support cases on both sides when stored vertically.
2. After unpacking, place interleaving protection between lites.
3. Keep glass and interleaving dry by storing inside where temperatures are above dewpoint, or if outside storage is necessary, cover glass interleaving with opaque tarpaulins or plastic and inspect periodically. Wet interleaving can stain glass.
4. Avoid exposing stored glass to direct sunlight.

B. Handling:

1. Stack individual lites on edge and lean them against sturdy uprights at a slope of 5 degrees to 7 degrees from vertical.

2. Cushion bottom edges with soft, firm pads free of dirt, grit, glass chips, or other foreign material.
3. Do not rotate or cartwheel insulating glass units over their corners. Use turning device such as a rolling block if units must be rotated.

1.05 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this specification section found defective during a period of 10 years for vertical application insulating glass after date of Substantial Completion. Guarantee to cover deterioration because of normal conditions of use and not because of handling installing and cleaning practices performed contrary to glass manufacturer's published instructions. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. Single Source Fabrication Responsibility: Fabrication processes, including Low-E and reflective coatings, insulating, and tempering, shall be fabricated by a single fabricator.

B. Performance/Design Criteria:

1. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:
   a. In conjunction with vapor retarder and air barrier materials described in Section 07 26 00, Vapor Retarders.
   b. To utilize inner pane of multiple pane sealed units for continuity of air barrier and vapor retarder seal.
   c. To maintain continuous air barrier and vapor retarder throughout glazed assembly from glass pane to heel bead of glazing sealant.
2. Glass Thickness: Select minimum thickness in accordance with ASTM E1300 to resist specified design loads with the following maximum probability of breakage:
   a. Vertical Glass: Eight lites per 1,000 for wind loads with 60 seconds maximum load duration.
   b. Minimum Thickness: 1/4 inch (6 mm) for individual exterior glass sheet.

C. Structural Design: Design in accordance with applicable code for most critical combination of wind, snow, seismic, and dead loads.

D. Wind Loads: Design and size glass to withstand positive and negative wind loads acting normal to plane of wall, including increased loads at building corners.

1. Design Wind Load: As calculated in accordance with applicable code.
2. Wind-Borne Debris Loads: Design and size glass located less than 60 feet (18.288 m) above grade to withstand the following loads:
   a. Glass Within 30 Feet (9.144 m) of Grade: ASTM E1886 and ASTM E1996; large missile impact test.
   b. Glass Greater than 30 Feet (9.144 m) Above grade: ASTM E1886 and ASTM E1996; small missile impact test.
3. Seismic Loads: Design and size components to withstand seismic loads and sway displacement as calculated in accordance with applicable code.
4. Exterior Glass Deflection: Maximum of 1/175 of glass edge length or 3/4 inch (19 mm), whichever is less with full recovery of glazing materials.
5. Interior Glass Deflection: Maximum differential deflection for two adjacent unsupported edges when 50 plf (730 N/m) force is applied to one panel at any point up to 42 inches (1067 mm) above finished floor less than thickness of glass.
6. Thermal and Solar Optical Performance: Measured or calculated in accordance with the following:
   a. U-Values: NFRC 100.
   b. Solar Heat Gain Coefficients: NFRC 200.
   c. Solar Optical Properties: NFRC 300.

E. Fire Rated:

1. Window Glazing:
   a. Tested in accordance with NFPA 257 and complying with NFPA 80.
   b. NFPA 257; adjusted so two-thirds of test specimen is above neutral pressure plane at 10 minutes into test.
2. Door Glazing: Tested in accordance with one of the following and complying with NFPA 80.
   a. NFPA 252; with neutral pressure level at 40 inches (1,015 mm) maximum above sill at 5 minutes into test.
   b. UL 10C.

3. Apply label from agency approved by authority having jurisdiction to identify each fire rated glass lite.

F. Perform Work in accordance with State of California standard.

2.02 FLOAT GLASS MATERIALS

A. Annealed Glass:

1. ASTM C1036, Type 1 transparent flat, Quality Q3, float glass.
2. Furnish annealed glass except where heat strengthened or tempered glass is required to meet specified performance requirements.

B. Heat Strengthened Glass:

1. ASTM C1048, Type 1 transparent flat, Quality Q3, Kind HS heat strengthened, Condition A uncoated, float glass.
2. Furnish heat strengthened glass where annealed glass cannot meet specified performance requirements.

C. Tempered Glass:

1. ASTM C1048, Type 1 transparent flat, Quality Q3, Kind FT fully tempered, Condition A uncoated, float glass with horizontal tempering.
2. Furnish tempered glass where heat strengthened glass cannot meet specified performance requirements.
3. Conforming to CPSC 16 CFR 1201 Category II at locations where safety glass is required by applicable code.

2.03 FLOAT GLASS PRODUCTS

A. Clear Glass:

1. Tempered float glass as specified; Class 1 clear.
2. Minimum Thickness: 1/4 inch (6 mm).

2.04 FIRE RESISTIVE GLASS PRODUCTS

A. Fire Resistive Ceramic Glass:

1. Transparent polished both surfaces.
2. Clear ceramic glass.
3. Thickness: Manufacturer’s standard.

4. Fire Rating: 90-minute rating as listed in UL Building Materials Directory and approved by authority having jurisdiction for applications indicated.
5. Manufacturer and Product: Technical Glass Products; FireLite.

2.05 INSULATING GLASS PRODUCTS

A. Double Pane Insulating Glass:

1. Total Unit Thickness: 1 inch (25 mm).
2. Product: VUE 1-50 manufactured by Viracon.
3. U-Factor Winter: 0.29 maximum.
4. U-Factor Summer: 0.26 maximum.
5. Solar Heat Gain Coefficient: 0.25 maximum.
6. UV Transmittance: 5 percent maximum.
7. Visible Light Transmittance: 48 percent minimum.
8. Solar Transmittance: 20 percent maximum.
9. Reflectance Inside: 11 percent maximum.
10. Reflectance Outside: 11 percent maximum.

2.06 GLAZING SEALANTS

A. Elastomeric Glazing Sealants: Materials compatible with adjacent materials including glass, insulating glass seals, and glazing channels.

1. Silicone Glazing Sealant:
   a. ASTM C920, Type S, Grade NS, Class and Use suitable for glazing application indicated; single component; chemical curing; capable of water immersion without loss of properties; nonbleeding, nonstaining, cured Shore A Hardness Range 15 to 25.
   b. Structural Silicone: Furnish high-modulus structural silicone glazing materials where sealant bonds glass to substrate.
   c. Color: Aluminum.
   d. Interior Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with MDAQMD Rule 1113.
   e. Manufacturer and Product: Dow Corning; 999A Silicone Glazing Sealant.

B. Dense Gaskets:

1. Resilient extruded shape to suit glazing channel retaining slot; black color.

2. Neoprene: ASTM C864.
3. EPDM: ASTM C864.
4. Silicone: ASTM C1115.

C. Soft Gaskets:

1. ASTM C509 Type II; resilient extruded shape to suit glazing channel retaining slot; black color.
2. Neoprene.
3. EPDM.
4. Silicone.

D. Preformed Glazing Tape:

1. Size to suit application.
2. Glazing Tape:
   a. Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent, designed for compression of 25 percent to affect air barrier and vapor retarder seal.
   b. Interior Adhesives: Maximum volatile organic compound content in accordance with MDAQMD Rule 1113.
   c. Manufacturer and Product: Saint-Gobain; Norseal PVC Foams.

2.07 GLAZING ACCESSORIES

A. Setting Blocks: Elastomeric material recommended by glass manufacturer, 80 to 90 Shore A durometer hardness, length of 0.1 inch for each square foot (25 mm for each square meter) of glazing or minimum 4 inch (100 mm) by width of glazing rabbet space minus 1/16 inch (1.5 mm) by height to suit glazing method and pane weight and area.

B. Spacer Shims: Elastomeric material recommended by glass manufacturer, 50 to 60 Shore A durometer hardness, minimum 3-inch (75-mm) long by one half the height of glazing stop by thickness to suit application, self-adhesive on one face.

C. Glazing Clips: Manufacturer's standard type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings for glazing are correctly sized and within acceptable tolerance.

B. Verify surfaces of glazing channels or recesses are clean, free of obstructions impeding moisture movement, weeps are clear and ready to receive glazing.

3.02 PREPARATION

A. Do not perform glazing work in damp, foggy, or rainy weather, or when temperatures are not within range recommended by GANA “Glazing Manual.”

B. Surfaces:

1. Smooth, even, sound, dry, and clean.
2. Clean contact surfaces with solvent and wipe dry.

C. Priming:

1. Complete and cured.
2. Prime surfaces scheduled to receive sealant.

D. Measure size of frames to receive glass and compute actual glass size allowing for edge clearances.

E. Use fire rated glass in glazed openings in labeled fire doors and tempered glass in other doors, transoms, and sidelights.

F. Verify functioning weep system is present.

G. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.03 GLAZING INSTALLATION

A. General: Follow recommendations of glass manufacturer GANA “Sealant Manual,” GANA “Glazing Manual,” and the following:

1. Glazing Sealants: Comply with ASTM C1193.
2. Fire Rated Openings: Comply with NFPA 80.

B. Exterior Wet/Dry Method (Preformed Tape and Sealant) Installation:

1. Cut glazing tape to length and set against permanent stops, 3/16 inch (5 mm) below sight line. Seal corners by butting tape and dabbing with compatible butyl sealant.
2. Apply heel bead of butyl sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete continuity of air and vapor seal.
3. Place setting blocks at 1/4 points with edge block no more than 6 inches (150 mm) from corners.
4. Rest glazing on setting blocks and push against tape and heel bead of sealant with sufficient pressure to attain full contact at perimeter of pane or glass unit.
5. Install removable stops, with spacer strips inserted between glazing and applied stops, 1/4 inch (6 mm) below sight line.
6. Fill gap between glazing and stop with elastomeric glazing sealant to depth equal to bite of frame on glazing, but not more than 3/8 inch (9 mm) below sight line.
7. Apply cap bead of elastomeric glazing sealant along void between stop and glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

C. Interior Wet/Dry Method (Tape and Sealant) Installation:

1. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.
2. Place setting blocks at 1/4 points with edge block no more than 6 inches (150 mm) from corners.
3. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.
4. Install removable stops, spacer shims inserted between glazing and applied stops at 24-inch (600-mm) intervals, 1/4 inch (6 mm) below sight line.
5. Fill gaps between pane and applied stop with elastomeric glazing sealant to depth equal to bite on glazing, to uniform and level line.
6. Trim protruding tape edge.

3.04 FIELD QUALITY CONTROL

A. Hose Test:

1. Use 3/4-inch minimum hose without nozzle. With full stream, flood glazing from bottom to top.

2. Correct leaks disclosed by hose test by reglazing and retesting until eliminated.

3.05 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's representative at Site for installation assistance and inspection.

3.06 CLEANING

A. Leave glass and glazing in undamaged condition and ready for final cleaning.

B. Remove excess glazing compound from installed glass.

C. Remove labels from glass surface at time of final cleaning.

D. Wash and polish both faces of glass.

E. Clean adjacent surfaces of glass.

3.07 PROTECTION OF COMPLETED WORK

A. Protection:

1. Keep glass free from contamination by materials capable of staining glass.
2. Install tape across lights secured to frames or structure.
3. No tape or marking allowed on glass.

B. Replacements and Repairs: Prior to Substantial Completion, replace broken, defective, or scratched glass and repair damaged compounds.

3.08 SCHEDULE

A. Glazing Type G-1: Float glass, tempered at code required locations.

B. Glazing Type G-2: Insulated glass, tempered at code required locations.

END OF SECTION

SECTION 08 90 00
LOUVERS AND VENTS

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Movement and Control Association (AMCA): 500-L, Laboratory Methods of Testing Louvers for Rating.
2. The Aluminum Association, Incorporated (AA): Designation System for Aluminum Finishes.
3. ASTM International (ASTM):
   a. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   b. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. Underwriters Laboratories, Inc. (UL): Building Materials Directory.

1.02 DESIGN REQUIREMENTS

A. Installed Louvers: Capable of resisting wind load required by the AHJ and the Owner.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Large scale details of louvers, anchorage, and relationship to adjoining construction.
   a. Manufacturer’s Literature: Descriptive and performance data of louvers, including standard drawings and louver-free area.
   b. Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
2. Samples: Manufacturer’s standard finishes and colors.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
2. Factory test data.
3. Certificates of AMCA ratings.
4. Installation instructions.
5. Parts list, if applicable.
6. Maintenance procedures.
7. Special Guarantee.

1.04 SPECIAL GUARANTEE

A. Manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction, or at option of Owner, removal and replacement of special fluorocarbon or baked-on finish found defective during a period of 20 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. Nonacoustical louver sizes are based on 50 percent free area and 800 FPM maximum velocity through free area. If louvers furnished do not meet these parameters, Contractor is responsible for resizing louvers and wall openings, and for making other adjustments to allow for larger openings.

B. Water Penetration Rate: No greater than 0.02 ounce per square foot.

C. Louvers: Rated and tested in accordance with AMCA 500-L.

D. Furnish louvers with interior duct collars.

2.02 FIXED STORMPROOF LOUVERS (TYPE SP)

A. Frame: Extruded aluminum channel, 0.081 inch thick, 4 inches deep, with concealed mullions.

B. Blades: Extruded aluminum, 0.081 inch thick, Z-shaped, 35-degree to 45-degree pitch angle, spaced 3 inches to 4.25 inches on center.

C. Pressure Loss: AMCA certified rating of no greater than 0.10-inch WC.

D. Sizes: As shown on Drawings.

E. Screen: Inside mounted, painted aluminum, 1/2-inch mesh.

F. Finish: AA-M1022A41, clear anodized.

G. Manufacturers and Products:

1. Construction Specialties; Model 4110.
2. Dowco; Series LEB-4.
3. Ruskin; Model ELF-375DXH.

2.03 ACCESSORIES

A. Anchors and Fasteners: Stainless steel.

B. Flashings: Match louver frame.

C. Isolation Tape: Tremco 440, 3M EC1202, or Presstite 579.6.

D. Isolation Paint: ASTM D1187, bituminous coating.

2.04 SOURCE QUALITY CONTROL

A. Factory Performance Tests:

1. Airflow versus pressure loss.
2. Rain penetration data.

PART 3 EXECUTION

3.01 EXAMINATION

A. Check openings to ensure dimensions conform to Drawings.

B. Ensure openings are free of irregularities that would interfere with installation.

C. Do not install louvers until defects have been corrected.

3.02 INSTALLATION

A. Install louvers as shown on reviewed Shop Drawings. Coordinate with heating or ventilation ductwork to be connected.

B. Follow procedures in manufacturer's recommended installation instructions.

C. Install insulated blank-off panels where indicated, completely closing space between ducts and louver frames.

D. Separate aluminum from other metals with isolation tape or paint.

3.03 CLEANING

A. After erection, protect exposed portions from damage by machines, paint, lime, acid, cement, or other harmful compounds.

B. Remove protective materials and clean with plain water, water with soap, or household detergents.

3.04 SUPPLEMENT

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

1. Louver and Vent Schedule: A tabulation of louver and vent characteristics for each opening numbered on Drawings. Provide items as scheduled.

END OF SECTION

LOUVER AND VENT SCHEDULE

LOUVER TYPES:

AC	Acoustical
AJ	Adjustable
BV	Block Vent
DB	Drainable
FX	Fixed
LD	Combination Louver/Damper
MO	Manually Operable
SP	Stormproof
TR	Transom

ABBREVIATIONS:

AL	Aluminum
AS	As Selected
FCTY	Factory
FRP	Fiber Reinforced Plastic
GALV	Galvanized Steel

NOTES:

No. 1 For details see Drawings.

Opening			Louver				Details			
No.	**Width**	**Height**	**Type**	**Matl**	**Fnsh**	**Col**	**Head**	**Jamb**	**Sill**	**Other Requirements**
			FX	AL	Anodize	Clear				

SECTION 09 22 36
LATH AND PLASTERING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A641, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   b. C150, Standard Specification for Portland Cement.
   c. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   d. C834, Standard Specification for Latex Sealants.
   e. C841, Standard Specification for Installation of Interior Lathing and Furring.
   f. C842, Standard Specification for Application of Interior Gypsum Plaster.
   g. C897, Standard Specification for Job-Mixed Portland Cement-Based Plasters.
   h. C926, Standard Specification for Application of Portland Cement-Based Plaster.
   i. C932, Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering.
   j. C979, Standard Specification for Pigments for Integrally Colored Concrete.
   k. C1032, Standard Specification for Woven Wire Plaster Base.
   l. C1059, Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete.
   m. C1063, Standard Specification for Installation of Lathing and Furring for Portland Cement-Based Plaster.
   n. E72, Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
   o. E514, Standard Test Method for Water Penetration and Leakage Through Masonry.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Detailed control joint layout.
2. Samples: One each of metal lath, metal accessories, and applied acrylic coating illustrating color, finish and texture.

B. Informational Submittals: Documentation of lath and plaster applier's successful experience for past 5 years on projects of equal size and scope.

1.03 QUALITY ASSURANCE

A. Mock-up:

1. Prepare a 4-foot by 4-foot Sample panel of each plaster system on similar substrate to illustrate surface finish.
2. Approved panels shall establish a standard of quality and color by which similar work will be evaluated.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Keep materials dry; store off ground, under cover, and away from damp places.

B. Protect accessories and metal goods against deformation, breakage, staining, and rusting.

1.05 ENVIRONMENTAL CONDITIONS

A. Temperature: Maintain uniform temperature above 55 degrees F for 24 hours before, during, and after application in areas receiving lathing and plastering.

B. Ventilation:

1. Provide ventilation to properly dry plaster during and after its application.
2. Use temporary air circulators in enclosed areas lacking natural ventilation.

PART 2 PRODUCTS

2.01 LATH

A. Wire Lath:

1. Woven Wire (Stucco Netting): ASTM C1032, copper-bearing, galvanized steel, hexagonal interwoven wire, 20 gauge minimum with 1-inch openings, similar to 20 gauge woven wire lath manufactured by K-Lath.

B. Fasteners for Metal Lath: Galvanized nails or staples of the type recommended by the lath manufacturer.

2.02 ACCESSORIES

A. For Portland Cement Plaster-Stucco Systems: Galvanized steel or polyvinyl chloride, size suitable for the thickness of the stucco.

Accessories for Portland Cement Plaster-Stucco Systems			
Material	**Metalex Keene**	**Vinyl Tech**	**Fry**
Corner bead	1-X	#4	PCM-75-75
Casing bead (exposed type)	J-Trim	#5C	JPM 75
Control joint	XJ15-3	#20X	PCS-75-25
Foundation screed	Drip Screed	#631	FWS-875
Expansion joint	#40	#20	PCS-75-25

B. Vented Channel Screed: Fry Reglet Corp., No. PCS-75-V-300.

C. Channel Screed: Fry Reglet Corp., No. PCS-75-150.

D. Underlayment: As described in Section 07 26 00, Vapor Retarders.

2.03 BONDING AGENTS

A. Type II Ethylene Polyvinyl Acetate Co-Polymer Bonding Agent for Portland Cement Repair Mortars, complying with ASTM C1059.

1. Acceptable Products:
   a. Concrete Bonding Adhesive (No. 9902) as manufactured by the Quickrete Companies.
   b. Bond-crete as manufactured by Omega Products International.
   c. Approved substitution.

2.04 PORTLAND CEMENT PLASTER (STUCCO BASE COAT) MATERIALS

A. Manufacturers and Materials

1. The Quikrete Companies:
   a. The Quikrete One-Coat Fiberglass Reinforced Stucco Wall Systems manufacture's packaged dry material included sand. Quikrete Liquid Stucco – Acrylic Finish Coat, fine sand finish, color to match colored CMU block in Section 04 30 00, Unit Masonry System. Provide sample of actual finish for approval.
2. Omega Products International, Inc.:
   a. Omega Diamond Wall Insulating Exterior Stucco System manufacture's packaged dry material included sand.
   b. Akroflex Desert Series Finishes: Acrylic finish coat, uniform fine sand-like finish, color to match colored CMU block in Section 04 30 00, Unit Masonry System. Provide sample of actual finish for approval.
3. Approved substitution.

2.05 MIXES

A. General:

1. Provide suitable mechanical mixers, measuring devices and placement equipment recommended by manufacturers printed directions. Hand mixing will not be permitted.
2. Use potable water.
3. Thoroughly mix plaster ingredients.
4. Use mixed plaster within 1 hour after mixing. Retempering will not be permitted.
5. Do not allow material to remain overnight in mixers or mixing boxes.

6. Clean machines, boxes, tools, and equipment as required during the plastering operation.
7. At the end of the working day, clean up all tools and equipment.

PART 3 EXECUTION

3.01 PREPARATION

A. Protection: Protect other portions of the Work.

B. Surface Preparation: Repair defective surfaces prior to starting Work.

C. Prior to beginning mixing operations ensure that dust emissions will be minimized.

3.02 APPLICATION OF METAL LATH TO FRAMING

A. Apply to framing in strict accordance with ASTM C841 and the manufacturer's printed directions.

3.03 APPLICATION OF METAL LATH FOR EXTERIOR STUCCO

A. Conform to ASTM C1063.

B. Verify wall surfaces are covered with rigid insulation, specified in Section 07 21 00, Thermal Insulation, and vapor retarder system, specified in Section 07 26 00, Vapor Retarders, before application of lath.

C. Coordinate Work with metal flashings.

D. Apply metal lath over the vapor retarder in conformance with manufacturer's printed directions.

E. Install accessories with all flanges and attachment point fastened to substrate as recommended in manufacturer's printed instructions. Provide accessories in place that:

1. Are installed true, plumb, and securely fastened, providing a path for trapped moisture behind stucco is routed to the building exterior.
2. Embed accessory butt ends in sealant compliant to ASTM C834.
3. Provide a true, plumb, and moisture resistant stucco surface.
4. Layout of accessories to create stucco panels of 150 to 180 square feet area at frame construction and 250 square feet on masonry or concrete construction.

3.04 JOINTS BETWEEN DIFFERENT MATERIALS USED FOR PLASTER BASE

A. Where metal lathed surfaces join surfaces of other materials to be used for a plaster base, extend metal lath across the junction, lapping at least 4 inches each side of joint for the entire height or width.

3.05 ACCESSORIES

A. Install accessories plumb or level, straight, and true to line. Verify drainage provisions are clear and functioning.

B. Tie with wire or nail at 12-inch intervals to metal or gypsum lath as required to accomplish the construction.

C. Provide corner beads at external angles, casing beads where indicated and where plaster abuts unplastered surfaces, metal screeds, and other accessories as shown and required.

3.06 PORTLAND CEMENT PLASTER (STUCCO) APPLICATION

A. Conform to ASTM C926, except as specified.

B. Commence operations only when weather conditions are in compliance with manufacturer’s recommendations. Work only as weather conditions permit.

C. Apply stucco mixture over lath in thickness specified, via machine-spraying using manufacturer recommended equipment, sized and powered as required by printed manufacturer’s instructions.

D. Apply stucco onto lath working from bottom to top. Force stucco through the mesh so that it fills the gap between mesh and walls completely.

E. Screed stucco flat with rod and darby.

F. After stucco has lost sheen, use float to smooth surface.

G. Water cure surfaces, adjusting rate and frequency of application over period required by manufacturer, adjusted for weather conditions.

3.07 APPLICATION THICKNESSES

A. Provide thicknesses in table below, measured from the face of plaster base to finished plaster surface.

B. Install wood or metal grounds, or plaster screeds, to assure required thickness.

C. Increase plaster thickness where necessary to meet building code requirements.

Plaster Base	Thickness of Plaster Including Finish Coat (Inches)
Metal lath (stucco)	7/8 minimum

3.08 ACRYLIC FINISH COAT

A. Apply acrylic finish over plaster work base coat a minimum 1/16 inch dry thickness.

B. Apply acrylic finish coat with sufficient material to uniformly and completely cover the plaster work base coat.

3.09 FIELD QUALITY CONTROL

A. Engineer will take samples from plaster work in-place to verify conformance with intent of Contract Documents. Areas represented by samples that show oversanding will be rejected.

3.10 REPAIRING DEFECTIVE WORK

A. Plaster surfaces containing cracks, blisters, pits, checks, or discolorations will be considered defective and will not be acceptable.

B. Patching of defective Work will be permitted only when approved by the Engineer; match existing in texture and color.

C. Cut and repair plaster for installation of omitted Work.

D. Apply bonding agent as recommended by the manufacturer, at surfaces to be repaired.

E. Patch lath and plaster that has been cut or damaged due to installation of materials or equipment after the plaster has been applied.

3.11 CLEANING

A. Remove excess plaster from building surfaces and clean.

END OF SECTION

SECTION 09 29 00
GYPSUM BOARD

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A641/A641M, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   b. C208, Standard Specification for Cellulosic Fiber Insulating Board.
   c. C475/C475M, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
   d. C514, Standard Specification for Nails for the Application of Gypsum Board.
   e. C645, Standard Specification for Nonstructural Steel Framing Members.
   f. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
   g. C754, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
   h. C840, Standard Specification for Application and Finishing of Gypsum Board.
   i. 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.
   j. C1047, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
   k. C1177/C1177M, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
   l. C1178/C1178M, Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel.
   m. C1396/C1396M, Standard Specification for Gypsum Board.
   n. D4977, Standard Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion.
   o. D5420, Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact).

p. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
q. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
r. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
s. E413, Classification for Rating Sound Insulation.
t. E695, Standard Test Method of Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading.

2. Gypsum Association (GA):
   a. 214, Recommended Levels of Gypsum Board Finish.
   b. 216, Application and Finishing of Gypsum Panel Products.
3. Underwriters Laboratories Inc. (UL): UL Fire Resistance Directory.

1.02 DESIGN CRITERIA

A. Partition assemblies shall be constructed to resist all loads to which they are subjected, but not less than a force of 5 pounds per square foot applied perpendicular to the partition.

   1. Deflection of partition under a load of 5 pounds per square foot shall not exceed L/240 of the span.
   2. Cold-formed metal framing section properties shall be computed in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.

B. Special structural conditions, defined as those not addressed in framing manufacturer’s span tables, shall be addressed through the use of stamped calculations, performed by engineer licensed in the project jurisdiction.

1.03 SUBMITTALS

A. Submittals:

   1. Control joint pattern proposed for gypsum board.
   2. Manufacturer’s list of items and materials proposed for use, with descriptive literature for each system used.
   3. Shop and erection drawings indicating all types, profiles, sizes, gauges, finish, dimensions, properties, positions, openings, welds, fastening, accessories, etc., for the fabrication and erection of all structural metal stud framing. Include stamped calculations for oversized openings,

conforming to requirements of Section 05 41 00, Structural Metal Stud Framing.

1.04 QUALITY ASSURANCE

A. General: Regardless of the minimum specifications herein, utilize materials and applications recommended by manufacturer.

B. Applicator's Qualifications: Use only workers regularly employed in this type of work who can show experience in application of similar materials and specific systems specified.

C. Single Source Responsibility: Use gypsum board and related joint treatment materials from a single manufacturer for each type used.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver fire-rated materials bearing testing agency label and required fire classification numbers.

B. Storage:

1. Store materials inside, under cover, stacked flat, off floor.
2. Stack gypsum board so that long lengths are not over short lengths.
3. Avoid overloading floor system of storage area.
4. Store adhesives and finishing compounds in dry areas; protect against freezing at all times.

1.06 ENVIRONMENTAL CONDITIONS

A. Temperature: In areas receiving gypsum board installation, maintain minimum temperature of 40 degrees F for 48 hours before, during, and after gypsum board application. Maintain minimum temperature of 50 degrees F for 48 hours before, during, and after application of adhesive methods of attachment and finishing compounds until drying is complete.

B. Ventilation:

1. Provide ventilation during and following adhesives and joint treatment applications.
2. Use temporary air circulators in enclosed areas lacking natural ventilation.
3. Under slow drying conditions, allow additional drying time between coats of joint treatment.

4. Protect installed materials from drafts of ambient air during hot, dry weather.
5. Protect materials from drying too rapidly during hot and dry weather.

PART 2 PRODUCTS

2.01 GYPSUM BOARD

A. Regular Board (GWB): ASTM C1396/C1396M, 5/8-inch thick with tapered edges and featured rounded or beveled for prefilling.

1. Curved Board (GWB): ASTM C1396/C1396M, 1/4-inch thick with tapered edges and featured rounded or beveled for prefilling.

B. Water-Resistant Board (WRB): ASTM C1396/C1396M, 5/8-inch thick with tapered edges.

2.02 FASTENERS

A. Gypsum Board:

1. Annular Ring Nail: ASTM C514, GWB-54, 1-1/4 inches long for 1/2-inch gypsum board, and 1-3/8 inches long for 5/8-inch gypsum board.
2. Smooth Shank Nail: ASTM C514, 1-3/8 inches long for 1/2-inch gypsum board, and 1-1/2 inches long for 5/8-inch gypsum board.
3. Screws: ASTM C1002, self-drilling, self-tapping, bugle head, for use with power-driven tool.
   a. Type S, 1 inch long for gypsum board to sheet metal.
   b. Type W, 1-1/4 inches long for gypsum board to wood.

2.03 JOINT TREATMENT MATERIALS

A. Tape:

1. General Interior Applications: ASTM C475/C475M, perforated paper tape.

B. Compound:

1. General Interior Applications: ASTM C475/C475M, all-purpose, ready-mixed compound.
2. Water-Resistant GWB: Chemically curing, polyindurate type material as recommended by manufacturer.

2.04 ANCILLARY MATERIALS

A. Adhesives: As recommended by gypsum board manufacturer for intended use. Use adhesives that have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 TRIM ACCESSORIES

A. ASTM C1047, Zinc-Coated Metal.

B. Manufacturers and Products:

1. Corner Bead:
   a. 1-1/4 inch by 1-1/4 inch:
      1) United States Gypsum; Dur-A-Bead.
      2) Gold Bond; standard corner beads.
   b. Edge Trim:
      1) United States Gypsum; 200B metal trim.
      2) Gold Bond; No. 200 casing bead.
   c. Metal Control Joint:
      1) United States Gypsum; No. 093.
      2) Gold Bond; E-Z strip control joint.

2.06 NONSTRUCTURAL METAL FRAMING MEMBERS

A. ASTM C645, galvanized C-studs with 1-5/8-inch flanges.

B. Sizes and Gauge: As noted on Drawings.

C. Manufacturers:

1. United States Gypsum.
2. Dale/Incor.
3. Gold Bond.
4. Unimast, Inc.

2.07 LIGHT-GAUGE METAL FRAMING ACCESSORIES

A. Cold-Rolled Carrying Channel: Cold-rolled steel, 18-gauge metal with minimum 1/2-inch wide flange, free of rust galvanized 2-1/2 inches deep.

B. Cold-Rolled Bridging Channel: Cold-rolled steel, 18-gauge metal with minimum 1/2 inch wide flange galvanized 1-1/2 inches deep.

C. Cold-Rolled Furring Channel: Cold-rolled steel, 25-gauge metal with minimum 1/2-inch wide flange, free of rust galvanized 3/4 inches deep.

D. Z-Furring: Galvanized 18-gauge, 3 inches deep.

E. Hat-Shaped Furring Channels: Roll-formed hat shaped section of 16-gauge galvanized steel with a face width of 1-1/4 inches and a depth of 7/8 inch.

F. Resilient Furring Channels: Roll-formed section of 25-gauge galvanized steel with face width of 1-1/2 inches designed for resilient attachment of gypsum board to framing.

G. Hanger Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.

H. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.625-inch diameter or double strand of 0.0475-inch diameter wire.

2.08 DRY WALL CEILING SUSPENSION SYSTEM

A. Use system of main runners, cross tees, and furring channels.

B. Curved Ceiling Elements: Use system of main runners, crosstees, furring channels, and specialty connectors. Factory form pieces required to be curved to fulfill intent of Drawings.

1. Basis of Design: USG Interiors, Inc.; Drywall Suspension System.

C. Manufacturers and Products:

1. Armstrong World Industries, Inc.; Furring Systems/Drywall.
2. Chicago Metallic Corporation.
3. USG Interiors, Inc.; Drywall Suspension System.

2.09 SPRAY TEXTURE

A. Manufacturers and Products:

1. Aggregate Finish:
   a. National Gypsum Company; ProForm Spray Quick.
   b. United States Gypsum Company; Ceiling Spray Texture.

B. Manufacturers and Products:

1. Nonaggregate Finish:
   a. National Gypsum Company; ProForm Perfect Spray EM/HF.
   b. United States Gypsum Co.; SHEETROCK Wall and Ceiling Spray Texture (unaggregated).

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect surfaces to receive gypsum board and related materials before beginning work and report to Engineer any defects in such work which will adversely affect the quality of work specified herein.

3.02 PREPARATION

A. General: Provide, install, and maintain necessary scaffold, staging, trestles, planking, and temporary heating, lighting, and ventilation as necessary for duration of gypsum board work.

B. Protection: Protect work of other trades.

C. Coordination:

1. Coordinate work with that of other trades. Check specifications and drawings of other trades to determine parts of work requiring coordination.
2. Cut and repair gypsum board systems for installation of omitted work.

D. Surface Preparation: Repair defective surfaces prior to starting work. Prepare as specified for application of specific materials.

3.03 ERECTION OF SUSPENDED CEILING

A. General:

1. Securely brace all ceiling areas against sway as required by code for seismic control.
2. Prevent runner and furring channels from contacting masonry walls.
3. Provide 1-1/2-inch channels around recessed lighting fixture openings to support fixtures.

B. Hangers:

1. Space not over 4 feet on center (OC) in direction of runners and within 6 inches of ends of runners.
2. Securely attach to structure above and provide for full saddle tie to main runner at indicated height.
3. Install additional hangers at ends of each suspension member and at light fixtures, 6 inches from vertical surfaces.
4. Do not splay wires more than 5 inches in a 4-foot vertical drop.
5. Provide four-way wire splays at 45 degrees from main runner to support structure for every 144 square feet of ceiling area to prevent sway.
6. Wrap wire minimum three times horizontally, turning ends upward.
7. Where hanger wires cannot be hung vertically from structure above because of ducts, pipes, cable trays, or other interferences, provide trapezes of steel channels (minimum 2-inch deep, 16-gauge cold-rolled carrying channels) hung on steel rods or 8-gauge wire from structural members above. Hang ceiling wires from trapezes or similar members supporting ducts or pipes. Do not hang directly from ducts or pipes.

C. Main Runner Channels:

1. Run main runner channels spaced not more than 4 feet OC, and 6 inches from parallel walls, at right angles to the length of joists.
2. Overlap splices in main runners 12 inches minimum, interlock flanges, and securely tie near each end of splice with double loops of tie wire.

D. Furring Channels:

1. Attach furring channels to main runners at right angles, space at 16 inches OC.
2. Securely saddle tie furring to the main runners at each crossing or equivalent clips or attachments.
3. Splices in Cross-Furring: Lap 8 inches minimum, interlock flanges, and securely tie near each end of splice with two loops of tie wire.

3.04 ERECTION OF DRY WALL CEILING SUSPENSION SYSTEM

A. Follow manufacturer’s printed instructions.

B. Hangers:

1. Space not over 4 feet OC in direction of runners and within 6 inches of ends of runners.

2. Securely attach to structure above and provide for full saddle tie to main runner at indicated height.
3. Connections shall develop full strength of hanger wire.

C. Bracing:

1. Securely brace ceiling areas against sway.
2. Where required by code, install for seismic control.
3. Prevent runner and furring channels from contacting masonry walls.

D. Where ducts interfere with normal spacing of hangers and carrying channels, install additional hangers and channels to properly suspend ceiling.

3.05 ERECTION OF LIGHT-GAUGE NONSTRUCTURAL METAL FRAMING

A. Layout: Align partitions as shown on Drawings.

B. Tracks:

1. Attach metal runner tracks to floor slabs with suitable fasteners located 2 inches from each end and spaced not more than 24 inches OC.
2. Where partitions terminate at suspended or framed ceilings attach top tracks to suspended ceiling with toggle or molly bolts spaced 24 inches OC.
3. Where partitions terminate at underside of concrete or metal decking attach deflection channels to substrate with suitable fasteners located 2 inches from each end and spaced not more than 24 inches OC. Locate partition top tracks within deflection channels with a minimum top clearance of 1 inch. Do not attach track to channel.

C. Studs:

1. ASTM C754.
2. Following manufacturer’s printed instructions, position studs vertically, engaging floor and ceiling tracks and spaced as noted on Drawings.
3. Splice: When necessary, use 8-inch nested lap and one positive attachment per stud flange.
4. Place in direct contact with doorframe jambs, abutting partitions, and partition corners. Provide for anchorage of doorframes to studs.
5. Anchor studs for shelf-walls and those adjacent to window and doorframes, partition intersections, and corners to ceiling and floor runner flanges. Securely anchor studs to jamb and head anchor clips of door or borrowed-light frames by bolt or screw attachment.

6. Over metal door and borrowed-light frames, place horizontally a cut-to-length section of runner, with a web-flanged bend at each end, and secure with one positive attachment per flange. Position a cut-to-length stud (extending to ceiling runner) at vertical panel joints over doorframe header.
7. Locate studs at abutting construction, partition intersections, and partition corners.
8. Spacing: At 16 inches OC, unless otherwise required by manufacturer.
9. At Doorframes and Cased Openings:
    a. Full height double studs, No. 20 gauge minimum, secured to jamb anchors by bolts, screws, or welds.
    b. Header Track: Secure to frame head anchors and double studs.
    c. Provide double channel stiffeners through studs above frame and extend at least one stud space beyond each jamb.
10. Windows: Similar framing to door openings with stiffeners both above and below.
11. Wall Mounting Accessories: Provide channels, horizontal studding, No. 16 gauge sheet 8 inches by 2 inches greater than stud spacing, or other members within walls as required to provide secure and adequate support.

D. Furring:

1. Space furring channels the same as studs or as shown.
2. Around columns and beams construct furring as shown using metal studs and furring channels securely tied together and anchored in-place.
3. Attach resilient furring channels to wood framing with screws.

3.06 APPLICATION OF GYPSUM BOARD

A. Inspection and Preparation:

1. Check framing for accurate spacing and alignment.
2. Verify spacing of installed framing does not exceed maximum allowable for thickness of gypsum board to be used.
3. Verify frames are set for thickness of gypsum board to be used.
4. Do not proceed with installation of gypsum board until deficiencies are corrected and surfaces to receive gypsum board are acceptable.
5. Repair protrusions of framing, twisted framing members, or unaligned members before installation of gypsum board is started.

B. General:

1. Meet requirements of ASTM C840 and GA 216.
2. Joints: Use gypsum board of maximum lengths to minimize end joints. Stagger end joints when they occur. Locate end joints as far as possible from center of wall or ceiling. Abut gypsum board without forcing. Neatly fit ends and edges of gypsum board. Do not place butt ends against tapered edges.
3. Support ends and edges of gypsum board panels on framing or furring members except for face layer of double layer and where ends are back blocked and floated.
4. Use metal edge trim where gypsum board abuts another material, at corners, and where shown or noted on Drawings.
5. Use water-resistant board in toilet and at Remedy building room walls and elsewhere as indicated on Drawings.
6. Follow manufacturer's recommendation of good practice.

C. Over Framing:

1. Apply gypsum board first to ceiling and then to walls for single layer horizontal application.
2. Use vertical application for fire-rated walls.
3. Fasten gypsum board securely to framing using double nailing, screw, or adhesive method.

D. Sound-Rated Partitions:

1. Fabricate and erect in accordance with manufacturer's printed instructions for required rating.
2. Install sound-deadening board and attenuation blankets as detailed.
3. Seal with acoustical sealant perimeter edges of gypsum board, joints around penetrations, and other joints as noted.

E. Fireproofing:

1. Install fireproofing of columns, beams, and shaft walls as shown.
2. Close tops of duct and pipe shafts, and elevator hoistways with horizontal metal framing and gypsum board to provide 2-hour rated assembly.

3.07 JOINT SYSTEM FOR GYPSUM WALLBOARD

A. Interior Gypsum Board: Conform to ASTM C840.

B. Required: On exposed gypsum board, under ceramic tile and wall covering, and behind casework.

C. Prefill: Fill V-grooves formed by abutting rounded edges of gypsum board with prefill joint compound. Fill V-joint flush and remove excess compound beyond groove. Leave clear depression to receive tape. Permit prefill joint compound to harden prior to application of tape.

D. Taping and Finishing Joints:

1. Taping or Embedding Coat: Apply compound in thin, uniform layer to joints and angles to be reinforced. Apply reinforcing tape immediately. Center tape over joint and seat tape into compound. Leave approximately 1/64-inch to 1/32-inch compound under tape to provide bond. Apply skim coat immediately following tape embedment but not to function as fill or second coat. Fold tape and embed in angles to provide true angle. Dry embedding coat prior to application of fill coat.
2. Filling Coat: Apply joint compound over embedding coat. Fill taper flush with surface. Apply fill coat to cover tape. Feather out fill coat beyond tape and previous joint compound line. For joints with no taper, feather out at least 4 inches on either side of tape. Do not apply fill coat on interior angles. Allow fill coat to dry prior to application of finish coat.
3. Finishing Coat: Spread joint compound evenly over and beyond fill coat on joints. Feather to smooth uniform finish. Apply finish coat to taped angles to cover tape and taping compound. Sand final application of compound to provide surface ready for decoration.
4. Filling and Finishing Depressions: Apply joint compound as first coat to fastener depressions. Apply at least two additional coats of compound after first coat is dry. Leave filled and finished depressions level with plane of surface.

E. Finishing Beads and Trim:

1. First Fill Coat: Apply joint compound to bead and trim. Feather out from ground to plane of the surface. Dry compound prior to application of second fill coat.
2. Second Fill Coat: Apply joint compound in same manner as first fill coat. Extend beyond first coat onto face of gypsum board. Dry compound prior to application of finish coat.
3. Finish Coat: Apply joint compound to bead and trim. Extend beyond second fill coat. Feather finish coat from ground to plane of surface. Sand finish coat to provide flat surface ready for decoration.

3.08 FINAL FINISHES FOR GYPSUM WALLBOARD

A. Levels of Finish: Conform to GA 214.

B. Level 1:

1. Taping or embedding coat only.
2. Use in concealed areas, and where indicated, unless a higher level is required for fire-resistive or sound-rated assemblies.

C. Level 2:

1. Taping, filling, and finishing coats.
2. Use on water-resistant gypsum backing board.

D. Level 3:

1. Taping, filling, and finishing coats.
2. Use on surfaces indicated to have spray texture or ceramic tile.

E. Level 4:

1. Taping, filling, and finishing coats plus two separate coats applied over joints, angles, fastener heads, and trim accessories.
2. Sand between coats and after last coat.
3. Use on surfaces indicated to receive wall coverings.

F. Level 5:

1. Same as Level 4, plus a thin, smooth, uniform skim coat of joint compound, or product specially formulated for this purpose, over entire surface.
2. Produce surfaces free of tool marks and ridges, ready for decoration.
3. Use on surfaces not indicated otherwise, those indicated to receive gloss, semi-gloss, and nontextured flat paints, and where indicated.

3.09 SPRAY TEXTURE

A. Application:

1. Apply on gypsum board wall and ceiling surfaces, except behind ceramic tile and wall covering, following manufacturer’s printed directions for a medium build spray/spatter orange peel texture.
2. Before texture application, finish gypsum board as specified for Level 3.

3. When surfaces are prepared and dry, apply sealer and allow to dry. Mix texture finish material as directed by manufacturer.
4. Use spray equipment of a size and type to assure acceptable results.
5. Apply by spray only at a coverage rate as recommended by manufacturer and in accordance with directions printed on container. Apply material to blend uniformly and cover fully without starved spots or other evidence of thin application. Provide uniform texture without application patterns.
6. After spray application, knockdown and flatten high spots with trowel to produce a Brocade or Travertine marble texture.

3.10 ADJUST AND CLEAN

A. Clean: Remove droppings or texture overspray from walls, windows, and floor, leaving room clean for following trades.

B. Nail Pop: Repair nail pop by driving new nail approximately 1-1/2 inches from nail pop and reseat nail. When face paper is punctured, drive new nail or screw approximately 1-1/2 inches from defective fastening and remove defective fastening. Fill damaged surface with compound.

C. Ridging:

1. Do not repair ridging until condition has fully developed, approximately 6 months after installation or one heating season.
   a. Sand ridges to reinforcing tape without cutting through tape.
   b. Fill concave areas on both sides of ridge with topping compound.
   c. After fill is dry, blend in topping compound over repaired area.
2. Fill cracks with compound and finish smooth and flush.

END OF SECTION

SECTION 09 65 13
RESILIENT BASE AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM): F1861, Standard Specification for Resilient Wall Base.

1.02 SUBMITTALS

A. Action Submittals:

1. Samples: Two 2-1/2-inch wide strips of base material.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements (to be completed).
2. Operation and Maintenance Data:
   a. As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).
   b. List of recommended maintenance products, methods, and procedures.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Unless otherwise directed by Engineer, store materials in original containers at not less than 70 degrees F for not less than 24 hours immediately before installation.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature in space to receive flooring between 70 and 90 degrees F for not less than 24 hours before and 48 hours after installation.

B. Maintain minimum temperature of 55 degrees F after flooring is installed, except as specified above.

1.05 SEQUENCING AND SCHEDULING

A. Do not install resilient base until wall construction is complete, including dry wall finishing to the level of finish specified in Section 09 29 00, Gypsum Board, and according to manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Resilient products of the following manufacturers meeting these Specifications may be used on this Project:

1. Armstrong World Industries, Inc.
2. Burke Flooring Products.
3. Flexco, Corporation.
4. Johnsonite, Division of Duramax, Inc.
5. Mannington Commercial.

2.02 RESILIENT BASE MATERIALS

A. Rubber Base: ASTM F1861, Type TP, Group 2, 0.125 inch thick, coved style, 4 inches high.

B. Adhesive: Type and brands of adhesive as recommended by manufacturer of covering material for conditions of installation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrate for excessive moisture content and unevenness preventing execution and quality of resilient base as specified.

B. Correct defects before installation of resilient base.

3.02 PREPARATION

A. Remove dirt, oil, grease, or other foreign matter from surfaces to receive resilient base materials.

3.03 INSTALLATION OF BASE

A. Remove defects in wall and floor that would prevent level and true installation of base material.

B. Install base around perimeter of room or space, where shown, and at toe spaces of casework and cabinets.

C. Unroll base material and cut into accurate lengths as desired or as required for minimum number of joints.

D. Match edges of seams or double cut adjoining lengths to give continuous appearance.

E. Install with tight butt joints with no joint widths greater than 1/64 inch.

F. Apply adhesive and firmly adhere to wall surfaces.

G. Press down so bottom cove edge follows floor profile.

H. Ensure top and bottom edges of base are in firm contact with walls and floors.

I. Form internal and external corners by using premolded corners. Other methods, acceptable to Engineer, may be used if premolded corners are not available.

J. Scribe base accurately to abutting materials.

3.04 CLEANING AND PROTECTION

A. Upon completion of the installation of resilient base work, and after materials have set, clean surfaces with a neutral cleaner as recommended by manufacturer for type of resilient base material installed.

B. Repair adjacent surfaces damaged by resilient base installation.

C. Protect completed work from traffic and damage until Substantial Completion.

3.05 INSTALLATION SCHEDULE

A. Areas to receive resilient base are indicated on Drawings, in the Room Finish Schedule for each building.

END OF SECTION

SECTION 09 69 00
ACCESS FLOORING

PART 1 GENERAL

1.01 REFERENCES

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

1. National Fire Protection Association (NFPA): 75, Standard for the Protection of Information Technology Equipment.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Dimensioned drawings showing layout, special panels, and details of installation, including anchorage and bracing pedestals.
   b. Catalog cuts and samples showing choice of flooring surfaces and colors available.
   c. Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing (to be completed).
2. Samples: One each full size panels without penetrations.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing (to be completed).
2. Manufacturer’s installation instructions.
3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements (to be completed); system meets or exceeds specified design strengths and electrical resistance.
4. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services (to be completed).
5. Final layout of penetration locations.

1.03 QUALITY ASSURANCE

A. Installer Qualifications:

1. Approved by access flooring manufacturer.
2. Successful installation of access floor systems of scope similar to this Project.

B. Preinstallation Meeting:

1. Schedule prior to access floor installation and after construction of mockup.
2. Attendees: Manufacturer's authorized Site representative, installer, Contractor's authorized representative, and Engineer.

1.04 EXTRA MATERIALS

A. Provide six floor panels with finish materials from same production run as installed materials, six spare pedestals, stringers, and components.

B. Panel Lifting Device: Manufacturer's standard, portable tool.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Tate Access Floors.
2. Approved substitution.

2.02 FLOORING SYSTEM DESCRIPTION

A. Portable assembly of modular floor panels with an elevated supporting system (understructure) forming an accessible underfloor cavity to accommodate ducts, conduits, cables, piping, and other services.

1. Basis of Design: WC 5000 Panels on combination heavy duty bolted stringer/cornerlock support system designed specifically for panel system.

B. Assembly Characteristics:

1. Laterally stable in all directions with panels in place or removed; snap-together grid system is acceptable.
2. Completely interchangeable panels, easily removable with a suction lift tool; square to within a tolerance of plus or minus 0.010 inch on the diagonal.
3. Positive contact between components for safe, continuous electrical grounding of entire floor system.
4. Sustained Rolling Load Capacity: 850 pounds throughout entire floor area, permanent set not to exceed 0.02 inch.
5. Access Floor Height: 10 inches measured from top of base floor to top of finished floor panels.
6. System Electrical Resistance: Measured across surface of floor covering through panel to understructure.
   a. Static-Control Floor Covering Resistance: Not less than 500,000 ohms or more than 20,000 megohms.
   b. Static-Conductive Floor Covering Resistance: Not less than 25,000 ohms or more than 1,000,000 ohms.
   c. Panel to Understructure Resistance: Not more than 10 ohms.

2.03 COMPONENTS

A. Pedestal Assembly:

1. Steel with flat bottom baseplate, threaded supporting rod, vibration-proof locknut to permit vertical adjustment, galvanized finish.
2. Load Capability: Support 5,000 pounds.
3. Safety Factor: 2.5.
4. Leveling and Locking Device: Total vertical adjustment of 1-1/2 inches.
5. Pedestal Base and Connection to Subfloor: Withstand moment of 2,400 inch-pounds.

B. Frame Grid Stringers: Removable type, consisting of steel channels, box, or T-sections.

C. Floor Panels:

1. Core laminated with galvanized sheet steel structurally bonded with thermosetting adhesive to both faces.
2. Size: 24 inches by 24 inches.

3. Load Carrying Capability:
   a. Concentrated Load (Minimum): 1,250 pounds on 1 square inch with a maximum deflection of 0.080 inch.
   b. Uniform Live Load (Minimum): 250 pounds per square foot with a maximum deflection of 0.040 inch.
4. Safety Factor: 2.5.
5. Floor Finish Panel Inlay: Vinyl composition tile, 1/8 inch thick.
6. Floor Finish Adhesive: Moisture-resistant type recommended by floor finish manufacturer; electrically conductive type.
7. Finish of Exposed Metal Surfaces: Baked enamel finish selected from manufacturer's standard color range.

D. Grating:

1. Same size of floor panels, structural cast aluminum with octagonal rib or basket weave design, more than 50 percent open area, coated white baked enamel finish.
2. Provide mechanical slide dampers adjustable from above on grating panels.

E. Grounding Connectors: Solid copper.

F. Cable Cutout Protection: Extruded polyvinyl chloride or neoprene edging 3/8 inch thick, self-extinguishing.

2.04 FABRICATION

A. Floor Panel Tolerances:

1. Flatness: Plus or minus 0.02 inch in all directions.
2. Length: Plus or minus 0.02 inch.
3. Squareness: Plus or minus 0.03 inch in diagonal dimension.

PART 3 EXECUTION

3.01 PREPARATION

A. Commence installation only after Work area is free and clear of all other trades.

B. Take accurate elevations of entire area.

C. Protect flooring against damage and stains during and after installation.

3.02 INSTALLATION

A. Lay out system and install in accordance with approved Shop Drawings and manufacturers' instructions.

B. Thoroughly vacuum clean the subfloor areas as installation of floor panels proceeds.

C. Secure pedestal baseplate to subfloor with metal fasteners.

D. Install additional pedestals where grid pattern is interrupted by room appurtenances and at cutouts.

E. Install stringers and floor panels solidly on pedestals.

F. Adjust pedestal height to provide maximum out-of-level tolerance of 1/16 inch in 10 feet.

G. Install grilles.

H. Seal field cuts of floor panels with plastic angles or channels.

I. Completed Floor System:

1. Rigid, free of vibration and rocking panels; provide an even and uniform floor surface.
2. Complies with requirements of NFPA 75.

J. Cut holes in floor panels, to be located by Engineer, for installation of Owner's equipment and include cable cutout protection.

K. Install floor, ramp complete with edge trim and end closures.

L. Install lateral braces at stair edges and other locations where pedestal is not braced.

M. Provide electrical grounding of entire access floor assembly.

N. Include sponge rubber plugs to ensure airtight seal where holes are cut in elevated floor for passing of cable.

3.03 MANUFACTURERS' SERVICES

A. Provide manufacturer's representative at Site for preinstallation conference, installation assistance, inspection, and certification of installation.

3.04 CLEANING, PROTECTION, AND FINAL ADJUSTMENTS

A. Upon completion of installation, vacuum clean entire floor system and cover with continuous sheets of reinforced paper or plastic.

B. Damaged Access Floor Components: Replace chipped, broken, stained, scratched, or otherwise damaged panels, or panels and other components that do not conform to specified requirements.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   b. C210, Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
   e. C216, Standard for Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Pipelines.
   f. C218, Coating the Exterior of Aboveground Steel Water Pipelines and Fittings.
   g. C222, Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings.
   h. D102, Coating Steel Water-Storage Tanks.
2. ASTM International (ASTM):
   a. D4285, Standard Test Method for Indicating Oil or Water in Compressed Air.
   b. D5064, Standard Practice for Conducting a Patch Test to Assess Coating Compatibility.
   c. D6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
   d. E337, Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures).
3. Environmental Protection Agency (EPA).
4. NACE International (NACE): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
5. NSF International (NSF): 61, Drinking Water System Components - Health Effects.

6. Occupational Safety and Health Act (OSHA).
7. The Society for Protective Coatings (SSPC):
    a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
    b. PA 3, Guide to Safety in Paint Applications.
    c. SP 1, Solvent Cleaning.
    d. SP 2, Hand Tool Cleaning.
    e. SP 3, Power Tool Cleaning.
    f. SP 5, White Metal Blast Cleaning.
    g. SP 6, Commercial Blast Cleaning.
    h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
    i. SP 10, Near-White Blast Cleaning.
    j. SP 11, Power Tool Cleaning to Bare Metal.
    k. SP 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
    l. SP 13, Surface Preparation of Concrete.
    m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.
    n. QP1 Certification (Field Application to Complex Industrial and Marine Structures).
    o. QP2 Certification (Field Removal of Hazardous Coatings).
    p. QP3 Certification (Shop Painting Certification Program).

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PPDS: Paint Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.
12. SP: Surface Preparation.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Data Sheets:
      1) For each product, furnish a Paint Product Data Sheet (PPDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PPDS form is appended to the end of this section.
      2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
      3) Technical and performance information that demonstrates compliance with Specification.
      4) Furnish copies of paint system submittals to the coating applicator.
      5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
   b. Detailed chemical and gradation analysis for each proposed abrasive material.
2. Samples:
   a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.
   b. Reference Panel:
      1) Surface Preparation:
         a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
         b) Provide panel representative of the steel used; prevent deterioration of surface quality.
         c) Panel to be reference source for inspection upon approval by Engineer.
      2) Paint:
         a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
         b) Furnish additional samples as required until colors, finishes, and textures are approved.
         c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

1. Applicator's Qualification: List of references substantiating experience in accordance with SSPC QP-1, QP-2, QP-3 or equivalent.
2. Products shall meet the Volatile Organic Compounds (VOC) limits set by Mohave Desert Air Quality Management District Rule 1113 Architectural Coatings.
3. Coating manufacturer's Certificate of Compliance.
4. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
5. Manufacturer's written verification that submitted material is suitable for the intended use.
6. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
7. Manufacturer's written instructions and special details for applying each type of paint.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. SSPC PA 3, Guide to Safety in Paint Applications.
   c. Federal, state, and local agencies having jurisdiction.

C. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

B. Status of Existing Coatings:

1. The following information on existing coatings or substrate conditions is provided for information only, and is generally believed to be accurate, but is not guaranteed. Perform tests as required to verify applicability of this information to the Work.
   a. Lead containing paint may be present.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years' verifiable experience in manufacture of specified product.

C. Each of the following manufacturers is capable of supplying most of the products specified herein:

1. Carboline.
2. International Paints.
3. PPGPMC.
4. Sherwin Williams.
5. Tnemec.

2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Use only products from one manufacturer in each coating system. Mixing of manufacturers between primer, intermediate and finish coat is not permitted. Exclusive use of one manufacturer for all coating systems is not required.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

2.04 PRODUCTS

Product	Definition
100% Acrylic Latex	Single-component, finish as required
100% Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Bituminous Paint	Single-component, coal-tar pitch based
Block Filler	Primer-sealer designed for rough masonry surfaces, 100% acrylic emulsion
DTM Acrylic Primer	Surface tolerant, direct-to-metal water borne acrylic primer

Product	Definition
DTM Acrylic Finish	Surface tolerant, direct-to-metal water borne acrylic finish coat
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy Primer—	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, ferrous or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Sanding Sealer	Co-polymer oil, clear, dull luster
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Stain, Concrete	Acrylic, water repellant, penetrating stain
Stain, Wood	Satin luster, linseed oil, solid or transparent as required
Varnish	Nonpigmented vehicle based on a variety of resins (alkyd, phenolic, urethane) in gloss, semigloss, or flat finishes, as required

2.05 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

PART 3 EXECUTION

3.01 GENERAL

A. Provide Engineer minimum 7 days' advance notice to start of surface preparation work and coating application work.

B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

D. External coatings on aboveground equipment outside PG&E property will consist of muted, earth tone colors that are consistent with the surrounding natural color palette, and matte finishes, unless overridden by OSHA requirements. Colors for aboveground equipment inside PG&E property will be selected based on PG&E standards.

3.02 ENVIRONMENTAL CONDITIONS

A. Monitor and record temperature and humidity in accordance with ASTM E337.

B. Unless approved otherwise, do not abrasive blast or apply coating when relative humidity is above 85 percent relative humidity.

C. The substrate surface temperature shall be greater than 5 degrees F (15 degrees C) above dew point.

D. Stop work when the humidity, surface and ambient temperatures are outside the manufacturer's recommended maximum and minimum allowable.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere 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.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

F. Surfaces not to be coated unless specified:

1. Stainless steel, galvanized steel, non-ferrous metals.
2. Original Equipment Manufacturer (OEM) coatings.
3. Machined surfaces.
4. Electrical or instrument conduits.
5. Sprinkler heads.

3.04 SURFACE PREPARATION

A. Abrasive Blasting:

1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
2. Refer to coating systems for degree of abrasive blasting required.
3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.
4. Check compressed air supply for water and oil in accordance with ASTM D4285.

B. Surface Contamination Testing:

1. A surface contamination analysis test shall be performed every 500 square feet (46 square meters) by means of a Chlor Test CSN Salts or approved equivalent.
2. Surface with chloride levels exceeding 3 µg/square centimeter for submerged surfaces and 5 µg/square centimeter for exposed surfaces shall be treated with a liquid soluble salt remover equivalent to CHLOR*RID (CHLOR*RID International, Chandler, AZ).
3. Follow manufacturer's recommendations and procedures for the use of this product to remove the surface contamination.

C. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
   a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
   b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
   c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
   d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
   e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
   f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
   g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no

more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.

i. SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating: Surface preparation using high-pressure and ultrahigh-pressure water jetting to achieve specified surface cleanliness condition. Surface cleanliness conditions are defined in SSPC SP 12 and are designated WJ-1 through WJ-4 for visual surface preparation definitions and SC-1 through SC-3 for nonvisual surface preparation definitions.

2. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning”, or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.
3. 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.
4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
   a. Prepare such that there is:
      1) No undercutting or reverse ridges on weld bead.
      2) No weld spatter on or adjacent to weld or any area to be painted.
      3) No sharp peaks or ridges along weld bead.
      4) Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
8. 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 clean with suitable solvent and clean cloth.

9. Blast Cleaning Requirements:
   a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
   b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
   c. Use only dry blast cleaning methods.
   d. Do not reuse abrasive, except for designed recyclable systems.
   e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. 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 wipe with a tack cloth.
   b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

D. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation as directed:

1. Prepare galvanized steel in accordance with ASTM D6386.
2. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
3. Remove oil and grease by wiping or scrubbing surface with suitable solvent, rag, and brush. Use clean solvent and clean rag for final wiping to avoid contaminating surface.
4. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

E. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.

2. Meet requirements of SSPC SP 13. Moisture level in the concrete shall meet the coating manufacturer requirements.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.
5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

F. Plastic and FRP Surface Preparation as directed:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

G. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
   a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
   b. Brush-off blasting.
   c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

H. Wood Surface Preparation:

1. Replace damaged wood surfaces or repair in a manner acceptable to Engineer prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.
4. Filler:
   a. Synthetic-based wood putty approved by paint manufacturer for paint system.
   b. For natural finishes, color of wood putty shall match color of finished wood.
   c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.
   d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer's recommendations.
   e. Use cellulose type putty for stained wood surfaces.
5. Ensure surfaces are clean and dry prior to painting.

I. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.

1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

J. Existing Painted Surfaces to be Repainted Surface Preparation:

1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of specified primer to entire surface.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
7. For ductile iron pipe with asphaltic varnish finish not specified to be abrasive blasted, apply coat of tar stop prior to application of cosmetic finish coat.

8. Application of Cosmetic Coat:
   a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
   b. Check compatibility by application to a small area prior to starting painting in accordance with ASTM D5064.
   c. If lifting or other problems occur, request disposition from Engineer.
9. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

3.05 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for existing and new, interior and exterior wood, masonry, concrete, and metal, and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.

3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys as directed:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. Porous Surfaces, such as Concrete and Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

D. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with Specification.
   c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas by applying stripe coat to those areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. Additional requirements are included in the Piping Schedule.

C. Exterior surfaces of buildings, equipment, cranes, structural steel and associated structures, concrete surfaces, and miscellaneous buildings. Dry film thicknesses (DFT) rangers listed are for reference only. Manufacturer's DFT ranges should be used, as found in product data sheets provided by coating manufacturers.

D. System No. 1 Steel Surfaces – Semi-Gloss / Gloss:

Surface Prep.	Paint Material	Min. Cover
SP 1, 2	100% Acrylic Latex DTM primer	2-5 Mils
Finish coat	100% Acrylic Latex, Semi-Gloss or Gloss	2-3 Mils

E. System No. 2 Steel Surfaces – Flat or Semi-Gloss:

Surface Prep.	Paint Material	Min. Cover
SP 1, 2	100% Acrylic Latex DTM primer	2-5 Mils
Finish coat	100% Acrylic Latex, Flat or Semi-Gloss	2-3 Mils

F. System No. 3 Steel Surfaces – Gloss:

Surface Prep.	Paint Material	Min. Cover
SP 2, 3, 11	Epoxy primer	3-5 Mils
Finish coat	Polysiloxane Coating	3-7 Mils

G. System No. 4 Steel Surfaces – Gloss:

Surface Prep.	Paint Material	Min. Cover
SP 6, 10	Epoxy Zinc-Rich Primer	3-4 Mils
Finish coat	Polysiloxane Coating	3-7 Mils

H. System No. 5 Galvanized Steel Surfaces (new with chrominum treatment removed or aged galvanized steel) – Flat / Semi-Gloss / Gloss:

Surface Prep.	Paint Material	Min. Cover
Primer	Galvanized Metal Primer	Not Applicable
Finish coat	100% Acrylic Latex, Flat, Semi-Gloss, or Gloss	2-3 Mils

I. System No. 6 Aluminum Surfaces (remove all of white oxidize products) – Flat or Semi-Gloss:

Surface Prep.	Paint Material	Min. Cover
Primer	Epoxy Primer	0.3-0.5 Mils
Finish coat	100% Acrylic Latex, Flat or Semi-Gloss	2-3 Mils

J. System No. 7 Galvanized Steel/Aluminum Surfaces – Gloss:

Surface Prep.	Paint Material	Min. Cover
Primer	Epoxy Primer	1.5-3 Mils
Finish coat	100% Acrylic Latex, Gloss	2-3 Mils

K. System No. 8 Concrete Surfaces – Matte/Semi-Gloss:

Surface Prep.	Paint Material	Min. Cover
Filler	Latex Block Filler	Not Applicable
Finish coat(s)	Acrylic Elastomeric Coating	5-11 Mils

L. System No. 9 Wood Surfaces – Clear Sealer:

Surface Prep.	Paint Material	Min. Cover
Primer	Clear Resin Sealer	0.5-1 Mils
Finish coat(s)	Clear Resin Sealer	1-2 Mils

M. System No. 10 Wood Surfaces – Semi-Gloss Pigmented:

Surface Prep.	Paint Material	Min. Cover
Primer	Clear Resin Sealer	0.5-1 Mils
Finish Coat(s)	100% Acrylic Latex, Semi-Gloss	2-4 Mils

N. System No. 11 Steel Surfaces (exterior not top coated) Flaying Surface:

Surface Prep.	Paint Material	Min. Cover
Single Coat Zinc	Inorganic Zinc Primer	2-4 Mils

O. System No. 12 Steel (Rebar) Surfaces – Not top coated:

Surface Prep.	Paint Material	Min. Cover
Single Coat Zinc	Epoxy Zinc Rich Primer or Epoxy	2-4 Mils

P. System No. 13 Steel (Rebar) Surfaces – Not top coated (alternate to System No. 12):

Surface Prep.	Paint Material	Min. Cover
Single Coat Zinc	Water-Based Inorganic Zinc Primer	2-5 Mils

Q. System No. 14 Concrete Floor Surfaces – Semi-Gloss:

Surface Prep.	Paint Material	Min. Cover
Primer	Clear Sealer for Dry or Porous Concrete (Optional)	0.5-1 Mils
Finish coat	High Solids Epoxy	3-6 Mils

3.08 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

A. See Section 09 90 05, Architectural Painting.

3.09 COLORS

A. Provide as selected by Engineer and noted herein.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
2. Paint equipment and piping one color as selected.
3. Paint nonsubmerged portions of equipment the same color as the 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 and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Pipe Color Coding: As shown in table below.
3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
4. Pipe Supports: Painted light gray, as approved by Engineer.
5. Fiberglass reinforced plastic (FRP) pipe, polyvinylidene fluoride (PVDF), and polyvinyl chloride (PVC) pipe located inside of buildings and enclosed structures will not require painting, except as noted or scheduled.

E. Pipe System Color Code:

Pipe System	Color
Air, Process	Federal Safety Green
Air, Instrument	Federal Safety Purple
Ammonia, Liquid	Federal Safety Orange
Ammonia, Solution	Federal Safety Orange
Alum	Dark Green
Chlorine, Gas	Federal Safety Yellow
Chlorine, Liquid	Federal Safety Yellow
Chlorine, Residual Sampling	Silver/Gray
Chlorine Solution	Federal Safety Yellow
Chlorine Ejector Water	Silver/Gray
Chlorine Vent	Federal Safety Yellow
Compressed Air	Federal Safety Purple
Carbon	Black
Drains and Sludge	Light Brown
Decant	Light Brown
Dewatering	Black
Drains	Black
Effluent, Final	Silver/Gray
Effluent, Primary	Silver/Gray
Effluent, Flushing Water, High Pressure	Dark Green
Effluent, Flushing	Dark Green
Fuel Oil Supply	Federal Safety Orange
Fuel Oil Return	Federal Safety Orange
Flocculation Basin Influent	Buff
Filter Backwash Supply	Medium Blue
Filter Surface Wash Supply	Medium Blue
Hot Flushing Loop	Federal Safety Blue
Headworks	Buff
Lime	White

Pipe System	Color
Mixed Liquor	Silver/Gray
Overflow	Silver/Gray
Plant Service Water	Medium Blue
Potable Water	Light Blue
Polymer/Cationic	Buff
Polymer Nonionic or Anionic	Buff
Raw Sewage	Dark Gray
Rapid Mix Influent	Light Brown
Scum	Light Brown
Sample	Medium Green
Seal Water	Federal Safety Blue
Sludge, Digested	Dark Brown
Sludge, Primary	Dark Brown
Sludge, Return Activated	Light Brown
Sludge, Thickened	Light Brown
Sludge, Waste Activated	Dark Brown
Sludge, Stored	Dark Brown
Sludge, Recirculated	Dark Brown
Sludge, Mixed	Light Brown
Thickener Dilution Water	Dark Green

3.10 QUALITY CONTROL

A. Testing Equipment:

1. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, calibrated and verified before use.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, calibrated and verified before use.

3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer, calibrated and verified before use.

B. Testing:

1. Thickness and Continuity Testing:
   a. Measure coating thickness specified in mils with an eddy current or UT dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
   b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.
   c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE RP0188.
   d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of paint manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.

3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.11 MANUFACTURER'S SERVICES

A. Coating manufacturer's representative shall be present at Site as follows:

1. On first day of application of any coating system.
2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
3. As required to resolve field problems attributable to or associated with manufacturer's product.
4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.12 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.13 SUPPLEMENTS

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

1. Paint System Data Sheet (PSDS).
2. Paint Product Data Sheet (PPDS).

END OF SECTION

PAINT SYSTEM DATA SHEET (PSDS)

Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

PAINT PRODUCT DATA SHEET (PPDS)

Complete and attach manufacturer's Technical Data Sheet to this PPDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio: .

Maximum Permissible Thinning:_____

Ambient Temperature Limitations: min.:___ max.:_____

Surface Temperature Limitations: min.:_____ max.:_____

Surface Profile Requirements: min.:_____ max.:_____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

SECTION 09 90 05
ARCHITECTURAL PAINTING

PART 1 GENERAL

1.01 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils, or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness.
5. MDFTPC: Minimum Dry Film Thickness Per Coat.
6. mil: Thousandth of an inch.
7. Military Specification-Paint.
8. PSDS: Paint System Data Sheet.
9. SFPG: Square Feet Per Gallon.
10. SFPGPC: Square Feet Per Gallon Per Coat.
11. SP: Surface Preparation.
12. Existing: Those coated surfaces that are cut into, connected to, or otherwise changed or affected by the work of this contract.

B. Paint Terms: Conform to ASTM D16.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer’s descriptive literature for coating materials and coating application accessories.
   a. Products shall meet the Volatile Organic Compounds (VOC) limits set by Mohave Desert Air Quality Management District Rule 1113 Architectural Coatings.
   b. For each paint system used, furnish a Paint System Data Sheet (PSDS) and technical data sheet for each product used in the paint system. PSDS form is appended to the end of this section.
   c. Submit required information on a system by system basis.
   d. Provide copies of paint system submittals to applicator.
2. Verification Samples: Two samples, minimum size 6 inches (152 mm) square, representing actual color and finish of each finish coating type, color, and finish to be applied.

B. Informational Submittals:

1. List of references substantiating applicator's experience.
2. Manufacturer's printed application instructions for each product, including product storage requirements and surface preparation requirements.

1.03 QUALITY ASSURANCE

A. Applicator's Experience: Minimum 5 years' practical experience in application of specified products and approved by the paint manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store products of this section in manufacturer's unopened packaging until installation.

B. Establish and maintain storage area conditions for products of this Section in accordance with manufacturer's instructions until installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction over project.

1.05 PROJECT CONDITIONS

A. Do not apply coatings to exterior surfaces except under environmental conditions recommended by coating manufacturer.

B. Establish and maintain environmental conditions recommended by coating manufacturer before, during, and after application of coatings to interior surfaces.

C. During application of coating materials, post "WET PAINT" signs.

D. During application of coating materials, post "NO SMOKING" signs.

1.06 SEQUENCING

A. Do not allow application of finish coats in an area until moisture-producing construction activities, dust-producing construction activities, and other construction activities which could impair performance or appearance of finish coatings, have been completed in that area.

1.07 EXTRA MATERIALS

A. Supply for each finish coating material, color, and finish specified 2 gallons (7.75L) of paint material, in sealed 1-gallon (3.875L) containers, marked with color and finish identification.

B. Custom Colors: Provide details of color formulae and product availability.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Products of the following manufacturers, meeting these specifications, may be used on this Project:

1. Glidden Professional, part of PPG Architectural Finishes, Inc.
2. Benjamin Moore Paint Company.
3. Pratt & Lambert, Inc.
4. Sherwin-Williams.
5. Duron, Inc.
6. Behr Process Corporation.
7. Dunn-Edwards Corporation.

B. Use only products from one manufacturer in each painting system. Mixing of manufacturers between primer, intermediate and finish coat is not permitted. Exclusive use of one manufacturer for all painting systems is not required.

2.02 MATERIALS

A. General:

1. Unless otherwise indicated, furnish factory-mixed paints. When required, mix coatings to correct consistency in accordance with manufacturer’s instructions before application. Do not dilute or thin paints, except as instructed.
2. Do not add additives, except as instructed or recommended by paint manufacturer.
3. Furnish each coating material in quantity required for this section from a single production run.
4. Colors: To be selected by Engineer from manufacturer’s full range of available colors.

B. Paint Application Accessories: As specified in this section or as recommended by paint manufacturer's application instructions, including but not limited to thinners, sealers, primers, cleaning agents, etching agents, cleaning cloths, sanding materials, and clean-up materials.

C. Water Based Wood Stain: Sherwin-Williams; MINWAX Water Based Wood Stain.

D. Acrylic Primer: Sherwin-Williams; Multi-Purpose Latex Primer/Sealer.

E. 100 Percent Acrylic Low Sheen: Sherwin-Williams; ProMar 200 EgShel B20W200.

F. 100 Percent Acrylic Latex, Semigloss: Sherwin-Williams; ProMar 200 Semi-Gloss B31W200.

G. Latex Primer Sealer: Sherwin-Williams; PrepRite High-Build B28W600.

H. Sanding Sealer: Sherwin-Williams; Wood Classics FastDry Sanding Sealer B26V43.

I. Clear Varnish: Sherwin-Williams; MINWAX Polycrylic Protective Finish, Satin.

J. Metal Primer: Sherwin-Williams; Kem Kromik Universal Metal Primer B50Z Series.

K. Concrete Block Filler: Sherwin-Williams; ProMar Interior/Exterior Block Filler B25.

L. Acrylic Masonry Primer: Sherwin-Williams; Loxon Interior Acrylic Masonry Primer B28 Series.

M. Water Based Epoxy: Sherwin-Williams; Pro Industrial Water Based Catalyzed Epoxy B73.

N. Multi-Surface Primer: Dunn-Edwards Corporation; Ultrashield Interior/Exterior Multi-Surface Primer ULMS00.

O. Acrylic Urethane: Dunn-Edwards Corporation; Ultrashield Interior/Exterior Gloss Paint ULSH60.

PART 3 EXECUTION

3.01 EXAMINATION

A. Immediately prior to coating application, ensure that surfaces to receive coatings are dry.

B. Ensure that moisture-retaining substrates to receive coatings have moisture content within tolerances allowed by coating manufacturer, using moisture measurement techniques recommended by coating manufacturer.

C. Immediately prior to coating application, examine surfaces to receive coatings for surface imperfections and for contaminants which could impair performance or appearance of coatings, including but not limited to, loose primer, rust, scale, oil, grease, mildew, algae, or fungus, stains or marks, cracks, indentations, or abrasions.

D. Correct the above conditions and other conditions that could impair performance or appearance of coatings in accordance with specified surface preparation procedures before proceeding with coating application.

3.02 PREPARATION

A. Do not start work until surfaces to be finished are in proper condition to produce finished surfaces of uniform, satisfactory appearance.

B. Stains and Marks: Remove completely, if possible, using materials and methods recommended by coating manufacturer; cover stains and marks which cannot be completely removed with isolating primer or sealer recommended by coating manufacturer to prevent bleed-through.

C. Mildew, Algae, and Fungus: Remove, using materials and methods recommended by coating manufacturer.

D. Remove dust and loose particulate matter from surfaces to receive coatings immediately prior to coating application.

E. Remove or protect hardware, electrical plates, mechanical grilles and louvers, lighting fixture trim, and other items not indicated to receive coatings that are adjacent to surfaces to receive coatings.

F. Existing Painted Surfaces: Remove loose and peeling paint. Degloss surface if recommended by manufacturer. Sand smooth. Clean entire surface prior to painting.

G. Aluminum Surfaces: Remove surface contamination by steam or high pressure water. Remove oxidation by phosphoric acid-water solution etching and solvent washing. Apply specified primer as soon as cleaned surfaces are dry.

H. Concrete and Concrete Masonry: Clean surfaces free of loose particles, sand, efflorescence, laitance, form oil, curing compounds, and other substances which could impair coating performance or appearance.

I. Concrete Floors: Remove contaminants which could impair coating performance or appearance, acid-etch, flush with clean water; verify alkaline-acid balance recommended by coating manufacturer; mechanically abrade surface, if required, to achieve medium-sandpaper texture.

J. Galvanized Surfaces: Remove surface contamination and oils by solvent cleaning (SSPC-SP1) and allow to dry. Apply Galvanized Metal Primer in accordance with manufacturer instructions.

K. Wood:

1. Seal knots, pitch streaks, and sap areas with sealer recommended by coating manufacturer; fill nail recesses and cracks with filler recommended by coating manufacturer; sand surfaces smooth.
2. Apply primer coat to back of wood trim and paneling.

L. Gypsum Board: Repair cracks, holes, indentations, and other surface defects using joint compound to produce surface flush with adjacent undamaged surface; sand to produce uniform flat surface when dry.

M. Metal Doors: Seal top and bottom edges with specified primer.

N. Uncoated Steel and Iron Surfaces: Remove grease, rust, scale, and dust from steel and iron surfaces in accordance with Solvent Cleaning SSPC-SP1. Where heavy coatings of scale or contaminants are evident, clean in accordance with Hand Tool Cleaning SSPC-SP2 or other approved SSPC-SP method as needed.

O. Shop Primed Steel Surfaces: Remove loose primer and dust. Sand and feather edges to smooth surface. Clean areas with solvent and spot prime bare metal surfaces with appropriate primer recommended by manufacturer.

3.03 APPLICATION

A. Apply paint where indicated in Interior Finish Schedule.

B. Apply each coat to uniform coating thickness following manufacturer's instructions, not exceeding manufacturer's specified maximum spread rate for indicated surface; thins, brush marks, roller marks, orange-peel, or other application imperfections are not permitted.

C. For opaque finishes, tint each coat, including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.

D. Allow manufacturer's specified drying time, and ensure correct coating adhesion, for each coat before applying next coat.

E. Inspect each coat before applying next coat; touch-up surface imperfections with coating material, feathering, and sanding if required; touch-up areas to achieve flat, uniform surface without surface defects visible from 5 feet (1.5 m).

F. Do not apply succeeding coat until previous coat has been approved by Engineer; only Engineer-approved coats will be considered in determining number of coats applied.

G. Remove dust and other foreign materials from substrate immediately prior to applying each coat.

H. Where coating application abuts other materials or other coating color, terminate coating, making clean sharp termination line without coating overlap.

I. Where color changes occur between adjoining spaces, through framed openings that are of same color as adjoining surfaces, change color at outside stop corner nearest to face of closed door.

J. Re-prepare and recoat unsatisfactory finishes; refinish entire area to corners or other natural terminations.

3.04 ITEMS NOT TO BE PAINTED

A. Do not paint the following:

1. Items specified or provided with factory finish.
2. Items indicated to receive other finishes.
3. Items indicated to remain unfinished.
4. Brick, precast concrete, integrally colored plaster.
5. Concrete masonry in utility, mechanical, and electrical spaces.

6. Stainless steel, anodized aluminum, bronze, terne, or lead.
7. Equipment nameplates, fire rating labels, and operating parts of equipment.
8. Acoustical materials.
9. Concealed piping, ductwork, and conduit.

B. Materials and products having factory-applied primer are not considered factory finished.

3.05 PAINT SYSTEMS

A. System No. 102 Wood, Semigloss (Interior or Exterior):

Surface Prep.	**Paint Material**	**Min. Coats, Cover**
Wood	Acrylic Primer	1 coat, 1.4 MDFT
	Acrylic (Semigloss)	2 coats, 3.0 MDFTPC

B. System No. 105 Wood, Stained and Varnished (Interior or Exterior):

Surface Prep.	**Paint Material**	**Min. Coats, Cover**
Wood	Water based Wood Stain	Match Sample
	Sanding Sealer	1 coat, 450 SFPG
Lightly Hand Sand	Varnish (Satin)	2 coats, 1.3 MDFTPC

C. System No. 107 Ferrous Metal Acrylic:

Surface Prep.	**Paint Material**	**Min. Coats, Cover**
Abrasive Blast, or Centrifugal Wheel Blast (SP 6) -OR- Pickle (SP 8)	Metal Primer	1 coat, 3 MDFT
	Acrylic Semigloss	2 coats, 1.7 MDFTPC

D. System No. 108 Ferrous Metal Polyurethane:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP6) –OR- Pickle (SP 8)	Multi-Surface Primer	2 coats, 2-6 MDFT
	Acrylic Urethane	2 coats, 2-6 MDFT

E. System No. 109 Concrete Masonry, Low Sheen:

Surface Prep.	Paint Material	Min. Coats, Cover
Masonry	Concrete Block Filler	1 coat, 75 SFPG
	100% Acrylic Low Sheen	2 coats, 1.6 MDFTPC

F. System No. 113 Concrete, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
Concrete	Acrylic Masonry Primer	1 coat, 3.0 MDFT
	100% Acrylic Low Sheen	2 coats, 1.6 MDFTPC

G. System No. 115 Gypsum Board and Plaster, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
Gypsum Board	Acrylic Primer	1 coat, 3.0 MDFT
	Acrylic Latex Semigloss	2 coats, 1.3 MDFTPC

H. System No. 116 Concrete Masonry, Low Sheen Epoxy:

Surface Prep.	Paint Material	Min. Coats, Cover
Masonry	Concrete Block Filler	1 coat, 75 SFPG
	Water Based Epoxy	2 coats, 2.0 MDFTPC

I. System No. 118 Gypsum Board and Plaster, Low Sheen Epoxy:

Surface Prep.	**Paint Material**	**Min. Coats, Cover**
Gypsum Board	Acrylic Primer	1 coat, 3.0 MDFT
	Water Based Epoxy	2 coats, 2.0 MDFTPC

3.06 SUPPLEMENTS

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

1. Paint System Data Sheet (PSDS).
2. Paint Product Data Sheet (PPDS).

END OF SECTION

PAINT SYSTEM DATA SHEET (PSDS)

Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

PAINT PRODUCT DATA SHEET (PPDS)

Complete and attach manufacturer's Technical Data Sheet to this PPDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio:

Maximum Permissible Thinning:_____

Ambient Temperature Limitations: min.:___ max.:_____

Surface Temperature Limitations: min.:____ max.:_____

Surface Profile Requirements: min.:_____ max.:_____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

SECTION 09 96 35
CHEMICAL-RESISTANT COATINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI): 350.2R, Concrete Structures for Containment of Hazardous Materials.
2. Society for Protective Coatings (SSPC): SSPC-SP 13, Surface Preparation of Concrete.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. List materials in proposed system.
   b. Manufacturer's product specification.
   c. Chemical resistance test results for exposure to service conditions.
   d. Application instructions.
   e. Configuration details of materials at terminations, construction joints, floor drains, and trenches.
2. Samples: 4-inch square complete system proposed for use showing thickness and finish.

B. Informational Submittals:

1. Letter from manufacturer stating applicator is qualified to do the Work and meets the quality assurance minimum experience requirements.
2. Sample of warranty, prior to starting the Work.
3. Installation instructions.
4. Field inspection and test reports.
5. Manufacturer's Certificate of Proper Installation.
6. Special guarantee.

1.03 QUALITY ASSURANCE

A. Manufacturer's Experience: Minimum 5 years' manufacturing proposed products.

B. Applicator's Experience: Minimum 3 years' applying proposed products.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers.

B. Storage: Maintain materials in clean and dry condition. Follow manufacturer's instructions.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Apply coating only when substrate, ambient air, and coating material are 65 degrees F or above.

B. Substrate: Not wet or have standing water. Moisture level in substrate shall meet the coating manufacturer's requirement for a warrantable installation.

C. Ventilation: Provide during and after application to meet all applicable safety and health regulations.

D. Products shall meet the Volatile Organic Compounds (VOC) limits set by Mohave Desert Air Quality Management District Rule 1113 Architectural Coatings.

1.06 EXTRA MATERIALS

A. Furnish minimum 2 gallons of unopened topcoating material for future use by Owner.

1.07 SPECIAL GUARANTEE

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers include:

1. Carboline.
2. PPGPMC.
3. Rhino.
4. Sherwin-Williams.
5. Tnemec.

2.02 SERVICE CONDITIONS

A. Location: Outdoors, exposed to weather at Carbon Amendment tank, existing Decon Pad, and lower level of Remedy Produced Water Conditioning Plant. Covered, ambient temperature conditions at Carbon Amendment and upper level Remedy Produced Water Conditioning Plant.

B. Surface: Concrete and masonry floors, walls, and vault for chemical storage and handling.

C. Traffic: Foot, light hand truck, forklifts, commercial tanker trucks at Decon Pad.

D. Chemicals Stored in Containment Areas: See Application Schedule at end of Section.

2.03 COATING SYSTEMS

A. Chemical-Resistant Coatings: A mixture of liquid resin-based material, setting agent, and filler designed to be troweled into place to cure to a hard state. Walking surfaces to be slip resistant.

B. Polyurea (System CRC-1): Spray-on one coat, fast, cure, monolithic, lining. Finished system thickness 100 mils minimum.

C. Epoxy (System CRC-2): Primer and one trowel-applied coat of epoxy resin with silica fillers. Finished system thickness 100 mils minimum.

2.04 MIXING

A. Thoroughly mix until homogeneous following manufacturer’s instructions.

B. Mix only components furnished by coating manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Surface Preparation:

1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of the system manufacturer whose product is to be applied.
2. Provide Engineer minimum 3 days' advance notice of start of surface preparation and system application Work.
3. Perform Work only in presence of Engineer, unless Engineer grants prior approval to perform Work in Engineer's absence.

B. Schedule inspection with Engineer in advance for cleaned surfaces and system application Work.

3.02 PREPARATION

A. In accordance with the manufacturer's printed directions and recommendations.

B. Fill holes and cracks with manufacturer's recommended materials to produce even surface for application of systems.

C. Concrete Surfaces:

1. Do not begin to prepare concrete until 30 days after 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. Verify substrate moisture level is within the coating manufacturer's requirement, as required in SSPC SP13.
4. Brushoff blast clean to remove loose concrete and provide a tooth for binding. Upon approval by Engineer, surface may be acid etched with muriatic acid solution. Approval, subject to producing desired profile.
5. Secure coating manufacturer's recommendations for additional preparation if required for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

D. Masonry Surfaces:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation Work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
   a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
   b. Brushoff blasting.
   c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Coated: Uniform texture and free of surface imperfections which would impair the intended finished appearance.

3.03 APPLICATION

A. Install coating systems in accordance with manufacturer's printed instructions.

B. Install coating systems on vertical and horizontal surfaces, including caps, within containment wall for storage tanks, pumps, and piping.

C. Extend surfacing completely under structures and equipment located within the containment area. Install at construction joints in substrate and floor drains, trenches, and other components within the containment area.

3.04 FIELD QUALITY CONTROL

A. Inspection:

1. Inspect finished system for complete, uniform coverage of specified area. Evidence of defects include improper thickness, hardness, and appearance.
2. Engineer may require electrical spark test or other tests to be performed by Contractor when evidence of incomplete coverage exists.

3.05 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed), for installation assistance, inspection, and Manufacturer's Certificate of Proper Installation.

3.06 APPLICATION SCHEDULE

A. Unless otherwise shown or specified, apply coatings in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting Work in question.

B. Coating System CRC-1: Use at the Remedy Produced Water Conditioning Plant, CRC coating as secondary containment for concentrated acid or caustic that is resistant to the following chemicals:

1. 25 percent Sodium Hydroxide.
2. 19 percent Hydrochloric Acid.
3. 30 percent Aluminum Chloride Hydroxide.
4. 40 percent Hydrotreated Light distillate (CAS NO 64742-47-8).

C. Coating System CRC-2: Use at the Carbon Amendment Building, Ethanol Tank Pad, and existing Decon Pad, CRC coating as secondary containment for concentrated acid or caustic that is resistant to the following chemicals:

1. 100 percent Ethanol.
2. 34 percent Hydrochloric Acid.
3. 80 percent Phosphoric Acid.
4. 50 percent Sodium Hydroxide.
5. 30 percent Hydrogen Peroxide.

3.07 SUPPLEMENT

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

1. Corrosion Control Assistance Form.

END OF SECTION

CORROSION CONTROL ASSISTANCE FORM

To: Corrosion Control Dept.
CH2M HILL

Date: _____

From: Name: _____ Title: _____

Address: _____

Project Description: _____

Project No.: _____

Area Requiring Specific Protection: _____

_____

Items to be Coated: _____

_____

Site Location: _____

SERVICE CONDITIONS

(Check Appropriate Items)

Immersion ___ Splash/Spillage ____ Chemical Fumes ___

Marine/Offshore ___ Industrial ____ Other _____

Chemicals Involved _____

New Construction __ Existing Structure __ Uncoated ____

Coated _____ Coated With (If Known) __

Operating Temp. Range __ Ambient Conditions _____

Surface Preparation Possible: Abrasive Blast ____

Power Tool Cleaning: ____ Other _____

Other Pertinent Data: _____

_____

Feedback Required By (Date): _____

SECTION 09 97 13
STEEL TANK COATINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. C210, Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   b. C222, Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
2. ASTM International (ASTM):
   a. D520, Standard Specification for Zinc Dust Pigment.
   b. D6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
3. NACE International: RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
5. Society for Protective Coatings (SSPC):
   a. Surface Preparation Standards:
      1) SP 1, Solvent Cleaning.
      2) SP 2, Hand Tool Cleaning.
      3) SP 3, Power Tool Cleaning.
      4) SP 5, White Metal Blast Cleaning.
      5) SP 7, Brush-Off Blast Cleaning.
      6) SP 10, Near White Blast Cleaning.
      7) SP 11, Power Tool Cleaning to Bare Metal.
      8) SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating.
   b. Paint Application Guides:
      1) PA 1, Shop, Field, and Maintenance Painting of Steel.
      2) PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
      3) PA Guide 3, A Guide to Safety in Paint Application.
   c. Technology Guide: Guide 6, Guide for Containing Debris Generated During Paint Removal Operations.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils, or square feet per gallon.
2. MDFT: Minimum Dry Film Thickness, mils.
3. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
4. Mil: Thousandth of an inch.
5. PPDS: Paint Product Data Sheet.
6. PSDS: Paint System Data Sheet.
7. SP: Surface preparation.
8. VOC: Volatile Organic Compounds.

1.03 SUBMITTALS

A. Action Submittals:

1. Data Sheets:
   a. For each paint system used, furnish a Paint System Data Sheet (PSDS), Paint Product Data Sheet (PPDS), and paint colors available (where applicable) for each product used in paint system. The PSDS and PPDS forms are appended to the end of this section.
   b. Submit required information on a system-by-system basis.
   c. Provide copies of paint system submittals to coating applicator.
   d. Also provide copies of paint system submittals to the coating applicator.
   e. Indiscriminate submittal of manufacturer’s literature only is not acceptable.
   f. Submit AWWA C210 or C222 test reports.
2. Detailed chemical and gradation analysis for each proposed abrasive material.
3. Samples:
   a. For each paint system used, furnish colors available (where applicable) for each product used in paint system.
   b. Proposed Abrasive Materials: Minimum 1/2-pound Sample for each type proposed.

B. Informational Submittals:

1. Coating manufacturer’s Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers’ Field Services (to be completed).

2. Current NSF certification for potable water contact, where applicable.
3. Anticipated tank coating sequence.
4. Dehumidification plan, including equipment and air change rates. Submit plan based on type of equipment used, length of time required to hold blast, reservoir volume, and time of year that coating work is undertaken.
5. Applicator's Qualification: List of references substantiating experience.
6. Independent structural Engineer review of proposed tank containment system.
7. Shop and field applicator's quality control program, including, but not limited to:
    a. Environmental test methods and frequency.
    b. Steel surface temperature and profile measurement procedure and frequency.
    c. Record keeping form.
8. Manufacturer's written instructions for applying each type of coating.
9. When self-contained blast cleaning equipment using recycled abrasives is proposed. Submit the following:
    a. List of at least three successful projects within past 3 years where equipment and procedures have been used on steel tank of similar size and dimensions.
    b. Provide tank owner's name and telephone numbers.
    c. Description of proposed equipment, procedures, and abrasive blast mix to be used.
10. Field Testing: Inspection and test reports.
11. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).

1.04 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Minimum 5 years' experience in application of specified products.
2. Certified by coating manufacturer for application of epoxy or elastomeric polyurethane lining.

B. Regulatory Requirements: Meet federal, state, and local agencies having jurisdiction for Site and types of work activities included in Project, including, but not limited to:

1. Limitations on emission of volatile organic compounds, dust, and other contaminants.

2. Requirements for disturbance, handling, and disposal of paint waste and associated debris, including lead, coal tar, abrasive, and other regulated substances.

C. Industry Best Practices:

1. Perform surface preparation and painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. SSPC–PA Guide 3.
2. Do not apply paint in temperatures outside of manufacturer's recommended maximum or minimum allowable, in dust, in smoke-laden atmosphere, in damp or humid weather.
3. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent or whenever surface temperature is less than 5 degrees F above dewpoint of ambient air.

D. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

E. Preinstallation Meeting:

1. Prior to beginning painting Work, schedule a meeting and be prepared to discuss the following subjects, as a minimum:
   a. Required schedule.
   b. Sequence of critical path work items.
   c. Use of Site, access, office and storage areas, security, and temporary facilities.
   d. Major product delivery and priorities.
   e. Safety plan.
2. Attendees shall include:
   a. Owner's representatives.
   b. Contractor's office representative.
   c. Contractor's resident superintendent.
   d. Contractor's quality control representative.
   e. Subcontractors' representatives whom Contractor may desire or Engineer may request to attend.
   f. Engineer's representative.

g. Paint manufacturer's technical representative.
h. Others as appropriate.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Protect precoated items from damage. Batten coated items to prevent abrasion.
2. Use nonmetallic or padded slings and straps in handling.

B. Deliver materials to Site in unopened containers labeled with designated name, date of manufacture, color, and manufacturer.

C. Store paints in a protected area that is heated or cooled as required to maintain temperatures within range recommended by paint manufacturer.

1.06 SPECIAL GUARANTEE

A. Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of Owner, removal and replacement of Work specified in this Specification section found defective during a period of 2 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

1. 24-Month Warranty Period Inspection: Owner will conduct inspection of interior and exterior coated surfaces prior to the end of warranty period. Owner will notify Contractor in advance of inspection and Contractor may attend at its option. Owner will prepare list of coating defects and failures identified during inspection and transmit to Contractor. List shall serve as notice of repairs required under warranty.
2. Repairs:
   a. If repairs are required, requirements of Contract shall apply including, but not limited to, requirements to remove standing water in tanks, perform repair work, and tank cleaning prior to disinfection.
   b. Repair defective coatings using coating materials, equipment, and methods similar to those used in original work. Materials shall be of fresh manufacture and within manufacturer's stated shelf life at time of application.
   c. Provide extended warranty of 1 year for repairs.

d. Provide separate bond for 1-year repair warranty period.
e. Complete repairs within 30 calendar days of Warranty Period Inspection.

1.07 EXISTING COATING STATUS

A. The following information is provided for Contractor's information. Information shall not relieve Contractor from responsibility to inspect reservoir and assess existing coatings and structural dimensions.

1. The tank is protected with cathodic protection system.
2. Welded steel tank has concrete floor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Sherwin-Williams.
2. Tnemec Coatings.

2.02 MATERIALS

A. Quality: Manufacturer's highest quality products and suitable for intended use.

B. Materials Including Primer and Finish Coats: Produced by same paint manufacturer.

C. Thinners and Cleaners: As recommended by paint manufacturer of the particular coating.

D. NSF Epoxy: Polyamidoamine or phenalkamine cured epoxy coatings approved for potable water contact and conforming to NSF 61.

1. The Sherwin-Williams Company; Macropoxy 646-100 PW.
2. Tnemec Company, Inc.; Pota-Pox Plus V140F.

E. Aliphatic Acrylic Polyureathane: Two-component system for finish coat of exterior tank surfaces.

1. The Sherwin-Williams Company; HiSolids Polyureathane 100 (semi-gloss).
2. Tnenec Company, Inc.; 1075 Endura-Shield II (semi-gloss).

F. Anti-corrosive polyamidoamine epoxy primer two component system for intermediate layer of exterior coating system.

1. Tnemec Company, Inc.; V69 Hi-Build Epoxoline II.

G. Zinc-rich Primer: Single component, moisture cured system for steel structures.

1. The Sherwin-Williams Company; Corothane I Galvapac Zinc Primer.
2. Tnemec Company, Inc.; 94-H2O Hydro-Zinc.

H. Zinc Dust: Meet minimum requirements of ASTM D520, Type III.

I. Caulking: Two-component polyurethane caulk, suitable for potable water contact conforming to NSF 61 and compatible with the NSF Epoxy.

2.03 COLORS

A. Formulate with colorants free of lead and lead compounds.

B. Furnish as selected by Engineer.

C. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using contents of container for each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.

6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Keep paint material containers sealed when not in use.

2.05 ABRASIVES

A. Select abrasive type and size to produce a surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

B. Select abrasives that conform to federal and state regulations for metals and toxicity.

2.06 SOURCE QUALITY CONTROL

A. Prime coat structural steel surfaces.

B. 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 Engineer's approval before shipment to Site.

PART 3 EXECUTION

3.01 GENERAL

A. Surface Preparation and Coating Application: Meet or exceed requirements of these Specifications and SSPC–PA 1, whichever is more stringent.

B. Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied.

C. Paint new and existing interior and exterior exposed metal surfaces whether specifically mentioned or not, except as modified herein.

D. Provide Engineer a minimum of 7 days' advanced notice prior to start of surface preparation work or coating application work. Perform such work only in the presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence.

E. Schedule inspection with Engineer in advance for cleaned surfaces and coats prior to succeeding coat.

F. Do not apply paint in temperatures outside of manufacturer's recommended maximum or minimum allowable, or in dust, smoke-laden atmosphere, damp or humid weather.

G. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dewpoint of ambient air.

H. Ventilation for Coating Cure: Provide fans to continuously ventilate tank interior, as required, to assist with coating cure.

I. Remove existing cathodic protection system anodes, reference electrodes, and wiring prior to starting surface preparation activities. After coating work has been completed, reinstall and test cathodic protection system as specified in Section 26 42 00, Cathodic Protection.

3.02 PREPARATION

A. Items such as structural steel, metal floor doors, manways, and frames, metal louvers, and similar fabricated items may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternative to shop blast cleaning.

B. Remove, mask, or otherwise protect hardware, machined surfaces, nameplates, and other surfaces not intended to be painted.

C. Protect surfaces adjacent to or downwind of Work area from overspray.

D. Protect interior of inlet/outlet and overflow pipes from abrasive blast residue and dust with inflatable pipe plug, as approved by Engineer. Install temporary, appropriately sized polyethylene pig in pipe before installation of plug.

3.03 ENVIRONMENTAL CONTROLS

A. Containment System:

1. Provide full containment of blast emissions during entire blast operation for tank exterior. Meet requirements of SSPC–Guide 6 as modified below.
   a. Design: Reviewed by structural Engineer, licensed in the State of California. Consider load bearing capacity of roof for supporting containment system.

b. Provide Class 1 containment structure. Completely shroud tank with opaque fabric that prevents spread of blast media, spent chips, corrosion byproducts, and dust.
c. Exhaust air shall be filtered by appropriately sized dust collectors.
d. Verify effectiveness using Method A, General Surveillance, Level 2, as described in SSPC–Guide 6.

2. As an option to containment, consideration will be given to use of self-contained blast cleaning equipment using recycled abrasives.
   a. Exterior coatings shall be roller-applied to surfaces prepared using contained blast cleaning equipment.

B. Dehumidification Equipment:

1. Provide full-time dehumidification for field painting interior of reservoir. Dehumidification and heating equipment shall be provided by a supplier with at least 3 years' experience with necessary equipment.
2. Use dehumidification and heating equipment to control environment 24 hours a day during blast cleaning and coating application. At Contractor's option, dehumidification equipment may also be used during curing process.
3. Provide desiccant dehumidifiers as manufactured by Cargocaire Corporation, or equal. Desiccant dehumidifiers shall have a single rotary desiccant wheel capable of fully continuous operation. No liquid, granular, or loose lithium chloride drying systems will be allowed.
4. Interior space of reservoir shall be sealed and a slight positive pressure maintained as recommended by supplier of dehumidification equipment.
5. During blasting operation, dehumidification equipment shall continuously maintain a dewpoint of air inside tank at least 5 degrees F less than temperature of coldest part of tank where the Work is underway. Inside relative humidity shall not exceed 45 percent, unless specifically required by paint manufacturer for coating application and cure.
6. Auxiliary heat may be necessary to maintain surface temperature at an acceptable level for application of coating. Auxiliary equipment shall be approved for use by dehumidification equipment supplier and shall meet the following requirements:
   a. Install heaters in process air supply duct between, and blended with, dehumidifier as close to space as possible.
   b. Use electric, indirect fired combustion, or steam coil auxiliary heaters. Direct fired space heaters will not be allowed during blasting, coating, or curing cycles.

c. Equip heaters with controls that automatically turn heater off if airflow is interrupted or internal temperature of heater exceeds its design temperature or design temperature of supply duct.

7. Measure and record ambient temperature, relative humidity, dewpoint and reservoir wall temperature a minimum of twice daily (beginning and end of work shifts) to verify proper environmental levels are achieved inside reservoir. Field-measured test results shall be made available to Engineer upon request.

C. Filtration System:

1. Designed to remove dust from air so that it does not interfere with dehumidification equipment's ability to control dewpoint and relative humidity inside reservoir.
2. Air from reservoir or dust filtration equipment shall not be recirculated through dehumidifier during coating application or when solvent vapors are present.

3.04 PREPARATION OF SURFACES

A. Metal Surfaces:

1. Meet requirements of the following SSPC Specifications:
   a. Solvent Cleaning: SP 1.
   b. Hand Tool Cleaning: SP 2.
   c. Power Tool Cleaning: SP 3.
   d. White Metal Blast Cleaning: SP 5.
   e. Brush-Off Blast Cleaning: SP 7.
   f. Near-White Blast Cleaning: SP 10.
   g. Power Tool Cleaning to Bare Metal: SP 11.
   h. High Pressure Water Jetting: SP 12.
2. 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.
3. 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.
4. 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 clean with suitable solvents and clean cloths.
d. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
e. Welds and Adjacent Areas:
    1) Prepare such that there is:
        a) No undercutting or reverse ridges on weld bead.
        b) No weld spatter on or adjacent to weld or other area to be painted.
        c) No sharp peaks or ridges along weld bead.
    2) Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

5. Blast Cleaning Requirements:
    a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
    b. Select type and size of abrasive to produce a surface profile that meets coating manufacturer's recommendations for particular primer to be used.
    c. Use only dry blast cleaning methods.
    d. Do not reuse abrasive, except for designed recyclable systems.
    e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning and disposition of spent aggregate and debris.
6. 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 wipe with a tack cloth.
    b. Paint surfaces the same day they are blast cleaned. Reblast surfaces that have started to rust before they are coated.

3.05 APPLICATION

A. General:

1. The intention of these Specifications is for existing and new, interior and exterior metal and submerged metal surfaces to be painted, whether specifically mentioned or not, except as modified herein.
2. Coatings Subject to Immersion:
   a. Apply coatings to internal vessel, pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals unless otherwise specified.
   b. Curing:
      1) Obtain full cure for completed system.
      2) Consult coatings manufacturer's written instructions.
      3) Do not immerse coating until completion of curing cycle.
3. Apply coatings in accordance with paint manufacturer's recommendations. Allow sufficient time between coats to ensure thorough drying of previously applied coat.
4. Prior to assembly or installation, paint units to be bolted together and to structures.
5. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that required number of coats have been applied.
6. With brush, work coating into and behind anchor bolts, anchor chairs, and other areas that are difficult to paint by spray.

B. Shop Primed Surfaces:

1. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
2. For two-package or converted coatings, consult coatings manufacturer for specific procedures as relates to manufacturer's products.
3. Prior to application of finish coats, clean shop primed surfaces free of dirt, oil, and grease and apply one coat of specified primer.
4. After welding, prepare and prime holdback areas as required for specified paint system. Apply primer in accordance with manufacturer's instructions.

C. Stripe Coating:

1. Consists of one coat, brush applied, to coating thickness specified.
2. Apply between intermediate and final coats.

3. Color shall contrast intermediate coat to allow visual verification of application.
4. Apply to field welds, edges, angles, fasteners, and other irregular surfaces located inside tanks.

D. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Maximum film build per coat shall not exceed coating manufacturer's recommendations.

3.06 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. System No. 1A Submerged Metal—Potable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
Shop: Solvent clean and abrasive blast or centrifugal wheel blast (SP-5) Field: Detergent wash and fresh water rinse. Brush-off blast shop primer, abrasive blast areas of damaged primer, and field weld holdback areas to white metal (SP-5)	NSF Epoxy (Shop Applied, White)	1 coat, 4 MDFT
	NSF Epoxy (white), Spot Repairs and Welds	1 coat, 4 MDFT
	NSF Epoxy Intermediate Coat (grey or beige)	1 coat, 4 MDFT
	Stripe Coat with NSF Epoxy	1 coat, 3 MDFT
	NSF Epoxy Finish Coat (white)	1 coat, 4 MDFT

1. Minimum Dry Film Thickness, Total System:
   a. Nonstripe Coated Areas: 12 MDFT.
   b. Stripe Coated Areas: 15 MDFT.
2. Application Schedule:
   a. Use on submerged metal surfaces inside tank, including, but not limited to, steel plates and structural steel, exposed surfaces of inlet, outlet, and overflow piping, hatches, covers, ladders, landings, and couplings.

b. Coat exposed stainless steel surfaces inside tank. Coat interior surfaces of stainless steel pipe for a distance of 24 inches where stainless steel pipe is connected to coated carbon steel pipe.
c. Use on exterior surfaces of direct buried and concrete encased steel pipe.
d. Coating is not required for bottom side of floor plates.
e. Provide full coating thickness to structural steel surfaces that will be covered by roof plates or otherwise shielded from full coating thickness, before structural members are installed. Not required for surfaces located behind members that are fully seal welded.

B. System No. 1D Special Coating under Column Baseplate (Low VOC):

Surface Prep.	Paint Material	Min. Coats, Cover
Shop: Solvent clean and abrasive blast or centrifugal wheel blast (SP-5)	NSF Epoxy (Shop Applied)	1 coat, 4 MDFT
	NSF Epoxy Tie Coat	Field applied, as required by paint manufacturer
Field: Detergent wash and fresh water rinse. Brush-off blast shop primer, and as required by paint manufacturer	NSF Epoxy, Low VOC	1 or 2 coats, 30 MDFT

1. Minimum Dry Film Thickness, Total System: 34 mils.
2. Application Schedule:
   a. Use on bottom of column baseplate and top of steel floor surface under baseplate.
   b. Prepare surfaces and apply coating prior to installation of column.
   c. Extend coating on floor 2 inches beyond outside perimeter of column baseplate.

C. System No. 5 Exposed Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
Shop : Abrasive blast, or centrifugal wheel blast	Polyamide, Anticorrosive Epoxy Primer	1 coat, 2.5 MDFT

Surface Prep.	Paint Material	Min. Coats, Cover
(SP 10) Field: Detergent wash and fresh water rinse. Brush-off blast shop primer, abrasive blast areas of damaged primer and field weld holdback areas to white metal (SP-10)	Polyamide, Anticorrosive Epoxy Primer	1 coat, 3 MDFT
	Aliphatic Acrylic Polyureathane	1 coat, 3 MDFT

1. Minimum Dry Film Thickness, Total System: 8.5 mils.
2. Application Schedule:
   a. Use on the following:
      1) Exposed exterior metal surfaces of tank.
      2) For galvanized surfaces to be coated, reference System No. 10.
      3) Exposed metal surfaces inside elevated tank supporting structures, including bottom of tank.

D. System No. 10 Galvanized Metal Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) followed by Hand Tool (SP 2), Power Tool (SP 3), or Brush-off Blast (SP 7) in accordance with ASTM D6386.	Coating manufacturers' recommended primer followed by System No. 5	

1. Application Schedule: Use on galvanized surfaces, including handrails and gratings, before application of System No. 5.

3.07 FIELD QUALITY CONTROL

A. Test Equipment:

1. Provide a dry film thickness gauge to test coating thickness as specified in mils. Use electronic dry film thickness, as manufactured by DeFelsko, Positest or approved.

2. Provide electrical holiday detector, low voltage, wet sponge type to test finish coat, except zinc primer and galvanizing as manufactured by Tinker and Rasor; Model M-1.

B. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:

1. Perform with properly calibrated instruments.
2. Repair or recoat defective areas as necessary for compliance with Specifications.
3. All coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.

C. Thickness Testing:

1. Measure coating thickness specified in mils with magnetic or electronic type dry film thickness gauge in accordance with SSPC–PA 2.
2. Check each coat for correct thickness. Do not make measurement before a minimum of 8 hours after application of coating.
3. After repaired and recoated areas have dried sufficiently, tests will be conducted by Engineer.

D. Holiday (Pinhole) Testing: Test finish coat on 100 percent submerged surfaces for holidays and discontinuities with electrical holiday detector in accordance with NACE RP0188.

E. Unsatisfactory Application:

1. If improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections are causes for rejection.
3. Repair defects in coating systems in accordance with written recommendations of coating manufacturer.
4. Leave staging up until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer.

F. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of paint manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat in accordance with Specifications. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.08 MANUFACTURER'S SERVICES

A. Coating manufacturer's technical representative shall be present at Site as follows:

1. On the first day of application of coating.
2. A minimum of three additional Site inspection visits, each for a minimum of 3 hours.
3. As required for application quality assurance, and to determine compliance with manufacturer's instructions and these Specifications.
4. As necessary to resolve field problems attributable to or associated with manufacturer's products furnished under this Contract.
5. To verify full cure of coating prior to placing coated surfaces into immersion service.

3.09 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave Site clean.

3.10 SUPPLEMENTS

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

1. Paint System Data Sheet (PSDS) Data Sheet.
2. Paint Product Data Sheet (PPDS) Data Sheet.

END OF SECTION

PAINT SYSTEM DATA SHEET (PSDS)

Complete and attach manufacturer's Technical Data Sheet to this PSDS for each coating system.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio: _____

Maximum Permissible Thinning:_____

Ambient Temperature Limitations: min.: _____ max.: _____

Surface Temperature Limitations: min.: _____ max.: _____

Surface Profile Requirements: min.: _____ max.: _____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

PAINT PRODUCT DATA SHEET (PPDS)

Complete and attach manufacturer's Technical Data Sheet to this PPDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio:

Maximum Permissible Thinning:_____

Ambient Temperature Limitations: min.: _____ max.: _____

Surface Temperature Limitations: min.: _____ max.: _____

Surface Profile Requirements: min.: _____ max.: _____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

SECTION 10 14 00
SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes interior signs.

B. Allowances: Include under provisions of Section 01 20 00, Price and Payment Procedures: Allowances (to be completed). Allowance includes furnishing and installing interior signs.

1.02 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed): Submittal procedures.

B. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Indicate sign styles, lettering font, foreground and background colors, locations, overall dimensions of each sign.
   b. Schedule of all signage required for the Work, indicating signage type location, and other information to demonstrate compliance with the Contract Documents.
   c. Fabrication and erection information for each type of signage
   d. Valve schedule for small-diameter valves, in accordance with this Section.
   e. Mounting and Installation Data:
      1) Drawings of and information on anchorages and accessory items.
      2) Submit location template drawings for items supported or anchored to permanent construction.
      3) Coordinate mounting position, method, and proposed mounting accessories and fasteners with actual Project conditions. Indicate required mounting accessories on plan drawings showing locations of required exit signs based on measurements taken at the Site. Show final location and identify type of mounting surface for each exit sign. Coordinate location of exit signs for non-interference with other Work and as required by authorities having jurisdiction.

2. Product Data: Copies of manufacturer’s technical data, including catalog information and specifications, for each product specified.
3. Samples:
   a. Each color and finish of exposed materials and accessories required for signage.
   b. Samples Signage: Submit two full size signs illustrating type, style, letter font, and colors specified; method of attachment.
   c. Engineer's review of Samples will be for color and texture only. Compliance with other requirements is Contractor's responsibility.

C. Informational Submittals: Submit the following:

1. Manufacturer's Instructions:
   a. Templates for anchorages to be installed in concrete or masonry.
   b. Manufacturer's instructions and recommendations for support and foundations of signs installed outdoors.

1.03 QUALITY ASSURANCE

A. Perform Work in accordance with State of California standard.

B. Maintain one copy of each document on site.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00, Product Requirements (to be completed): Product storage and handling requirements.

B. Package signs, labeled in name groups.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00, Product Requirements (to be completed): Environmental conditions affecting products on site.

B. Do not install signs when ambient temperature is lower than recommended by manufacturer.

C. Maintain this minimum temperature during and after installation of signs.

PART 2 PRODUCTS

2.01 GENERAL

A. Details shown or indicated for signage, such as alpha-numeric and text type representation, letter spacing, designs of borders, and other graphic features, are generic and intended only to establish text, general positions, and symbols.

B. Colors shall be brilliant, distinctive shades, matching the safety colors specified in ANSI Z535.1 and OSHA 1910.144.

2.02 INTERIOR SIGNS

A. Manufacturers:

1. APCO Graphics.
2. ASI Sign Systems.
3. Daktronics, Inc.
4. FFI Group, Inc.
5. Mills Manufacturing.
6. Unicor.

2.03 COMPONENTS (TO BE COMPLETED)

A. Engraved Signs: Laminated colored plastic; lettering engraved through face to expose core color:

1. Face Color: [Clear.] [wood grain, [walnut] [_____].] [_____.] [Color as selected.]
2. Core Color: [_____].
3. Total Thickness: [1/16] [1/8] inch.
4. Height: [2] [3] [_____] inches.
5. Edges: [Square.] [Beveled.] [Radiused.]
6. Character Font: [Helvetica.] [_____.]

B. Sand Blasted Signs: Acrylic high gloss plastic; letters sand blasted to dull sheen:

1. Color: [Clear.] [Solid color.] [Color as selected.]
2. Total Thickness: [1/8] [_____] inch.
3. Height: [2] [3] [_____] inches.
4. Edges: [Square.] [Beveled.] [Radiused.]
5. Character Font: [Helvetica.] [_____.]

C. Silk Screened Signs: Letters [_____] inch high silk screened onto plastic surface:

1. Sign Color: [Clear.] [Solid color.] [Color as selected.]
2. Character Color: [Contrasting] [_____] color.
3. Total Thickness: [1/8] [_____] inch.
4. Height: [2] [3] [_____] inches.
5. Edges: [Square.] [Beveled.] [Radiused.]
6. Character Font: [Helvetica.] [_____.]

D. Injection Molded [Cast] Signs: [Acrylic plastic] [Cast aluminum]:

1. Sign Color: [Clear.] [Solid color.] [Color as selected.]
2. Character Color: [Contrasting color.] [Ground satin surface.] [_____.]
3. Total Thickness: [1/8] [_____] inch.
4. Height: [2] [3] [_____] inches.
5. Edges: [Square.] [Beveled.] [Radiused.]
6. Character Font: [Helvetica.] [_____.]

E. Raised Letter Signs, Base Material: [Clear] [Solid color] acrylic plastic:

1. Total Thickness: [1/8] [_____] inch.
2. Height: [2] [3] [_____] inches.
3. Edges: [Square.] [Beveled.] [Radiused.]
4. Character Font: [Helvetica.] [_____.]

F. Raised Character Size and Style: Acrylic plastic, character adhered to base material:

1. Character Color: [Black.] [_____.]
2. Character Thickness: [1/8] [_____] inch.
3. Height: [1] [1-1/2] [_____] inch.
4. Edges: [Square.] [Beveled.] [Radiused.]
5. Character Font: [Helvetica.] [_____.]
6. Character Case: [Upper] [and] [lower] case.

G. Individual Graphics, Material: [Clear] [Solid color] acrylic plastic:

1. Thickness: [1/8] [_____] inch.
2. Height: [2] [3] [_____] inches.
3. Edges: [Square.] [Beveled.] [Radiused.]
4. Character Color: [Black.] [_____.]
5. Character Font: [Helvetica.] [_____.]

6. Character Case: [Upper] [and] [lower] case.

H. Graphic Style: [Handicapped type.] [_____.]

2.04 ACCESSORIES

A. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

A. Section 01 30 00, Administrative Requirements (to be completed): Verification of existing conditions before starting work.

3.02 INSTALLATION

A. Install signs after doors surfaces are finished, in locations as directed by Engineer.

B. Center sign on door surface, level.

3.03 SCHEDULES

A. Office Door Signs: Individual Helvetica letters, 1 inch high, white color, identifying room name indicated on drawing schedule.

B. Service Room Signs: Plaque signs, 2 inches high, black face color, white core color, “UTILITY ROOM”, “SERVICE ROOM”, and “ELECTRICAL ROOM”; at each respective room location.

C. Rest Room Door Graphic: 6 inches high, “male” and “female” graphic image; black color, located on each rest room door.

END OF SECTION

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes fire extinguishers; fire blankets; fire extinguisher cabinets; and brackets for wall mounting.

B. Related Sections:

1. Section 06 10 00, Rough Carpentry: Wood blocking and shims.
2. Section 09 90 00, Painting and Coating: Field applied paint finish.

1.02 REFERENCES

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

1. National Fire Protection Association (NFPA): 10, Standard for Portable Fire Extinguishers.
2. Underwriters Laboratories Inc. (UL): Fire Protection Equipment Directory.

1.03 PERFORMANCE REQUIREMENTS

A. Conform to NFPA 10.

B. Provide extinguishers classified and labeled by Underwriters Laboratories Inc. for purpose specified and indicated.

C. Provide fire extinguisher cabinets classified and labeled by Underwriters Laboratories Inc. for purpose specified and indicated.

1.04 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed): Submittal procedures.

B. Action Submittals: Submit the following:

1. Product Data: Manufacturer’s technical data, extinguisher operational features, color and finish, anchorage details, certification of UL rating, and installation instructions for fire protection specialties.

2. Shop Drawings: Indicate cabinet physical dimensions, rough-in measurements for recessed cabinets, wall bracket mounted measurements, location, and fire ratings.
3. Manufacturer's Installation Instructions: Submit special criteria and wall opening coordination requirements.

1.05 CLOSEOUT SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Closeout procedures.

B. Operation and Maintenance Data: Submit test, refill or recharge schedules and recertification requirements.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with State of California standard.

B. Maintain one copy of each document on site.

C. Component Supply and Compatibility: Provide fire protection specialties products from one manufacturer.

D. Regulatory Requirements: Provide fire protection specialties approved and labeled by UL.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00, Product Requirements (to be completed): Environmental conditions affecting products on site.

B. Do not install extinguishers when ambient temperature are capable of freezing extinguisher ingredients.

PART 2 PRODUCTS

2.01 FIRE EXTINGUISHERS

A. General: Provide manufacturer’s standard mounting brackets for portable fire extinguishers size as specified.

B. Multi-Purpose Dry Chemical Fire Extinguishers:

1. Ten-pound capacity, enameled steel container with pressure-indicating gauge, for Class A, Class B, Class C fires, UL rating 4A-60 BC.

2. Manufacturers and Products: Provide one of the following:
   a. J.L. Industries; Cosmic Model 10E.
   b. Or approved substitution.

C. Carbon Dioxide Fire Extinguishers:

1. Ten-pound enameled steel container capacity, for Class B and Class C fires UL rating.
2. Manufacturers and Products: Provide one of the following:
   a. J.L. Industries; Sentinel Model 10.
   b. Or approved substitution.

PART 3 EXECUTION

3.01 EXAMINATION

A. Section 01 30 00, Administrative Requirements (to be completed): Coordination and project conditions.

B. Examine substrates and conditions under which fire protection specialties will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Engineer.

3.02 INSTALLATION

A. When exact locations of fire protection specialties are not shown on Drawings, locate as directed by Engineer.

B. Securely fasten products to structure, square and plumb, per Supplier's instructions. Mounting heights shall be:

1. Install fire extinguishers with gross weight greater than 40 pounds with top of fire extinguisher no more than 3.5 feet above finished floor.
2. Install fire extinguishers with gross weight less than 40 pounds with top of fire extinguisher no more than 4.0 feet above finished floor.
3. Clearance between bottom of fire extinguisher and finished floor shall be at least four inches.

C. Identification Devices: Provide signs level and plumb directly above surface mounted portable fire extinguishers, securely mounted, and attached to substrate per sign manufacturer's instructions. Signage shall be per Section 10 14 00, Signage.

D. Recharge fire extinguishers provided under this Contract so that most recent inspection date coincides as nearly as possible with date of Substantial Completion. Inform Owner in writing of next required inspection and recharging date.

3.03 SCHEDULES

A. Type A: Dry chemical, wall mounted.

B. Type B: Carbon dioxide, wall mounted.

END OF SECTION

SECTION 10 80 00
MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Writing boards.
2. Toilet partitions.
3. Lockers.
4. Toilet room accessories.
5. Kitchen appliances.

1.02 REFERENCES

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

1. ASTM International:
   a. A879, Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
   b. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing (to be completed).
2. Manufacturers' descriptions, installation data, color charts, and cleaning and service instructions for all items proposed for use. Clearly identify each item.

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

PART 2 PRODUCTS

2.01 WRITING BOARDS

A. Materials: Stretcher level sheet steel facing, 28-gauge minimum; plywood, particle, or hardboard; anodized extruded aluminum frame and tray.

B. Composition: Face sheet bonderized and surfaced to accept watercolor and semipermanent writing inks with selective erasability; Class 1 Fire Hazard Classification with flame spread of 25 or less when tested in accordance with ASTM E84; bonded to plywood, hard, or particle board backing.

C. Finish and Color: White porcelain enamel semigloss writing surface finish impervious to cracking, checking, chipping, and peeling. Extruded aluminum frame and tray clear anodize finish.

D. Size: As noted on Drawings.

E. Accessories: Twelve watercolor markers, six black and six assorted colors compatible with writing surface; cleaners, towels, magnetic strips, and instruction booklet.

F. Manufacturers:

1. Alliancewall Corp.
2. Best-Rite Chalkboard Co.
3. Carolina Chalkboard Co.
4. Claridge Products and Equipment, Inc.
5. Greensteel, Inc.
6. Weber Costello Co.
7. Approved substitution.

2.02 TOILET PARTITIONS

A. Materials: Steel sheets for baked enamel finish in accordance with ASTM A591, Class C and galvanized-bonderized with core of manufacturer’s standard sound-deadening, honeycomb impregnated Kraft paper.

B. Composition: Overhead braced, floor supported flush metal toilet partitions and doors and wall-hung, bracket supported, flush metal urinal screens where shown on Drawings. Fabricate of two sheets of galvanized-bonderized stretcher leveled steel, assembled over, and cemented under pressure to a core of sound-deadening insulation and edged with a continuous locking strip.

C. Finish and Color: Baked enamel finish and color as selected by Engineer from manufacturer's standard colors.

D. Size: As indicated on Drawings. Minimum panel as follows:

1. Doors: 1 inch thick; 22 gauge.
2. Partitions and Screens: 1 inch thick; 20 gauge.
3. Pilasters: 1-1/4 inch thick; 20 gauge.
4. Headrails to be 1 inch by 1-1/2 inches by 20-gauge stainless steel.

E. Accessories: Manufacturer's standard hardware and accessories, including a combination coat hook and bumper.

F. Manufacturers:

1. All American Metal Corp.
2. Flush-Metal Partition Corp.
3. Global Steel Products Corp.
4. Metpar Steel Products Corp.

2.03 LOCKERS

A. Materials: Mild cold-rolled and leveled furniture steel, free from buckle, scale, and surface imperfections. Cadmium, zinc, or nickel plated steel exposed bolt heads, slotless type; self-locking nuts or lock washers for nuts on moving parts.

B. Composition: Single-tier, single-door, steel locker and standard door with louvers top and bottom.

C. Finish and Color: Baked-on enamel over bonding and rust-resisting phosphate undercoat, in color(s) as selected by Engineer.

D. Size: 15 inches wide by 18 inches deep by 72 inches high.

E. Accessories: Sloping top 20-gauge sheet steel, 6-inch high legs, combination padlock, single hat shelf with rolled front, and noncorrosive number plates with black numerals, numbered consecutively as shown on Drawings.

F. Manufacturers:

1. The Interior Steel Equipment Co.
2. List Industries Inc.
3. Republic Storage Systems.

2.04 TOILET ROOM ACCESSORIES

A. Furnish accessory items listed where indicated by mark or note on Drawings:

Item	Mark	Bobrick	
Surface Mounted Roll Toilet Paper Dispenser	TPD	N/A	Supplier Provided
Wall Mounted Liquid Soap Dispenser	SD	N/A	Supplier Provided
Mirror, Size on Drawings	MIR	No. B-290	
Surface Mounted Paper Towel Dispenser	PTD	N/A	Supplier Provided
Grab Bar	Drawing Keynote	B-5806.99 x Length	

B. Finish: Satin stainless steel finish or standard supplier provided.

C. Anchors: Furnish anchors, fasteners, or other devices necessary for a complete, secure installation.

2.05 KITCHEN APPLIANCES

A. Drop-in Cooktop: Similar to GE Profile Clean DesignPP945, 30-inch smooth top electric cooktop with four ribbon elements, electronic touch controls, tri-ring elements, power boil burner and ADA compliant.

B. Refrigerator/Freezer: Similar to GE Profile PWE23KGD, 22.7-cubic foot capacity with french door refrigerator upper section and drawer style freezer below.

PART 3 EXECUTION

3.01 INSTALLATION OF SPECIALTIES

A. Follow manufacturer’s recommendations and printed instructions. Consult with Engineer so that minor adjustments in the locations can be decided if necessary.

1. Install materials plumb or level as applicable and attach securely to adjacent materials with suitable fasteners.

2. Prevent scratching or damaging adjacent materials during installation.

B. Toilet Partitions:

1. Erect partitions, screens, and related items in a rigid substantial manner, straight and plumb, and with horizontal lines level.
2. Clearances: At the wall, 1 inch for panels and pilasters; at vertical edge of doors, uniform from top to bottom and not exceeding 3/16 inch. Install doors free of warp and wind.

C. Lockers: Attach lockers securely to the wall and to each other as recommended by the manufacturer. Align and level lockers with shims where necessary to provide for irregularities in the base. Install trim, adjust doors and latches for proper operation, and leave lockers level, plumb, rigid, and free from soil and imperfections.

D. Toilet Room Accessories:

1. Coordinate support framing and backing as necessary for proper installation of accessories.
2. Locate where shown on Drawings at height indicated.
3. Following manufacturer's instructions and recommendations, install and securely anchor accessories in their proper locations.
4. Remove protective maskings and clean surfaces, leaving them free of soil and imperfections.

E. Kitchen Appliances:

1. Cooktop:
   a. Coordinate countertop cutout size, support framing and utility connections in cabinetry with location shown on Drawings.
   b. Following manufacturer's instructions and recommendations, install and securely anchor in proper location. Connect to utilities.
   c. Remove protective maskings and clean surfaces, leaving them free of soil and imperfections.
2. Refrigerator:
   a. Install at location shown on Drawings in accordance with manufacturer's instructions and recommendations. Connect to utilities.
   b. Remove protective maskings and clean surfaces, leaving them free of soil and imperfections.

END OF SECTION

SECTION 11 53 00
LABORATORY EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes laboratory countertop, laboratory equipment; connection to utilities; and service fittings and outlets.

B. Related Sections: Section 03 10 00, Concrete Forming and Accessories: Execution requirements for inserts for laboratory equipment specified by this section.

C. Allowances: Include under provisions of Section 01 20 00, Price and Payment Procedures (to be completed later). Allowance includes purchase and delivery of laboratory equipment. Installation is included in this section and is part of Contract Sum/Price.

1.02 REFERENCES

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

1. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.

1.03 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed): Submittal requirements.

B. Shop Drawings: Indicate equipment locations, large scale plans, elevations, cross sections, rough-in and anchor placement dimensions and tolerances, and clearances required.

C. Product Data: Submit equipment dimensions and construction, equipment capacities, physical dimensions, utility and service requirements and locations, point loads

D. Manufacturer's Installation Instructions: Submit special installation requirements

1.04 CLOSEOUT SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Closeout procedures.

B. Project Record Documents: Record actual locations of concealed utility connections

C. Operation and Maintenance Data: Submit description of equipment operation, adjusting, and testing required Identify system maintenance requirements, servicing cycles, lubrication types required and spare part sources.

D. Warranty: Submit Manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Provide documentation proving useable state of operating equipment at time of Owner acceptance.

B. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 3 years’ documented experience.

1.07 COORDINATION

A. Section 01 30 00, Administrative Requirements (to be completed): Coordination and project conditions.

B. Leave building openings of sufficient size to permit transport of equipment to final position.

1.08 WARRANTY

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Product warranties and product bonds.

B. Furnish 5 year manufacturer warranty for laboratory equipment.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Equipment: Scheduled at end of section.

B. Rough-in: Frames, anchors, supports, accessories and closure trim; appropriate to scheduled equipment.

C. Resin counter top with splash guard; Counter-top sized to fit cabinetry shown on Drawings and specified in Section 06 41 00, Architectural Wood Casework.

D. 16 by14 inch Type 304 stainless steel, double compartment lab sink, Model #SR14-16-9.5.2 by Eagle group with faucet #300490 with 12-inch spout.

2.02 SHOP FINISHING

A. Equipment and Accessories: Zinc chromate primer; two baked enamel finish coats in color as selected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify rough-in frames, anchors and supports are accurately placed.

3.02 PREPARATION

A. Coordinate rough-in frame and anchor placement.

3.03 INSTALLATION

A. Install in accordance with standards required by authority having jurisdiction.

B. Anchor equipment securely in place.

C. Sequence installation to accommodate required utility connections.

D. Touch-up minor damaged surfaces caused during installation. Replace damaged components.

3.04 ADJUSTING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed later): Testing, adjusting, and balancing.

B. Adjust operating equipment to efficient operation.

3.05 SCHEDULES

A. Laboratory Equipment Schedule:

Item	Description	Quantity
Turbidity meter	Hach 2100Q turbidimeter kit including vials and calibration kit	1
pH/Conductivity meter	SensIon+ MM374 GLP Dual Channel kit with electrode stand	1
Colorimeter	Hach DR3900 Portable Colorimeter kit	1
Colorimeter accessories	Ferrous Fe powder pillow package	1
Colorimeter accessories	Total Fe powder pillow package	1
Colorimeter accessories	Cr6 powder pillows package	1
Colorimeter accessories	CrT powder pillow kit (set)	1
Colorimeter accessories	Arsenic Test kit	1
Breakers	100mL Poly pk12	1
Graduated cylinders	25 mL	2
Graduated cylinders	100 mL	2
Graduated cylinders	1,000 mL	2
Auto Sampler	Hach SIP 10 sipper system	1
Vacuum Pump	Welch VWR Catalog # 54994-110	1
Stirrer/hot plate	7 X 7 - Cimarec Ceramic top stirrer hot plate or Hach Product #:2881500	1

Item	Description	Quantity
Cabinet	30 Gallon Flammable Storage	1

END OF SECTION

SECTION 13 34 19
METAL BUILDING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes pre-engineered, shop fabricated structural steel building frame supporting an internal bridge crane; insulated metal wall panels and sloped roof system on rigid insulation including, soffits, gutters and downspouts, exterior doors, windows, rigid vent, overhead door, and louvers.

B. Related Sections:

1. Division 3, Concrete and Concrete Work.
2. Section 07 92 00, Joint Sealants.
3. Section 08 11 00, Metal Doors and Frames.
4. Section 08 33 23, Overhead Coiling Doors.
5. Section 08 71 00, Door Hardware.
6. Section 08 90 00, Louvers and Vents.
7. Section 09 90 00, Painting and Coating.
8. Section 31 23 16, Excavation.
9. Section 31 23 23, Fill and Backfill.

1.02 REFERENCES

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

1. American Architectural Manufacturers Association (AAMA): WDMA/CSA 101/I.S.2 A440, NAFS (North American Fenestration Standard Specification for Windows, Doors and Skylights.
2. American Institute of Steel Construction (AISC):
   a. S335, Specification for Structural Steel Buildings Allowable Stress Design, and Plastic Design.
   b. S342L, Load and Resistance Factor Design Specification for Structural Steel Buildings.
   c. S344L, Metric Load and Resistance Factor Design Specification for Structural Steel Buildings.
3. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   b. D1.1, Structural Welding Code, Steel.

4. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   d. A307, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
   e. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   f. A490, Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.
   g. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   h. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   i. A529/A529M, Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
   j. A572/A572M, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   k. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   l. A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
   m. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   n. C1371, Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
   o. C1549, Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
   p. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   q. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
   r. E408, Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
   s. E903, Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
   t. E1918, Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.

u. E1980, Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
v. E1996, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

5. Green Seal (GC): 03, Anti-Corrosive Paints.
6. Metal Building Manufacturers Association (MBMA): Low Rise Building Systems Manual.
7. The Society for Protective Coatings (SSPC):
   a. Steel Structures Painting Manual.
   b. Paint 20, Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).
8. Underwriters Laboratories Inc. (UL): Building Materials Directory.
9. U.S. Environmental Protection Agency: ENERGY STAR - ENERGY STAR Voluntary Labeling Program.

1.03 SYSTEM DESCRIPTION

A. Single span rigid frame.

B. Bay Spacing: As shown on Drawings.

C. Primary Framing: Rigid Frame solid web framing consisting of tapered or uniform depth rafters rigidly connected to tapered or uniform depth.

D. Secondary Framing: Girts, furring channels, angles, plates, bracing, and other secondary framing members for panel supports and anchorage.

E. Endwall Framing: Corner posts, endposts and rake beams.

F. Purlins: Zee-shaped; depth as required; simple span or continuous span as required for design.

G. Girts: Zee- or Cee-shaped; depth as required; simple span or continuous span as required for design.

H. Wind Bracing: Portal, torsional, diagonal bracing or diaphragm in accordance with manufacturer’s standard design practices; utilizing rods, angles, and other members, with minimum yield strengths as required for design.

I. Primary Frame Flange Bracing: Attached from purlins or girts to the primary framing, minimum yield strength as required for design.

J. Wall Panel Penetration Framing: Zee- or Cee-shaped; depth as required.

K. Wall System: Preformed, prefinished, interlocking, factory sealant/gasket applied, factory foamed in place polyurethane between two sheets of formed and seamed 26 gauge steel sheets with finishes selected from manufacturer's standard selection. Panels of 3-inch thickness yielding R-22 insulation value at 75 degrees F mean temperature.

1. Basis of Design: Varco Pruden Buildings, Thermalclad Reveal Wall Panel.

L. Roof System: Preformed, prefinished, factory applied sealant and field seamed standing seam 24 gauge panels, finished as selected from manufacturer's standard selection, supported by proprietary clips to formed structural steel deck. Roof panel clips to be sized to allow for rigid insulation under roof panels, thickness as shown on Drawings. Solar Reflectance Index (SRI) to be 16, minimum.

1. Basis of Design: Varco Pruden Buildings, SLR II Roof.

M. Roof Slope: As shown on Drawings.

1.04 DESIGN REQUIREMENTS

A. Applicable Building Code: California Building Code (CBC) 2013. See Drawings for loading information.

B. Roof Live Load: 30 psf.

C. Wind Load: CBC Section 1609: See General Notes on Drawings.

D. Seismic Loads: CBC Section 1613: See General Notes on Drawings

E. Foundation: 1,500 psf maximum allowable bearing pressure.

F. Floor Live Load: 250 psf.

G. Dead Loads: Include the weight of all indicated permanent construction and a collateral dead load of 5 psf.

H. Design wall and roof panel system to withstand specified loads with deflection of 1/240th of span, maximum.

I. Design the framing such that the maximum lateral drift shall be H/400 under wind loadings.

J. Anchor Bolts: Furnish design criteria for anchor bolts to resist the loads induced by the design loads on the structure.

K. Design members to support mechanical and electrical equipment indicated.

L. Design structure to support moving bridge crane loads indicated on Drawings.

M. Permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to temperature range of 120 degrees F.

N. Size and fabricate wall and roof systems free of distortion or defects detrimental to appearance or performance.

O. Thermal resistance of Calculated Wall System: R-Value of 22.

P. Thermal Resistance of Calculated Roof System: Base on thickness of insulation shown on Drawings.

1.05 PERFORMANCE REQUIREMENTS

A. Conform to applicable CBC code for submission of design calculations, reviewed shop and erection drawings, and as required for acquiring permits.

B. Cooperate with regulatory agency or authority and provide data as requested authority having jurisdiction.

C. Provide components of each type from one manufacturer compatible with adjacent materials.

1.06 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed): Submittal procedures.

B. Design Data: Provide detailed design criteria and calculations, with State of California professional engineer seal and signature, for pre-engineered metal building frame system including loads to foundation.

C. Shop Drawings: Show building layout, indicate assembly dimensions, locations of structural members, connections, attachments, openings, cambers, loads, and wall and roof system dimensions, panel layout, general construction details, anchorages and method of anchorage, method or installation and framing anchor bolt settings, sizes, and locations from datum, and foundation loads; indicate welded connections with AWS A2.4 welding

symbols; indicate net weld lengths; provide State of California professional engineer seal and signature on all shop drawings.

D. Product Data: Submit data on profiles, component dimensions, fasteners, and performance characteristics.

E. Manufacturer's Instructions: Submit preparation requirements and anchor bolt placement.

F. Certification: Manufacturer certification that the building conforms to the contract documents and manufacturer’s standard design procedures.

G. Erection Drawings: Indicate members by label, assembly sequence, and temporary erection bracing.

H. Color Samples: For selection of colors.

I. Specimen Warranty.

1.07 CLOSEOUT SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Closeout procedures.

B. Project Record Documents: Record actual locations of concealed components and utilities.

1.08 QUALITY ASSURANCE

A. Perform Work in accordance with AISC S335, AISC S342L, AISC S344L, and MBMA Low Rise Building Systems Manual.

B. Design structural components, develop shop drawings, and perform shop and site work under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State of California.

C. Design data, calculations and Shop Drawings submitted for review shall bear the seal of a Professional Engineer licensed in the State of California.

D. Insulation Installed in Concealed Locations Surface Burning Characteristics:

1. Rigid or Batt Insulation: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.09 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 5 years' documented experience and certified by ICC-IAS (International Code Council – International Accreditation Service).

B. Erector: Company specializing in performing Work of this section with minimum 5 years' experience and approved by manufacturer. Design structural components, develop shop drawings, and perform shop and site work under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of California.

1.10 PRE-INSTALLATION MEETINGS

A. Section 01 30 00, Administrative Requirements (to be completed): Pre-installation meeting.

B. Convene minimum 2 weeks prior to commencing work of this section.

1.11 WARRANTY

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Product warranties and product bonds.

B. Furnish 5 year manufacturer warranty for materials and workmanship of pre-engineered building systems and components.

C. Furnish 20 year warranty to include coverage for exterior pre-finished surfaces color coat against chipping, cracking or crazing, blistering, peeling, chalking, or fading.

D. Furnish 20 year warranty for weather tightness of building enclosure elements after installation.

PART 2 PRODUCTS

2.01 PRE-ENGINEERED BUILDINGS

A. Manufacturer:

1. Varco-Pruden Buildings.
2. Or as approved.

2.02 COMPONENTS - FRAMING

A. Structural Steel Plate, Bar, Sheet, and Strip for Use in Bolted and Welded Constructions: ASTM A572, A1011, A529, or A36, as applicable.

B. Structural Steel Material for Secondary Structural Members: ASTM A1011, with minimum yield strength of 57,000 psi.

C. Hot-Rolled Steel Shapes: ASTM A36 OR A992 as applicable; with minimum yield strengths of 36 or 50 ksi.

D. Structural Bolts and Nuts Used with Primary Framing: High strength, ASTM A325.

E. Bolts and Nuts Used with Secondary Framing Members: ASTM A325.

F. Sag Angles and Bridging: Steel angles, with minimum yield strength of 36,000 psi.

G. Anchor Bolts: ASTM A307 Grade A, unprimed.

H. Welding Materials: AWS D1.1; type required for materials being welded.

I. Fabrication: Fabricate according to manufacturer’s standard practice.

1. Fabricate structural members made of welded plate sections by jointing the flanges and webs by continuous automatic submerged arc welding process.
2. All welding operators and processes shall be qualified in accordance with the American Welding Society “Structural Welding Code,” AWS D1.1.
3. Field connections. Prepare members for bolted field connections by making punched, drilled, or reamed holes in the shop.

J. Shop Coating: Shop coat all structural steel members (except rods) using one coat of manufacturer’s standard primer (SSPC Paint 20, Red Oxide), after cleaning of oil, dirt, loose scale and foreign matter.

K. Shop Coating for Rods: Galvanize rods to ASTM A123; minimum 1.25 ounces per square foot galvanized coating.

L. Finish Coating: Finish coat all structural steel members (except rods) per Section 09 90 00, Painting and Coating.

M. Component Identification: Mark all fabricated parts, either individually or by lot or group, using an identification marking corresponding to the marking shown on the Shop Drawings, using a method that remains visible after shop coating.

N. Nonshrink Grout: Specified in Section 03 62 00, Nonshrink Grouting.

2.03 COMPONENTS - WALL AND ROOF SYSTEM AND MISCELLANEOUS MATERIALS

A. Galvanized Steel Sheet for Roof and Wall Covering Exterior Sheets, Trim and Flashing: ASTM A653, with minimum yield strength of 50,000 psi. Coating designation G-90.

B. Insulation:

1. Type IV extruded polystyrene from insulation.
2. Basis of Design: The Dow Chemical Company Styrofoam Brand Tongue and Groove Insulation.

C. Joint Seal Gaskets: Manufacturer's standard type.

D. Panel Fasteners:

1. For Roof Panels: Stainless steel-capped carbon steel fasteners with integral sealing washer.
2. For Wall Panels: Coated carbon steel.
3. Color of exposed fastener heads to match the wall panel finish.
4. Concealed Fasteners: Self-drilling type, of size as required.
5. Provide fasteners in quantities and location as required by the manufacturer.

E. Bituminous Paint: Asphaltic type.

F. Plastic Parts: Glass fiber reinforced resin or thermoformed ABS.

1. ABS: Minimum 1/8 inch thick.
2. Color: Manufacturer’s standard color.

G. Sealants, Mastics and Closures: Manufacturer’s standard type.

1. Provide at roof panel end laps, side laps, rake, eave, transitions and accessories as required to provide a weather-resistant roof system; use tape mastic or gunnable sealant at side laps and end laps.

2. Provide at wall panel rakes, eaves, transitions and accessories.
3. Provide at door and louver frames, and other penetrations.
4. Closures: Formed to match panel profiles; closed cell elastic material, manufacturer's standard color.
5. Tape Mastic: Pre-formed butyl rubber-based, non-hardening, non-corrosive to metal; white or light gray.
6. Gunnable Sealant: Non-skinning synthetic elastomer based material; gray or bronze.

H. Metal Mesh: Galvanized steel wire, woven.

I. Roof Curbs: Welded units fabricated for shingled installation with roof panels; minimum 18 ga. (1.22 mm) Galvalume coated steel, with welds cleaned and treated with protective coating compatible with the Galvalume substrate.

1. Top of curbs horizontal with 1-1/2 inch (38 mm) perimeter flange.
2. Curb walls insulated with 1-1/2 inch (38 mm), 3 pcf (48 kg/cu m) density rigid glass fiber insulation.
3. Water Diversion: Integral 4 inches (100 mm) high by full length cricket on upslope side.
4. Exposed curb flanges pre-drilled for correct fastener locations.
5. Upslope and downslope curb flanges with integral welded inside and outside cell closures compatible with the roof panel profile.
6. Curb Framing: Mounted on secondary structural members and installed from the top; compatible with the thermal expansion and contraction properties of the roof on which it is used.
7. Opening Size: As indicated on Drawings.
8. Acceptable Curbs for standing seam Roof Panels: Seamed in type.

J. Flashing and Trim: Match material and color of adjacent components. Provide trim at rakes, including peak and corner assemblies, high and low eaves, corners, bases, framed openings and as required or specified to provide weathertightness and a finished appearance.

2.04 ROOF PANEL COMPONENTS

A. Standing Seam Roof Panels: 16 inch wide net coverage, with 2 inch high major ribs formed at the panel side laps, formed for field seaming using electrically operated seaming machine.

1. Material: See Galvanized Steel Sheet for Roof and Wall Coverings in Article Components - Wall and Roof System and Miscellaneous Materials, Paragraph A.
2. Thickness: 24 gauge.

3. Side Laps: Two factory-formed interlocking ribs, with one weather sealed joint, mechanically field-seamed into place to form a double-fold 360 degree seam. Factory applied sealant for field seaming.
4. Length: Continuous from eave to ridge where possible.
5. End Laps, where Required: 6 inches wide, located at a support member. Stagger at least one purlin spacing.
6. The roof shall be tested and certified to meet Underwriters Laboratories uplift rating; UL90.
7. Panel to Roof Deck Attachments: Standing seam roof clips with movable tabs which interlock with seamed standing seam roof panel ribs and provide for 1-5/8 inches of panel movement in either direction from center of clip to compensate for thermal effects.
8. Panel to Plywood Attachments: Standing seam roof clips with movable tabs which interlock with seamed standing seam roof panel ribs and provide for 1-5/8 inches of panel movement in either direction from center of clip to compensate for thermal effects.
9. Finish: Kynar 500 or Hylar 5000 pre-painted finish on exterior surface, wash coat on interior surface. Color selected by Owner from manufacturer’s full line with SRI (Solar Reflectance Index) of 16 minimum.

2.05 WALL PANEL COMPONENTS

A. 42 inches wide net panel coverage, steel faced, shop assembled, factory foamed polyurethane insulated panel units.

1. Material: See Galvanized Steel Sheet for Roof and Wall Coverings in Article Components - Wall and Roof System and Miscellaneous Materials, Paragraph A.
2. Sheet Thickness: 26 gauge.
3. Panel side connection: Double tongue and groove interlocking design with factory applied sealant.
4. Length: Continuous from sill to eave.
5. Cut panels straight and as shown on Drawings; provide standard panel closures at exposed cut panel ends.
6. Finish: Kynar 500 or Hylar 5000 pre-painted finish on exterior surface, wash coat on interior surface. Color selected by Owner from manufacturer’s full line.

2.06 METAL FINISHES

A. Fluoropolymer Coating: Manufacturer's standard two-coat, thermo-cured, full-strength 70 percent "Kynar 500" coating consisting of a primer and a minimum 0.75 mil dry film thickness with a total minimum dry film thickness of 0.9 mil and 30 percent reflective gloss when tested in accordance with ASTM D523.

1. Durability: Provide coating that has been field-tested under normal range of weathering conditions for minimum of 20 years without significant peel, blister, flake, chip, crack, or check in finish; without chalking in excess of No. 8 in accordance with ASTM D4214; and without fading in excess of five NBS units.

2.07 COMPONENTS - METAL DOORS AND FRAMES

A. Doors and Frames: Specified in Section 08 11 00, Metal Doors and Frames.

2.08 COMPONENTS - OVERHEAD DOORS

A. Overhead Doors: Specified in Section 08 33 23, Overhead Coiling Doors.

B. Frame: Formed steel sections braced to building frame specified in Section 05 50 00, Metal Fabrications.

2.09 COMPONENTS - WINDOWS

A. Windows: Frame system to be metal building manufacturers thermally broken extruded aluminum, 2-1/2 inch sightline frame, clear anodized finish. Construct windows to the requirements of AAMA/WDMA/CSA1-1/I.S.2 A440, Class CW.

1. Basis of Design: Wintech Series S250 commercial aluminum window.

B. Glass and Glazing: Specified in Section 08 80 00, Glazing.

2.10 FABRICATION - FRAMING

A. Fabricate members in accordance with AISC Specification for plate, bar, tube, or rolled structural shapes.

B. Anchor Bolts: Formed with straight shank with headed bolt at embedded end, assembled with template for casting into concrete.

C. Provide framing for door, window, louver, and ventilator openings.

2.11 FABRICATION - WALL AND ROOF SYSTEM ACCESSORIES

A. Soffit panels: Minimum 24 gauge metal thickness, 12 inch net wide panel, V crimped, perforated profile, male/female edges.

1. Basis of Design: Varco Pruden Buildings FP-12 Soffit.

B. Girts/Purlins: Rolled formed structural shape to receive siding and roofing panels.

C. Internal and External Corners: Same material thickness and finish as adjacent material, profile shop cut and factory mitered to required angles. Back brace mitered internal corners with 12 gauge thick sheet.

D. Expansion Joints: Same material and finish as adjacent material where exposed, manufacturer's standard brake formed type, of profile to suit system.

E. Flashings, Closure Pieces, Fascia, Infills, and Caps: Same material and finish as adjacent material, profile to suit system.

F. Fasteners: To maintain load requirements and weather tight installation, same finish as cladding, non-corrosive type.

G. Ventilator: Sheet steel, galvanized, rotary design, 16 inch nominal size, designed for 24 inch wide roof deck ridge opening.

H. Wall Louvers: See Section 08 90 00, Louvers and Vents.

2.12 FABRICATION - GUTTERS AND DOWNSPOUTS

A. Fabricate of same material and finish as roofing metal.

B. Form gutters and downspouts of standard profile and size to collect and remove water. Fabricate with connection pieces.

C. Form sections in maximum possible lengths. Hem exposed edges. Allow for expansion at joints.

D. Fabricate support straps of same material and finish as roofing metal, color as selected.

2.13 FACTORY FINISHING

A. Framing Members: Clean, prepare, and shop prime. Do not prime surfaces to be field welded.

B. Galvanizing for Nuts, Bolts and Washers: ASTM A153/A153M.

C. Interior Surfaces of Wall and Roof Components and Accessories: See Articles Roof Panel Components and Wall Panel Components, respectively.

D. Exterior Surfaces of Wall and Roof Components and Accessories: See Articles Roof Panel Components and Wall Panel Components, respectively.

PART 3 EXECUTION

3.01 EXAMINATION

A. Section 01 30 00, Administrative Requirements (to be completed): Coordination and project conditions.

B. Verify foundation, floor slab, mechanical and electrical utilities, and placed anchors are in correct position.

3.02 ERECTION - FRAMING

A. Erect framing in accordance with AISC Specification, manufacturer's instructions, erection drawings, and other erection documents.

B. Provide for erection and wind loads. Provide temporary bracing, shoring, blocking, and bridging to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing. Locate braced bays as indicated on Drawings.

C. Set column base plates with non-shrink grout to achieve full plate bearing.

D. Do not field cut or alter structural members without approval of Architect/Engineer.

E. After erection, prime welds, abrasions, and surfaces not shop primed.

3.03 ERECTION - WALL AND ROOFING SYSTEMS

A. Exercise care when cutting prefinished material to ensure cuttings do not remain on finish surface.

B. Fasten cladding system to structural supports, aligned level and plumb.

C. Locate panel end laps over supports. End laps minimum 2 inches. Place side laps over bearing.

D. Locate insulated wall panel end joints, with closure pieces designed for use, over continuous supports that conform to the metal building manufacturer's requirements. Place panel side joints over bearing.

E. Install expansion joints where indicated on Drawings.

F. Install sealant and gaskets to prevent weather penetration.

3.04 ERECTION - GUTTER AND DOWNSPOUTS

A. Rigidly support and secure components. Joint lengths with formed seams sealed watertight. Flash and seal gutters to downspouts.

B. Apply bituminous paint on surfaces in contact with dissimilar materials.

C. Slope gutters minimum 1/4 inch/ft.

D. Connect downspouts as indicated on Drawings.

3.05 ERECTION - ACCESSORIES

A. Install door frame, door, overhead door, window and glass, and louvers.

B. Seal wall and roof accessories watertight and weather tight with sealant in accordance with Section 07 92 00.

3.06 ERECTION TOLERANCES

A. Section 01 40 00, Quality Requirements (to be completed): Tolerances.

B. Framing Members: 1/4 inch from level; 1/8 inch from plumb.

C. Siding and Roofing: 1/8 inch from indicated position.

END OF SECTION

PG&E

TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

PRE-FINAL (90%)
TECHNICAL SPECIFICATION

VOLUME 2

for the construction of the

TOPOCK GROUNDWATER REMEDIATION PROJECT

****

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CH2M HILL

Oakland, CA

September 8, 2014

Project No. 435062 Copy No. _____

TABLE OF CONTENTS

VOLUME 1

DIVISION 23—HEATING, VENTILATING, AND AIR-CONDITIONING

DIVISIONS 24 THROUGH 25—NOT USED

DIVISION 26—ELECTRICAL

DIVISIONS 27 THROUGH 30—NOT USED

VOLUME 3

Submersible Well Pump PMP-*541, *542 Data Sheet
Submersible Well Pump PMP-*544, *545, *543 Data Sheet
Submersible Well Pump PMP-*546, *547, *548, *549 Data Sheet
Submersible Well Pump PMP-*641A, *641B Data Sheet
Submersible Well Pump PMP-441 Data Sheet
Submersible Well Pump PMP-*540 Data Sheet
Submersible Well Pump PMP-*640 Data Sheet

44 42 56.09 Non-Clog Dry-Pit Centrifugal Pumps
Supplements:
Influent Tank Farm, Decon Pad, Remedy Produced Water Conditioning Plant Sump Pumps Submersible Centrifugal Pump Data Sheet
Conditioning Water Tank Farm Sump Pump Submersible Centrifugal Pump Data Sheet

44 42 56.10 Horizontal End Suction Centrifugal Pumps
Supplements:
Influent Storage Tank Recirculation Pump #1, 2, 3, 4 Pump Data Sheet
Filter Feed Pump 1 – A Side, Filter Feed Pump 2 – A Side Data Sheet
Filter Feed Pump 1 – B Side, Filter Feed Pump 2 – B Side Data Sheet
Conditioned Water Transfer Pump 1 & 2 Data Sheet
Truck Loading Pump Data Sheet
Electric Motor Data Sheet

44 42 56.15 Air Operated Diaphragm Pumps
Supplement:
Solids Pump Air-Operated Diaphragm Pump Data Sheet

44 43 13.16 Cartridge Filters

44 44 13.01 Chemical Metering Pumps
Supplement:
Caustic Feed Pump 1 and 2 Data Sheet
Coagulant Feed Pump 1 and 2 Data Sheet
Acid Feed Pump 1 and 2 Data Sheet
Carbon Substrate Pumps, Well Maintenance Reagent Pumps Data Sheet

DIVISIONS 45 THROUGH 49—NOT USED

VOLUME 4

DRAWINGS

END OF SECTION

SECTION 21 13 00
FIRE SPRINKLER SYSTEM

SECTION 1 GENERAL

1.01 SUMMARY

A. Section includes the requirements necessary to provide, install, and test complete automatic sprinkler system.

B. Related Sections:

1. Section 09 90 00, Painting and Coating.
2. Section 10 44 00, Fire Protection Specialties.

1.02 REFERENCES

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

1. National Fire Protection Association (NFPA):
   a. 13, Standard for the Installation of Sprinkler Systems.
   b. 14, Standard for the Installation of Standpipe and Hose Systems.
2. Factory Mutual (FM).
3. Underwriters Laboratories Inc. (UL).

1.03 DEFINITIONS

A. Abbreviations and Acronyms:

1. AHJ: Authority having jurisdiction.
2. EPDM: Ethylene propylene diene monomer.
3. ERW: Electric resistance welded.
4. FM: Factory Mutual.
5. FRP: Fiberglass-reinforced plastic.
6. gpm: Gallons per minute.
7. HVAC: Heating, Ventilating, and Air Conditioning.
8. Hz: Hertz.
9. IBC: International Building Code.
10. IFC: International Fire Code.
11. IPS: Iron pipe size.
12. NFPA: National Fire Protection Association.
13. psi: Pounds per square inch.
14. psig: Pounds per square inch, gauge.

15. UL: Underwriters Laboratories Inc.
16. V dc: Volts direct current.
17. VLF: Vertical laminar flow.
18. VOC: Volatile organic compound.

1.04 SYSTEM DESCRIPTION

A. A designed and installed hydraulically calculated automatic sprinkler system.

1.05 SUBMITTALS

A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

1.06 QUALITY ASSURANCE

A. Comply with the latest edition of the following:

1. NFPA 13.
2. NFPA 14.
3. California Building Code (CBC).
4. California Fire Code (CFC).

B. Materials and Equipment: UL-listed and FM-approved for fire protection service.

C. Work Experience: At least 3 years' experience on similar buildings; submit a list of projects and Owner's contact person for each Project.

D. Licenses: By the authority having jurisdiction (AHJ).

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

A. Material and Installation Requirements: Comply with these specifications, including applicable codes and standards.

B. Design the hydraulically calculated sprinkler systems (zones) per the following:

1. Calculate system pressure demand at not more than 90 percent of the available pressure at the demand flow based upon water supply information provided by CH2M HILL.
2. Minimum design density and area as shown on Drawings.
3. Hydraulically most-demanding rectangular area with a dimension parallel to the branch lines at least 1.4 times the square root of the area.

4. Combined hose stream allowance appropriate to the hazard being protected and the following:
    a. Outside Hose Stream: Flowing at a public or private fire hydrant nearest the base of the system riser.
    b. Inside Hose Stream: Flowing at the base of the system riser.

2.02 SUPERVISORY SWITCH

A. Design:

1. Operate between the first and second revolution of the valve control wheel or operate if housing cover is removed.
2. Electrical Rating: 0.25 amp, 24V dc.

2.03 WATERFLOW SWITCH

A. Electrical Rating: 0.25 amp, 24V dc.

B. Retard Element: Pneumatic with an adjustable range of 0 seconds to 70 seconds.

C. Signal Contacts: Provide with two contacts suitable for providing a signal to the local and remote fire alarm system.

2.04 FIRE ALARM BELL

A. Description: 10-inch electric bell, surface mounted.

B. Housing and Base: Aluminum with red, baked-enamel finish.

C. Electrical Rating: 120V, single-phase, 60 Hertz (Hz).

D. NEMA 1 for indoor and NEMA 3R for outdoor installation.

2.05 DOUBLE-INTERLOCKED PREACTION SYSTEMS

A. Acceptable Manufacturer:

1. Viking: TotalPac Integrated Double Interlocked Preaction System with Electric/Pneumatic Release.
2. Victaulic: Series 745 FireLock Fire-Pac Double Interlocked Preaction System with Electric/Pneumatic Release.

B. Description:

1. System: Preassembled, prewired, and tested.

2. Cabinet: 14 gauge steel cabinet, rust proof coating inside and outside, fire red, oven-baked polyester powder.
3. Valve: Ductile iron valve complete with trim, including actuation and supervisory devices, air pressure maintenance device kit and air compressor.

2.06 SPRINKLERS

A. Acceptable Manufacturers: From approved list of manufacturers of UL-listed and FM-approved products for fire sprinkler systems.

B. General Description:

1. Orifice Diameter: 1/2 inch minimum.
2. Temperature Rating:
   a. 165 degrees F.
   b. 212 degrees F in mechanical and electrical rooms and elevator shafts.
   c. As required otherwise by NFPA 13.
   d. Use current adopted edition.
3. Type: Quartzoid bulb, chrome-plated, pendent or upright, bronze in exposed areas.
4. Guards: Listed type where subject to mechanical damage or below 7-foot height above floor.

C. Other Finished Ceiling Areas – Type: Recessed pendant, chrome finish, quartzoid bulb with chrome-plated canopy.

2.07 CONTROL, TEST, AND DRAIN VALVES

A. Acceptable Manufacturers:

1. Viking.
2. Grinnell.
3. Victaulic.

B. Floor Control, Zone Control, and Auxiliary Control Valves: Indicating-type gate valves.

C. Test and Drain Valves: Ball or gate valves.

D. Auxiliary Drain Valve: Ball or gate valves with hose-end coupling and cap.

2.08 SYSTEM PIPING

A. Use new materials that comply with the requirements of NFPA 13, including the following:

1. Ratings: 175 pounds per square inch, gauge (psig) at minus 20 degrees F to 150 degrees F per ASTM A135 and NFPA 13.
2. Piping:
   a. 1-1/2 Inches and Smaller: ASTM A135, electric resistance welded (ERW), Schedule 40, black for wet pipe and galvanized for dry pipe, threaded.
   b. 2 Inches Through 4 Inches: ASTM A135, ERW, Schedule 40, black for wet pipe and galvanized for dry pipe, grooved.
   c. 5 Inches and Larger: ASTM A135, ERW, Schedule 10, black for wet pipe, galvanized for dry pipe, grooved end.
3. Plain-end Pipe Fittings and Couplings: Prohibited, including setscrew couplings.
4. Bushings and Grooved Reducing Couplings: Prohibited.
5. Uniflanges: Prohibited.
6. Mechanical Tees: Prohibited.
7. Stainless Steel Flexible Connectors: Complete assemblies with factory-installed sprinklers.

2.09 PIPE HANGERS AND SUPPORTS

A. General: Use hanger types and arrangements complying with the requirements of NFPA 13 and as shown on Drawings.

B. Attachments: Do not use powder-driven studs.

C. Additional Hangers: Provide hangers that meet the requirements of NFPA 13, AHJ, and the written approval of CH2M HILL.

D. Threaded Rod:

1. Clean Areas: Cadmium-plated.
2. Other Areas: Zinc-plated.

2.10 HYDRAULIC DATA SIGNAGE

A. Nameplate: Permanently attach sign to zone risers, indicating the information required by NFPA 13 at each zone control valve. Add the additional information.

1. Number of sprinklers.

2. Date of installation.

B. Description: Metal or plastic with stamped or engraved lettering of contrasting colors. Do not use paper, embossed plastic tape, ink, or other erasable or semipermanent media.

C. Zone Map: Plastic-laminated map indicating location of sprinkler zones within the building and the location of zone riser, attached in close proximity to control valve.

2.11 EXTRA STOCK

A. Furnish and install spare sprinkler cabinet(s) and sprinklers in accordance with NFPA 13.

PART 3 EXECUTION

3.01 INSTALLATION

A. Location: Install equipment, controls, piping, valves, and drains subject to CH2M HILL's approval.

B. Coordination: Coordinate sprinkler locations with the architectural reflected ceiling plans and as follows:

1. Locate heads in center of ceiling tiles or centered in the short dimension and 1-foot from the end with rectilinear arrangement throughout when the head locations are not shown on Drawings.
2. Locations shown on reflected ceiling plans are aesthetically critical; do not relocate without prior approval.
3. Coordinate locations with other trades and make revisions within the specified design criteria at no additional Owner cost.

C. Install supervisory switch on each fire system control valve.

D. Install flow detector switch in a straight section of pipe a minimum of 24 inches from a fitting that changes the direction of water flow.

E. Install fire alarm bell on the exterior of the building at the location of the ground floor riser rooms or as shown on Drawings.

F. Piping Joint Compound:

1. Apply joint compound in accordance with manufacturer's recommendation.

2. Remove excess joint compound from the exterior of pipe and fittings prior to installation.

G. Escutcheon Plates: Provide chrome-plated metal escutcheon plates on exposed piping which passes through:

1. Exterior walls.
2. Interior walls.
3. Ceilings.
4. Floors in finished areas.

H. Wall and Floor Penetrations:

1. Install pipe sleeves and provide core drilling in walls and floors where pipe penetrations are required.
2. Seal penetrations as specified in Section 07 84 00 Firestopping, and Section 07 92 00, Joint Sealants, and as shown on Drawings.

I. Access:

1. Install piping in a manner that does not block portion of window, doorway, stairway, and egress passageway.
2. Provide adequate access for proper operation and code-required clearances of equipment.
3. Seal sleeves in fire- and smoke-rated barriers to maintain the fire or smoke rating using approved materials and methods.

J. Vibration Isolation:

1. Support piping independently from the structure in areas requiring vibration isolation.
2. Do not suspend from other equipment or from hangers or supports for other equipment nor in area where vibration isolation is required.
3. Do not install piping and hangers with equipment, piping, conduit, or ductwork requiring vibration isolation.
4. Do not install pipe hangers and sway bracing rigidly connected to duct walls or to non-masonry walls.
5. Install piping which crosses vibration isolation breaks or structural isolation breaks using flexible couplings and vibration isolation hangers of the correct weight rating.

K. Fireproofing:

1. Install piping to allow full thickness of required fireproofing of structural components.
2. Install hangers fastened to structural members requiring fireproofing prior to application of fireproofing.
3. Replace fireproofing to original condition if fireproofing be removed.

L. Flexibility:

1. Install flexible couplings and sway bracing as required by NFPA 13.
2. Allow for flexibility, internal pressure, and differential movement between the piping and building, earth, or other supporting structure(s) so that allowable stress will not be exceeded in any member.
3. Install flexible coupling within 6 inches of branch piping in vertical drops greater than 4 feet in length.

M. Test and Drain Valves:

1. Access: Avoid installations above ceilings or behind walls, or obtain CH2M HILL's approval and install per the following:
   a. Accessible Ceilings: Install label on ceiling access location, identifying test, or drain valve location.
   b. Nonaccessible Ceiling or Wall: Install access panel and label on panel, identifying test, or drain valve location. Finish access panel to match ceiling or wall color per Section 09 90 05, Architectural Painting.
   c. Coordination: Provide information on number, locations, and required sizes of access panels and coordinate location with other trades.
2. Drain Location Required: Install in trapped portion of system that is over 5 gallons and cannot drain by gravity to the main drain valve for that system.
3. Auxiliary Drain Connections: Provide hose connection and cap at valve discharge for standard 3/4-inch hose.

N. Signage:

1. Provide identification signs on control valves and maps near risers indicating the portion of the total system controlled by the respective valve.
2. Install signs, valve tags, and piping identification labels as required by NFPA 13.

O. Do not weld or flame cut sprinkler pipe or components of the fire sprinkler system on the jobsite.

3.02 FIELD QUALITY CONTROL

A. Acceptance Test: As required by NFPA 13 and by AHJ. Notify Owner and AHJ 48 hours in advance of scheduled test allowing Owner to arrange a mutually agreeable time to perform tests. Provide written proof of acceptance by the inspecting authority.

B. Arrange and pay for inspections and tests of the fire sprinkler installation required by this Specification, codes and standards, and AHJ.

C. Obtain and pay for permits for the portion of the fire sprinkler systems covered by the work.

D. Final approval and acceptance of systems will be given by Owner when:

1. The completed wet pipe sprinkler system has been inspected, tested, and approved by Owner's insurance underwriters, AHJ, and Owner.
2. Required submittals, system operation and maintenance manuals, record drawings with final calculations, spare parts, and training have been provided to, reviewed, and accepted by Owner.

3.03 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
21 13 00-01	List of similar installations and Owner contact name.	X	
21 13 00-02	Include the following minimum service requirement of 1 man-day (excluding travel) for training of Owner's personnel for startup, operating and maintenance.	X	
21 13 00-03	Include the following minimum service requirement of 1 man-day (excluding travel) for testing and certification of the installation.	X	With record documents
21 13 00-04	Include the following minimum service requirement of 0 man-day (excluding travel) for emergency repair service: Within 4 hours of request, 24 hours per day, 7 days per week, throughout the warranty period.		

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
21 13 00-05	Detailed installation shop drawings of the complete automatic fire sprinkler system created with the 2008 release of AutoCAD. Show information required by NFPA 13 for working plans including Submittal Schedule items 21 13 00-06 through 21 13 00-14.		Per construction schedule
21 13 00-06	Descriptions of piping, valves, and drains.		With record documents With operations and maintenance manuals
21 13 00-07	Equipment locations and elevations.		Per construction schedule With record documents
21 13 00-08	Sway Bracing: Locations, and details, including minimum and maximum brace angle and method of attachment based on assigned loads given in NFPA 13.		Per construction schedule With record documents
21 13 00-09	Location of flexible couplings installed as vibration control or flexure joints.		
21 13 00-10	Location and diameter of core drills and pipe sleeves in walls and floors.		
21 13 00-11	Underground piping back to point of connection at the main.		With record documents
21 13 00-12	Existing drawings for remodel work showing supply from source to remodeled area.	NA	
21 13 00-13	Perimeter and square footage of most remote design area.		
21 13 00-14	Complete and accurate legend with type, finish, and temperature of sprinklers indicated.		With record documents

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
21 13 00-15	Fabrication shop drawings that show installation dimensions and cut lengths for piping. Coordinate and make minor revisions at no additional cost and verify that hydraulic calculations remain within the criteria.		With record documents
21 13 00-16	Reflected ceiling plans showing locations of sprinklers, lights, diffusers, grilles, etc.		With record documents
21 13 00-17	Product data showing the type and model of equipment or material to be installed, including, but not limited to: Pipe, hangers, valves, control valves, pipe fittings, sprinklers, alarm devices, supervisory devices, bracing, hardware, sleeves, escutcheons, coupling lubricant, thread dope, Teflon tape, and fire-rated sealant.		Prior to delivery
21 13 00-18	Shop drawings approved by the state or local fire marshal and the Owner's insurance underwriters. Obtain required approvals prior to the start of installation.		With record documents
21 13 00-19	Samples of specified sprinklers upon request.		
21 13 00-20	Copies of permits, licenses, and approvals of shop drawings prior to fabrication of system.		Per construction schedule
21 13 00-21	Operation and maintenance manuals, final drawings, and final calculations.		With record documents

END OF SECTION

SECTION 21 24 00
DRY-CHEMICAL FIRE-EXTINGUISHING SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
2. ASTM International (ASTM):
   a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   c. A197, Standard Specification for Cupola Malleable Iron.
3. National Electrical Manufacturer's Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. National Fire Protection Association (NFPA):
   a. 12A, Halon 1301 Fire Extinguishing Systems.
   b. 70, National Electrical Code.
   c. 72, National Fire Alarm Code.
   d. 75, Standard for the Protection of Electronic Computer/Data Processing Equipment.
   e. 2001, Standard on Clean Agent Fire Extinguishing Systems.

1.02 DEFINITIONS

A. Protected Area: The area of the building that the FM-200 system protects.

1.03 PERFORMANCE REQUIREMENTS

A. General: Design a clean agent fire extinguishing system to detect and suppress by total flooding, fires originating in the following protected areas:

1. MW-20 Bench Building.
2. TW Bench Building.

B. Fire Detection System:

1. Engineered type cross-zoned fire detection suitable for interfacing with the FM-200 suppression system.

2. Concept shall provide an alarm mode on the activation of any one fire detector and a predischarge mode on the activation of any two cross-zoned fire detectors located in the protected area.
3. The system shall be electrically supervised against wiring derangement of all circuitry involved by the device in the sensing of the fire, and the response signal of alarm. The occurrence of a wiring derangement shall cause an audible and visual trouble indication to occur at the clean agent releasing panel and building fire alarm panel.

C. Fire Suppression System:

1. Clean agent for the fire suppression system shall be FM-200 (Heptafluoropropane).
2. System shall discharge the total calculated agent quantity into the protected space in a 10-second time period.
3. System shall provide sufficient FM-200 agent for a minimum concentration of 7 percent and maximum of 9 percent by volume at 70 degrees F in the protected area. Adjust calculations as required for:
   a. Multiple protected areas served by a common FM-200 supply.
   b. Suspended ceiling space volume (if required).
   c. Volume of ductwork for HVAC system.

1.04 DESIGN REQUIREMENTS

A. General:

1. System shall include both automatic and manual operation, with control panel, fire detectors, alarm devices, manual discharge stations, abort stations, purge panels, agent storage containers, piping, nozzles, wiring, conduit, and other auxiliary devices specified herein or required to provide a complete system.
2. The system shall have a standard standby battery supply in the central control panel to provide a minimum of 24 hours of emergency power in the absence of its normal (utility) supply power.
3. System shall conform to the requirements of applicable codes, standards, and authorities including, but not limited to:
   a. National Fire Code-NFPA Nos. 70, 72, 75, and 2001, including appendages.
   b. Requirements of city, county, or state authorities having jurisdiction.
   c. Requirements of Owner’s insurance underwriter, if applicable.
   d. Equipment shall be Underwriters Laboratories (UL) listed and/or Factory Mutual (FM) approved for fire protection.

4. Obtain all permits, arrange all inspections, and perform all systems tests required by the applicable codes and the authorities having jurisdiction.

B. Protected Area Segregation:

1. System shall be based on the protected area enclosure being of sufficient tightness to guard against extinguishing agent exfiltration including, but not limited to ductwork leading into or from the protected area, exit doors and windows, piping, and electrical conduit.
2. Area segregation shall require HVAC system supply and return serving the protected space to shut down, and the air duct system motorized dampers to close.

C. Hydraulic Calculations: Base on the unbalanced piping principle as defined in NFPA No. 2001, and include:

1. Agent quantity for each nozzle.
2. Nozzle type and size.
3. Nozzle pressure.
4. Number of agent storage cylinders, cylinder fill weight, and density.
5. Total FM-200 agent weight.
6. Pipe schedule including sizes, length, volume, and percent of agent in pipe after discharge.
7. Discharge time.
8. Pressure at beginning of pipe network.
9. Pressure at beginning and end of each pipe section.
10. Flow rate, density, and pressure drop per pipe section.

D. Pipe Supports: Design and fabrication shall conform to the requirements of ASME B31.1.

E. Discharge Nozzles:

1. Provide sufficient nozzles to assure a uniform agent concentration throughout protected area.
2. Space discharge nozzles as required by applicable codes and manufacturer’s criteria.
3. Consider additional nozzles based on area conditions and manufacturer’s recommendations.

F. Fire Detectors:

1. Ionization and photoelectric type smoke detectors.

2. Base spacing and installation on guidelines in NFPA 72 recommended practices for ceiling construction and airflow, and on manufacturer's recommendations.

G. Locate manual discharge and abort stations at all exit doors inside and outside the protected area.

H. Locate alarm devices within the protected area and above each exit door outside the protected area.

I. Control Panel:

1. Panel Locations:
   a. MW-20 Bench Building.
   b. TW Bench Building.
2. Locate to provide control, supervision, annunciation, and power for the operation of the fire suppression zone and detection circuits.
3. Provide rechargeable battery supply to automatically operate each protected area system including detectors, control panel, manual stations, alarm sounding devices, and auxiliary equipment in the event of a loss of primary power.
4. Provide a common general alarm circuit for common area signaling.
5. Provide form "C" SPDT dry contacts for general alarm and trouble.
6. Provide a single switch that will silence active signals without affecting subsequent signals.
7. Provide diagnostic indicators to indicate, at a minimum, ac power loss, dc power fault, auxiliary power loss, system common ground fault, and trouble in the common general alarm circuit.
8. Control Circuitry: Provide each protected area with the following supervised circuits:
   a. Detection: Utilizing cross-zoned or counting zone.
   b. Individually Fused and Silenceable Audible Circuits:
      1) Three required.
      2) Individual diagnostic fault indicators.
      3) Minimum of 24V dc, at 350 mA available power.
      4) Program to operate on alarm, predischarge, and discharge.
   c. Manual Release: Programmable with the following options:
      1) Override time delay and abort circuit. Discharge will be immediate.
      2) Override abort circuit but not the time delay. Discharge occurs at the end of the time delay.
      3) Not override time delay or abort circuits.

d. Time Delay:
   1) Field programmable in 1-second intervals from 0 to 60 seconds.
   2) Have the ability, through the abort circuit, of being recycled and held until the abort switch is released.
   3) Control panel-mounted digital countdown timer.
   4) Illuminated digital display when the system time delay is active and counting down.

e. Agent Release:
   1) Parallel wired initiators or solenoids, fully supervised.
   2) Wired in a Class A configuration such that a trouble signal will occur if there is a break in the wiring.
   3) System shall function properly if a fire condition occurs with this abnormal condition.

f. Abort:
   1) Dedicated and supervised.
   2) Actuation shall recycle the time delay to its original setting, and begin counting after the abort station (momentary) pushbutton is released.

g. Container Low-Pressure: Dedicated and supervised.

h. Diagnostic Fault Indicators: Detection, alarm audible, predischarge audible, discharge audible, manual release, and abort circuits; discharge circuit wiring; discharge device; relay connection; and low pressure.

i. Area ALARM/DISABLED Switch:
   1) Switch to disable the FM-200 discharge circuit.
   2) Switch shall not interfere with the detection or audible circuits.
   3) Operation of this switch shall cause a distinctive trouble indication for the area involved.

j. Protected Area Control Panel:
   1) Six DPDT and two SPDT auxiliary relays rated at 10 amps at 120V ac/3V dc resistive.
   2) Programmable relays for operation in alarm, predischarge, discharge, or trouble modes.
   3) Programming of relays without the need to relocate wiring.
   4) Means to individually operate relays without the need to put the control panel into alarm condition.
   5) Means to prevent each relay from operating in event of system testing.

k. Capability to transmit a trouble indication from each area.

J. Control System:

1. Actuation of a fire detector in the protected area shall initiate the following control functions:
   a. Light the corresponding suppression zone light on control panel.
   b. Activate alarm.
   c. Shut down HVAC equipment and close motorized air duct dampers serving protected area.
   d. Transmit a signal (close a normally-open alarm contact) to the building fire alarm system.
2. Actuation of a second fire detector in the protected area shall initiate the following control functions:
   a. Light the corresponding suppression zone light on control panel.
   b. Activate strobe/horn combination signaling predischarge of FM-200.
   c. Shut down control and electrical equipment in the protected area.
   d. Start preset agent discharge time delay (evacuation timer).
   e. Transmit a signal (close a normally-open alarm contact) to the building fire alarm system.
3. If predischarge is not aborted, and time delay expires, system shall discharge and strobe lights shall be activated outside the protected area.
4. Actuation of manual discharge stations shall immediately discharge FM-200 into the protected area and initiate the following control functions:
   a. Light suppression zone light on control panel.
   b. Activate visual and audible alarm devices.
   c. Transmit a signal (close a normally-open alarm contact) to the building fire alarm system.
5. The protected area shall be purged 15 minutes (soaking period) after the complete release of the FM-200 agent. It will be impossible to activate the purge panel until the 15 minute soaking time has transpired. Activation of the purge panel shall cause HVAC dampers to sequence and start associated FM-200 exhaust fan.
6. Trouble conditions caused by open fire detector, valve actuator circuit wiring, or loss of agent storage container pressure shall initiate the following control functions:
   a. Light the corresponding suppression zone light on control panel.
   b. Light system trouble light.
   c. Sound system trouble signal.
   d. Transmit a signal (close a normally-open trouble contact) to the building fire alarm system.

7. Trouble conditions caused by open bell wiring, open battery circuit wiring, silenced alarm sounding devices, or loss of primary power shall initiate the following control functions:
   a. Light system trouble light.
   b. Sound system trouble signal.
   c. Transmit a signal (close a normally-open trouble contact) to the building fire alarm system.

K. FM-200 Reserve Supply:

1. Provide a reserve supply of agent and storage containers equal to the main supply.
2. Include required piping, actuating devices, and miscellaneous components to provide a permanently connected reserve system.
3. Reserve containers may have a completely separate set of piping and nozzles, or be connected to the same piping as the main supply.
4. Provide a key operated selector switch to change from the main system to the reserve supply.
5. Provide isolation check valves in discharge piping to prevent loss of agent or injury to personnel in event of system actuation when an agent container is removed.
6. Transfer to Connected Reserve shall be by means of an electrical switch mounted near the control panel.

L. Provide electrical intertie between building fire alarm system, HVAC equipment, and protected area FM-200 control panel as specified in Division 26, Electrical.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Data sheets, catalog cuts, and technical information describing system components and devices to be installed.
   b. Calculations for standby battery power.
   c. Wiring diagrams including elementary, electrical termination, and interconnection diagrams.
   d. One-line conduit diagrams showing equipment locations, conduit locations, wire size, number of conductors, equipment mounting and other construction details.
   e. Isometric piping diagrams showing location of agent storage containers, pipe sizes, pipe lengths, and fittings. Key to required

piping and nozzle calculations, and cross reference all junctions with calculations.

f. Method of anchoring or hanging pipe lines.
g. Complete details on support of agent storage containers.
h. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
i. Point-to-point wiring diagrams showing all circuit connections.
j. Calculations for the battery stand-by power supply taking in to consideration the power requirements of all alarms, initiating devices, remote panels, and auxiliary components under full load conditions.

B. Informational Submittals:

1. Experience qualification listing of firm(s) proposed to design and install the system. The Contractor shall be a California-licensed Contractor in possession of a valid special hazards fire suppression and fire alarm systems Contractor's licenses
2. Design Calculations:
   a. Hydraulic flow from a UL listed computer program, including the manufacturer's name and UL listing for verification.
   b. Include individual pipe lengths and fittings to be used.
   c. Verify that the design concentration of FM-200 is reached within specified time.
3. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
4. Test Plan: Submit as specified in Article Field Quality Control, at least 30 days prior to beginning functional testing.
5. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing (to be completed).
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).
7. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).

1.06 QUALITY ASSURANCE

A. Qualifications: System design and installation shall be by licensed firm(s) having a minimum of 5 years of documented experience in the design, installation, and testing of similar types of suppression systems.

1.07 MAINTENANCE

A. Inspections During Warranty Period:

1. Provide two system inspections, at 6 months and at 12 months, during the 1-year Correction Period.
2. Conduct the inspections in accordance with the manufacturer's guidelines and in compliance with NFPA 2001.
3. Submit documentation to Owner upon completion of each inspection certifying satisfactory system operation.

PART 2 PRODUCTS

2.01 SYSTEM CONTROL PANEL

A. General: Panel shall contain required system operation lights, reset and silence switches, circuits, relays, a standby battery power and either an enclosed or adjacently-mounted battery charger, and all other devices necessary to provide a complete automatic control system.

B. Cabinet:

1. UL listed and FM approved as an alarm-releasing control unit.
2. NEMA 250, Type 1.
3. Surface-mounted, 18-gauge steel.
4. Door: Hinged, key lockable.
5. Finish: Manufacturer's standard color.

C. Standby Battery:

1. Minimum Capacity: 6 Ah.
2. Sized to operate the system for a minimum of 24 hours in supervisory condition and 5 minutes in alarm control condition immediately after the time in supervisory condition.
3. Sealed, gelled electrolyte type, designed for fire alarm service.
4. Supervised to provide a trouble signal on low voltage, open, or shorted cell.

D. Battery Charger:

1. Automatic, solid state, capable of charging batteries from 75 to 100 percent of full charge within 24 hours.
2. Voltmeter or other means to display battery condition.
3. Enclosure: Manufacturer's standard.

2.02 FIRE DETECTION BASE AND DEVICES

A. Base:

1. Interchangeable with photoelectric or thermal type detectors.
2. LED that illuminates steadily upon detector sensing a fire condition and with ability to power a remote annunciator that will duplicate LED indication.

B. Detection Devices, General:

1. Equip with a means of securing head to base in a manner that head may not be readily tampered with or removed.
2. UL listed and FM approved.

C. Ionization Type Device:

1. Dual chamber type, utilizing solid state circuitry.
2. Unaffected by RF energy from 1 kHz through 100 MHz or air velocities up to 3,000 fpm.

D. Photoelectric Type Device:

1. Solid state circuitry, pulsed infrared LED light source, and silicon photodiode receiving element.
2. Incorporate means to discriminate between valid fire signals and nonfire signal.
3. Include a fine stainless steel mesh cover to prevent foreign objects from entering sensing chamber.
4. Dew-proof and unaffected by air velocities up to 3,000 fpm.

2.03 MANUAL DISCHARGE STATION

A. Furnish to provide a means of manually discharging the fire suppression system in case of an emergency.

B. Stainless steel, with keyed red release button.

C. Cover shall include operating instructions and identify discharge station as a FM-200 discharge component.

D. Double-pole switch.

E. UL listed and FM approved.

2.04 DISCHARGE ABORT STATION

A. "Dead-man" type requiring constant pressure to transfer one set of normally open and one set of normally closed contacts on each contact block.

B. Digital countdown timer to indicate time remaining until system discharge.

C. Faceplate constructed of stainless steel, with abort button, operating instructions, and identification as a component of the FM-200 system.

D. Rated 6 amps at 120V ac and 1 amp at 120V dc, with ability to override shutdown of HVAC and control equipment.

E. UL listed and FM approved.

2.05 ALARM BELL

A. Vibrating type, approved for use with the control unit provided.

B. Polarized for full supervision, and rated at 24V dc, drawing no more than 0.063 amps.

C. Noise Level: 86 to 90 dB at 10 feet.

D. Finish: Baked red enamel.

E. UL listed and FM approved.

2.06 STROBE LIGHT

A. Rating: 24V dc with amperage draw of 0.033 amps.

B. Lamp protected by a white translucent lens imprinted with the word FM-200 in red letters.

C. Polarized, powered from the control panel.

D. UL listed and FM approved.

2.07 AGENT STORAGE CONTAINERS

A. High-strength alloy steel, equipped with the following:

1. Integral lifting ring.
2. Automatic, remotely operated discharge valve assembly.

3. 0 to 600 psi pressure gauge.
4. Electrically supervised valve actuator.
5. Filling valve to allow recharging in place.
6. Supervisory pressure switch to sense loss of agent from the container.
7. Liquid level indicating device, UL listed.

B. Container and Valve: Conform to DOT Specification 4BW500 or 4BA500.

C. Automatic Pressure Relief: On overpressure condition of 810 to 1,000 psi.

D. Superpressurized with dry nitrogen to 360 psig at 70 degrees F.

2.08 PIPING

A. In accordance with NFPA 2001 and Section 22 10 01, Plumbing Piping and Accessories:

1. Distribution Piping: Black or galvanized steel, ASTM A53, Grade A, or ASTM 106, Grade A, B, or C.
2. Fittings: Malleable iron, 300-pound class, ASTM A197.

2.09 ELECTRICAL

A. In accordance with Division 26, Electrical.

PART 3 EXECUTION

3.01 DETECTORS

A. Install ionization and photoelectric detectors such that spacing per detector does not exceed 250 square feet.

B. Do not install detectors closer than 3 feet from air supply diffusers and 1 foot from wall.

C. Conform to NFPA 72E, latest edition.

3.02 AGENT STORAGE CONTAINERS

A. Floor mount and securely support to wall with wall brackets.

B. Attach mounting brackets and piping to the structure in a manner capable of withstanding the thrust developed during discharge without displacement.

C. Connect the same size containers to a common manifold.

3.03 CONNECTED RESERVE

A. Provide complete connected reserve supply of FM-200 in agent containers, duplicating those in main supply.

3.04 PIPING

A. Install in accordance with Section 22 10 01, Plumbing Piping and Accessories.

B. Cap pipe ends immediately after installation. Maintain until nozzles are installed.

C. Provide escutcheon plates at all pipe penetrations through walls, floors, and ceilings.

D. Pipe Supports: Install in accordance with ASME B31.1.

3.05 ELECTRICAL

A. Install in accordance with Division 26, Electrical.

3.06 SIGNS

A. In addition to the following, provide as required to comply with NFPA 2001 and the recommendations of the FM-200 equipment manufacturer:

1. Caution:
   a. Provide on all entry doors to FM-200 protected areas.
   b. Wording: Alert personnel that room is protected by FM-200 and all doors must be kept closed in event of fire.
   c. Size: 10 inches by 14 inches by 1/16 inch, constructed of plastic, with black face and yellow letters.
2. Manual Discharge:
   a. Provide adjacent to each manual discharge station.
   b. Identify the manual discharge station as the place where FM-200 can be manually discharged.
   c. Size: 4 inches by 4 inches by 1/16 inch, constructed of plastic, with red face and white letters.
3. Flashing Light:
   a. Provide adjacent to each strobe horn and light.
   b. Explain the presence of the flashing lights.

c. Size: 7 inches by 4 inches by 1/16 inch, constructed of plastic, with red face and white letters.

3.07 FIELD FINISHING

A. As specified in Section 09 90 00, Painting and Coating.

B. Pipe Labeling:

1. Label with the legend FM-200 EXTINGUISHING AGENT in letters 1 inch high.
2. Maximum Intervals:
   a. Exposed Piping: 12 feet.
   b. Concealed Piping: 20 feet.

3.08 FIELD QUALITY CONTROL

A. General: System functional and performance testing shall be conducted by qualified, trained personnel in accordance with the manufacturer's recommended procedures and NFPA 2001.

B. Pneumatically test all clean agent piping in accordance with NFPA 2001, Chapter 7, Inspection, Testing, Maintenance and Training.

C. Enclosure Integrity Test:

1. All clean agent protected areas shall be examined and tested in accordance with NFPA 2001, Annex C "Enclosure Integrity Procedure," to locate and effectively seal any air leaks that could result in the failure of the enclosure to hold the specified extinguishing agent concentration for the specified holding period.
2. Air leakage rate shall be determined by the ASTM E779, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization. A complete report as described by the ASTM Standard shall be provided at the conclusion of the test.
3. If the enclosure pressurization testing indicates that openings exist, which would result in leakage of the extinguishing agent, Contractor shall be responsible for coordinating and adequately sealing all protected areas to prevent leakage of the agent. If enclosure pressurization test fails, conduct additional tests, at no additional cost to the Owner, until a successful test is obtained.

D. Test Plan:

1. Prepare a plan of testing to include a step-by-step description of all tests to be performed and the type and location of test apparatus to be employed.
2. Testing shall not be conducted until the Test Plan has been approved.

E. Functional Tests:

1. Perform under supervision of equipment manufacturer and with the Engineer present.
2. All functional testing, including system and equipment interlocks, must be successfully completed at least 5 days prior to beginning performance testing.
3. Check all containers and distribution piping for proper mounting and installation.
4. Test all electrical wiring for proper connection, continuity, and resistance to ground.
5. Verify that HVAC connections to the area have properly installed dampers, and HVAC equipment will shut down upon a signal from the FM-200 control panel.
6. Test each detector in accordance with the manufacturer's recommended procedures, and record test values.
7. Demonstrate that all system and equipment interlocks, such as door release devices, audible and visual devices, equipment shutdowns, and local and remote alarms function as designed.
8. Test each control panel circuit by inducing a trouble condition into the system.

F. Performance Test:

1. Perform under actual or approved simulated operating conditions to demonstrate that the entire control system functions as designed and intended.
2. Perform under supervision of equipment manufacturer.
3. Demonstrate to the Engineer and authorities having jurisdiction, operation of all components under simulated fire conditions.
4. Test in accordance with NFPA 2001.
5. Conduct using the Retro-Tec Corp. door fan system, or equivalent, with integrated computer program.

6. Room Pressurization:
   a. Conduct test, at room pressurization in each protected space, to determine the presence of openings that would affect the system concentration levels.
   b. Seal all protected spaces against agent loss or leakage.
   c. Conduct pressurization tests until protected space is shown to be successfully sealed.
7. Test the following circuits:
   a. Automatic actuation.
   b. A.R.M.
   c. Manual actuation.
   d. HVAC and power shutdowns.
   e. Audible and visual alarm devices.
   f. Manual override of abort functions and agent container pressure supervision.
   g. Supervision of all panel circuits, including ac power and battery power supplies.
8. Upon acceptance by Owner, recharge system if required, and place the completed system into normal service.

3.09 MANUFACTURER'S SERVICES

A. Provide qualified manufacturer's representative(s) for the equipment specified herein at the Job Site and classroom designated by the Owner for the following services:

1. Installation assistance, inspection, and certification of installation.
2. Functional and performance testing assistance.
3. Classroom or Job Site training of Owner's operations and maintenance personnel.

END OF SECTION

SECTION 22 10 01
PLUMBING PIPING AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

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

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

hh. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
ii. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
jj. D2000, Standard Classification System for Rubber Products in Automotive Applications.
kk. D2239, Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
ll. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
mm. D2513, Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
nn. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
oo. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
pp. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
qq. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
rr. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ss. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
tt. E438, Standard Specification for Glasses in Laboratory Apparatus.
uu. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
vv. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
ww. F1412, Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.
xx. F1924, Standard Specification for Plastic Mechanical Fittings for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing.
yy. F1973, Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide

11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems.

6. American Water Works Association (AWWA):
   a. C104/A21.4, Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
   c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   e. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.
   f. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines, Enamel and Tape, Hot-Applied.
   g. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
   h. C606, Grooved and Shouldered Joints.
   i. C651, Disinfecting Water Mains.
7. Cast Iron Soil Pipe Institute (CISPI):
   a. 301, Standard Specification for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   b. 310, Specification for Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Strom Drain, Waste, and Vent Piping Applications.
8. Plumbing and Drainage Institute (PDI): WH 201, Water Hammer Arresters Standard.

1.02 DESIGN REQUIREMENTS

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

1. Sanitary Building Drainage and Vent Systems Local plumbing code.

1.03 SUBMITTALS

A. Action Submittals:

1. Product data sheets.
2. Shop Drawings:
   a. Show Contractor recommended changes in location of fixtures or equipment.

b. Seismic anchorage and bracing drawings and data sheets, as required.

3. Isometric riser diagrams.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required.
2. Changes in location of equipment or piping that affect connecting or adjacent work, before proceeding with the work.
3. Complete list of products proposed for installation.
4. Test records produced during testing.

PART 2 PRODUCTS

2.01 PIPING

A. Piping Schedule: Refer to Article Supplements.

B. Piping Material: Refer to Piping Data Sheet(s), Article Supplements.

2.02 PIPE HANGERS AND SUPPORTS

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

2.03 INSULATION

A. As specified in Section 23 07 00, HVAC Insulation.

2.04 VALVES

A. General:

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

B. Design Features:

1. Brass and bronze components, including appurtenances in contact with water.

2. Alloys containing less than 16 percent zinc and 2 percent aluminum.
3. Alloys are of the following ASTM designations:
   a. B61, B62, B98/B98M (Alloy A, B, or D), B139 (Alloy A), B164, B194, and B127.
   b. Stainless steel Alloy 18-8 may be substituted for bronze as an option with approval of Engineer.
4. Gland Bolts on Iron Body Valves: Bronze, fitted with brass nuts.

C. Valve Operators:

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

D. Gate Valves:

1. 3 Inches and Smaller for Water and Air Services:
   a. All-bronze with screwed bonnet, single solid wedge gate with non-rising stem, and hand wheel operator.
   b. Rated 125-pound SWP, 200-pound WOG.
   c. Manufacturers and Products for Threaded Ends:
      1) Crane; No. 438.
      2) Nibco; Model No. T-113.
   d. Manufacturers and Products for Soldered Ends:
      1) Crane; No. 1701S.
      2) Nibco; Model No. S-113.
2. 4 Inches and Larger for Water and Air Services:
   a. Iron body, bronze mounted, with flanged ends, solid wedge gate with non-rising stem, and hand wheel operator.
   b. Rated 125-pound SWP, 200-pound WOG.
   c. Manufacturers and Products:
      1) Crane; No. 461.
      2) Nibco; Model No. F-619.

E. Ball Valves:

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

F. Globe Valves:

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

G. Angle Valves 3 Inches and Smaller:

1. Bronze body, threaded ends, union bonnet, and rising stem.
   a. Rated 150-pound SWP and 300-pound WOG.

b. Manufacturers and Products for Threaded End:
   1) Crane; No. 17TF.
   2) Nibco; No. T-335-Y.

H. Check Valves 3 Inches and Smaller:

1. Bronze body, wye pattern, threaded ends and cap, regrinding seat, and swing type disc.
2. Rated 125-pound SWP, 200-pound WOG.
3. Manufacturers and Products:
   a. Crane; No. 37.
   b. Walworth Co.; Figure 406.

I. Backwater Check Valve 2 Inches to 8 Inches:

1. Coated cast iron backwater check valve, integral offset type swing-check assembly, and gasketed bolted access cover.
2. Manufacturers and Products:
   a. J. R. Smith; Figure 7012.
   b. Josam; Series 67500.
   c. Zurn; Model Z-1095.

J. Balancing Valves (Recirculating Hot Water):

1. Bronze, calibrated balancing type with provisions for connecting a portable differential pressure meter. Meter connections shall have built-in check valves.
2. An integral pointer shall register degree of valve opening.
3. Construct with internal seals to prevent leakage around rotating element.
4. Rated for 125 psig working pressure at maximum temperature of 250 degrees F.
5. Furnish one pressure gauge type readout meter in carrying case.
6. Furnish with preformed polyurethane insulation valve enclosure, suitable for use on hot water systems.
7. Manufacturers and Products:
   a. Bell & Gossett; No. CB circuit setter.
   b. TACO; Series 790.

K. Water Pressure Reducing Valves 1/2 Inch through 2-1/2 Inches:

1. Spring controlled, with a neoprene diaphragm.

2. Sizes and Ratings:
   a. PRV-1: 1-inch IPS, maximum 100 gpm, with inlet pressure 170 psig; outlet pressure 60 psig.
3. Manufacturers and Products:
   a. Fisher; Type 75.
   b. Watts; No. 223.

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

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

M. Manual Air Vent Valves:

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

2.05 MISCELLANEOUS PIPING SPECIALTIES

A. Strainers for Water Service:

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

B. Flexible Connectors for Stainless Steel Gas Lines:

1. Corrugated, Type 316 stainless steel hose, with 10-inch live length and Type 316 stainless steel male NPT pipe connectors at each end.
2. Manufacturers:
   a. Flexonics Braided Rex-Weld.
   b. Kin-Line.

C. Vacuum Breakers 2 Inches and Smaller:

1. Angle type, as required.

2. Manufacturers:
   a. Febco.
   b. Watts.

D. Water Hammer Arresters:

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

E. Sleeves:

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

F. Flashing Sleeves for Roof Penetrations: Refer to Architectural specifications.

G. Insulating Dielectric Unions and Flanges:

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

H. Joint Solder: 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.

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

J. Rubber Gaskets: ASTM C564.

2.06 MEASURING DEVICES

A. Thermometers:

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

B. Pressure Gauges:

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

PART 3 EXECUTION

3.01 GENERAL

A. Install plumbing systems to meet applicable plumbing code.

B. Field Obstructions:

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

C. Sleeves:

1. Pipe sizes shown are nominal sizes, unless shown or specified otherwise.
2. Provide piping passing through walls, floors, or ceilings with standard-weight pipe sleeves.
3. Provide pipes passing through finished walls with chrome-plated canopy flanges.
4. Dry pack sleeves in existing work in-place and provide finished appearance.

5. Pack holes left by removal of existing piping with grout and finish to match adjacent surface.

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

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

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

3.02 INSTALLATION

A. Steel Pipe:

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

B. Copper Tubing:

1. Cut tubing square and remove burrs.
2. Clean both inside of fittings and outside of tubing with steel wool and hydrochloric acid before soldering.
3. Prevent annealing of fittings and hard-drawn tubing when making connections.
4. Do not use mitered joints for elbows or notching of straight runs of pipe for tees.

C. Rigid PVC or CPVC:

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

7. Use strap wrenches only for tightening threaded plastic joints. Do not over tighten fittings.

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

E. Water Hammer Arresters:

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

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

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

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

3.03 SANITARY AND WASTE DRAINS AND VENTS PIPING

A. Installation:

1. Set piping above floor slab true and plumb.
2. Set exposed risers as close to walls as possible.
3. Where vent stacks pass through roof slab, fit with flashing sleeve secured to roof.
4. Extend vents minimum 1 foot above roof.
5. Provide cleanouts where shown and where required by code.

3.04 ACID-RESISTANT DRAINS AND VENTS

A. Install in accordance with manufacturer's recommendations.

B. Drainage Vents: Same piping system as used for acid-resistant drains.

C. Make connections between polypropylene piping systems and other acid-resistant drainage systems with adapters recommended by manufacturer.

D. Buried Polypropylene Pipe:

1. Heat join and test for leakage before placing in trench.
2. Snake slightly on long runs placed in trench.
3. When installed in extremely hot or cold weather, make proper allowance for expansion or contraction.

E. Buried Acid-Resistant Cast Iron Pipe With Teflon-Lined Couplings:

1. Install in accordance with manufacturer's instructions.
2. Do not allow acid waste to contact pipe and Teflon until installation is complete and tested.

F. Buried Polypropylene Drain and Vent Pipe:

1. Install in accordance with manufacturer's recommendations.
2. Trench shall have a clean sand bed graded to proper pitch.
3. Completely cover pipe with clean sand prior to backfilling.
4. Compact sand by flooding with water.
5. Do not permit sharp stones in backfill surrounding pipe.

3.05 HVAC CONDENSATE PIPING

A. Set piping true and plumb.

B. Slope piping 1/8 inch per foot minimum.

3.06 WATER SUPPLY PIPING

A. Water supply piping includes potable W1 systems.

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

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

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

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

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

3.07 INSULATION

A. As specified in Section 23 07 00, HVAC Insulation.

3.08 HANGERS AND SUPPORTS

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

B. Hanger Rod Sizing and Spacing for:

1. Steel Pipe:

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

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

C. Attach Support Rods For Horizontal Piping:

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

D. Trapeze Hangers:

1. Trapeze hangers may be used in lieu of individual hangers where horizontal piping is arranged with two or more parallel lines.
2. Attach lines to horizontal with U-bolts or one-hole clamps.

E. Vertical Piping:

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

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

3.09 INTERIM CLEANING

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

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

C. Shop cleaning may employ conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter physical properties of material being cleaned.

3.10 TESTING

A. General:

1. Conduct pressure and leakage tests on newly installed pipelines.
2. Provide necessary equipment and material, and make taps in pipe, as required.
3. Engineer or Owner’s Representative will monitor tests. Provide 24-hour advance notice of start of testing.
4. Test Pressures: As specified herein and in Piping Schedule.

5. Test Records: Make records of each piping system installation during test to document the following:
   a. Date of test.
   b. Description and identification of piping tested.
   c. Test fluid.
   d. Test pressure.
   e. Remarks, including:
      1) Leaks (type, location).
      2) Repairs made on leaks.
   f. Certification by Contractor and signed acknowledgment by Engineer that tests have been satisfactorily completed.

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

C. Preparation and Execution:

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

D. Hydrostatic Leak Tests:

1. Equipment: Provide the following:

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

2. Procedure:
   a. Use water as the hydrostatic test fluid.

b. Provide clean test water of such quality as to minimize corrosion of the materials in the piping system.
c. Open vents at high points of the piping system to purge air pockets while the piping system is filling.
d. Venting during filling of system may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.
e. Test piping systems at test pressure specified in Piping Schedule.
f. Maintain hydrostatic test pressure continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage.
g. Examine joints and connections for leakage.
h. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.
i. Correct visible leakage and retest to satisfaction of Engineer.

3. Gravity Sewers and Drains:
   a. Test by water or air exfiltration tests as prescribed by local or state plumbing codes and visually examine for leaks.
   b. Repair leaks and retest system until no further leakage is evident.

E. Pneumatic Leak Tests:

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

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

3. Procedure:
   a. Perform pneumatic testing using accurately calibrated instruments and oil-free, dry air.
   b. Perform tests only on exposed piping, after piping has been completely installed, including supports, hangers and anchors, and inspected for proper installation.
   c. Test piping system at test pressure specified in Piping Schedule.

d. Take necessary precautions to protect test personnel and Owner's operating personnel from hazards associated with air testing.
e. Secure piping to be tested to prevent damage to adjacent piping and equipment in event of a joint failure.
f. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by test.
g. Apply maximum 25 psig preliminary pneumatic test to piping system prior to final leak testing, to locate major leaks.
h. Examine joints and connections for leakage with soap bubbles.
i. Correct visible leaks and retest to satisfaction of Engineer.
j. Gradually increase pressure in system to not more than one-half of test pressure.
k. Thereafter increase pressure in steps of approximately 1/10 of maximum test pressure until required test pressure is reached.
l. Maintain pneumatic test pressure continuously for minimum 10 minutes and for such additional time as necessary to conduct a soap bubble examination for leakage.
m. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage.
n. Correct visible leakage retest to satisfaction of Engineer.
o. Following pneumatic testing, thoroughly purge lines that are to carry flammable gases with nitrogen to assure no explosive mixtures will be present in system during filling process.

3.11 CLEANING AND DISINFECTION

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

B. Minimum Flushing Velocity: 5 feet per second.

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

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

E. Immediately following drainage of flushed lines, dry piping with compressed air.

F. Plant process air and instrument air piping shall be blown clean of loose debris with compressed air.

G. Disinfect pipelines intended to carry potable water before placing in service:

1. Meet the requirements of AWWA C651, unless otherwise specified.
2. Disinfecting Mixture:
   a. A chlorine-water solution having a free chlorine residual of 40 ppm to 50 ppm.
   b. Prepare by injecting one of the following:
      1) Liquid chlorine gas-water mixture.
      2) Dry chlorine gas.
      3) Calcium or sodium hypochlorite and water mixture.
   c. Inject mixture into pipeline at a measured rate while freshwater is allowed to flow through the pipeline at a measured rate so the combined mixture of freshwater and chlorine solution or gas is of the specified strength.
   d. Apply liquid chlorine gas-water mixture by means of a chlorinating device.
   e. Feed dry chlorine gas through proper devices for regulating the rate of flow and providing effective diffusion of gas into water within pipe being treated.
   f. Chlorinating devices for feeding solutions of chlorine gas or gas itself must prevent backflow of water into chlorine cylinder.
   g. Calcium Hypochlorite: If this procedure is used, first mix dry powder with water to make a thick paste, then thin to approximately a 1 percent solution (10,000 ppm chlorine).
   h. Sodium Hypochlorite: If this procedure is used, dilute liquid with water to obtain a 1 percent solution.
   i. The following proportions of hypochlorite to water will be required:

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

H. Point of Application:

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

I. Retention Period:

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

J. Disposal of Disinfecting Water:

1. Dispose of disinfecting water in an acceptable manner that will protect the public and receiving waters from harmful or toxic concentrations of chlorine.
2. Do not allow disinfecting water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level.

3.12 PROTECTION OF INSTALLED WORK

A. Protective Covers:

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

3.13 PIPING IDENTIFICATION

A. Labeling and/or color-coding to be as follows:

1. Label insulated and uninsulated pipes.
2. Complete, dry, and clean the paint on the surface of the pipe prior to attaching labels.
3. Provide colors that are distinctive hues matching as closely as possible (without custom color blending). Use the following basic colors as specified by ASME A13.1.
   a. Green background with white lettering – water.
   b. Orange background with black lettering – toxic and corrosive fluids.
   c. Grey background with white lettering – drainage.
4. Fluid service name to match names shown in Plumbing Piping Schedule.
5. Provide plastic laminated type labels as manufactured by one of the suppliers below or an approved substitution.
6. Locate labels in accordance with ANSI/ASME A13.1, Fig. 1 (below) and sized per Table 3 guidelines (below Fig. 1).
7. Approved Manufacturers:
   a. Seaton.
   b. Brady.

Fig. 1 Location of Identification Markers

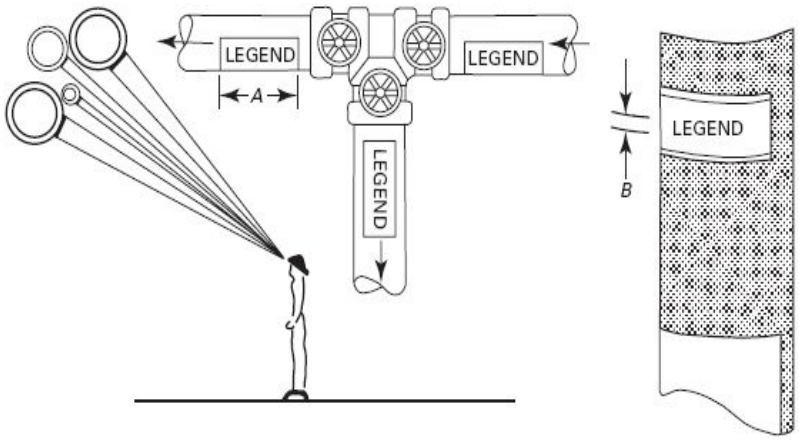


Table 3 Size of Legend Letters

Outside Diameter of Pipe Covering, in. (mm)	Length of Color Field, *A*, in. (mm)	Size of Letters, *B*, in. (mm)
¾ to 1¼ (19 to 32)	8 (200)	½ (13)
1½ to 2 (38 to 51)	8 (200)	¾ (19)
2½ to 6 (64 to 150)	12 (300)	1¼ (32)
8 to 10 (200 to 250)	24 (600)	2½ (64)
Over 10 (over 250)	32 (800)	3½ (89)

8. Coordinate colors, sizes and quantities required for the project with the Owner's existing supply of labels or planned coding requirements before placing order.

3.14 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are part of this specification.

1. Plumbing Piping Schedule.
2. Plumbing Piping Data Sheets:

Section Number	Title
22 10 01.01	Copper Tube and Fittings – Domestic Water Service
22 10 01.02	Polyvinyl Chloride Drain Waste and Vent (PVC-DWV) Pipe and Fittings
22 10 01.04	Acid-Resistant Cast Iron Pipe and Fittings
22 10 01.06	Acid-Resistant Polypropylene Waste and Vent Pipe and Fittings
22 10 01.08	Double Contained Pipe and Fittings

END OF SECTION

PLUMBING PIPING SCHEDULE

(BUILDING MECHANICAL ONLY)

Legend	Service	Size(s) (in.)	Exposure	Piping Material	Specification Section	Operating Pressure (psig)	Test Type	Test Pressure (psig)	Pipe Colors and Labels	Notes
CD	Condensate Drain, HVAC	All	EXP/BUR	COP	22 10 01.01	NA	H	5		
COG	Coagulant (Future)									
D	Sanitary Drain	All	EXP/BUR	CISP	22 10 01.03	NA	H	5		
FW	Fresh Water		EXP/BUR	HDPE COP (Note 2)	22 10 01.13	50	H	100		Note 2
HW, RHW	Hot Water, Potable	All	EXP/BUR	CPVC	40 27 00.11		H	100		
HW, RHW	Hot Water, Potable	All	EXP/BUR	COP	40 27 00.13		H	125		Ops Building Only
IA	Compressed Air (Instrument)	<= 4 > 4	EXP/BUR EXP	COP STL	22 10 01.01	100 100	P P	125 125		
LW	Lab Waste	All	EXP	HDPE	22 10 01.13	NA	H	5		
RL, RS	Refrigerant	All	EXP/BUR	COP-ACR	23 23 00	Note 1	Note 1	Note 1		Note 1
RO	Reverse Osmosis	All	EXP/BUR	COP/ HDPE	22 10 01.13 40 27 00.03					Note 2
SPD	Sump Pump Discharge	1 - 3	EXP/BUR	CPVC	40 27 00.11		H			
SPD	Sump Pump Discharge	3 - 6	EXP/BUR	CLDI	40 27 00.01		H			
TP	Trap Primer	1/2 - 3/4	EXP/BUR	COP	22 10 01.01	NA	H			

PLUMBING PIPING SCHEDULE

(BUILDING MECHANICAL ONLY)

Legend	Service	Size(s) (in.)	Exposure	Piping Material	Specification Section	Operating Pressure (psig)	Test Type	Test Pressure (psig)	Pipe Colors and Labels	Notes
PW	Potable Tempered Water	All	EXP/BUR	COP	22 10 01.01		H	100		
V, VTR	Sanitary Vent	All	EXP	PVC-DWV	22 10 01.02	NA	H	5		
PW	Cold Water, Potable	All	EXP/BUR	COP PVC HDPE (Note 2)	22 10 01.01 40 27 00.10		H	100		Copper Inside Building, PVC Outside Building

Notes:

1. Refer to Section 23 23 00, Refrigerant Piping, for testing requirements.
2. HDPE underground piping and Copper Tubing 'L' aboveground piping at Operations Building
3. HDPE underground piping and Carbon Steel aboveground piping at Operations Building

Legend

Exposure		Pressure Test		Material	
BUR	Buried	H	Hydrostatic	ACR	Air-Conditioning and Refrigeration
EXP	Exposed	I	In Service	CISP	Cast Iron Soil Pipe
SUB	Submerged	P	Pneumatic	CLDI	Cement-Lined Ductile Iron
ENC	Concrete Encased	NA	Not Applicable	CMP	Corrugated Metal Pipe
				COP	Copper

Legend		
Exposure	**Pressure Test**	**Material**
		CPVC Chlorinated PVC
		DI Ductile Iron
		DWV Drain Waste and Vent
		FRPX Fiberglass Reinforced Plastic
		GLDI Glass-Lined Ductile Iron
		GSP Galvanized Steel Pipe
		HDPE High Density Polyethylene
		MDPE Medium Density Polyethylene
		PP Polypropylene Pipe
		PSTL PVDF-Lined Steel
		PVC Polyvinyl Chloride
		PVDF Polyvinylidene Fluoride
		RCP Reinforced Concrete Pipe
		RSTL Rubber-Lined Steel
		SST Stainless Steel
		STL Steel (Sch 40)
		VC Vitrified Clay Pipe

END OF SECTION

SECTION 22 10 01.01 COPPER TUBE AND FITTINGS — DOMESTIC WATER SERVICE		
Item	**Size**	**Description**
General	All 2" and less	Maximum Pressure: 200 psi. Maximum Temperature: 250 Degrees F.
Tube	2" and less	Type L copper, seamless, conforming to ASTM B88, hard drawn.
Fittings	All	Wrought copper, solder joint, conforming to ASME B16.22.
Joints	All 2"and smaller	Soldered: In accordance with AWS, Soldering Handbook or CDA, Copper Tube Handbook. Brazed: In accordance with AWS, Brazing Handbook. Flanged: At valves and equipment, as required. Unions: At valves and equipment, as required.
Unions	2"and smaller	Unions: Wrought copper, solder joint, conforming to ASME B16.22.
Flanges	All	Wrought copper, socket joint, faced and drilled 150-pound ASME B16.24.
Branch Connections	All	Manufactured Fittings (in accordance with this table). Mechanically Formed Tee Connections: Not allowed.
Bolting	All	ASTM A307, carbon steel, Grade A hex head bolts, and ASTM A563 Grade A hex head nuts.
Gaskets	All	1/16" thick non-asbestos compression type, full face; manufactured by Cranite or Johns Manville.

SECTION 22 10 01.01
COPPER TUBE AND FITTINGS —
DOMESTIC WATER SERVICE

Item	Size	Description
Filler Metals	All	Solder: Lead free with 95-5 tin antimony, 96-4 tin silver, or 94-6 tin silver in accordance with ASTM B32. Flux conforming to ASTM B813. Do not use cored solder. Brazing: Classification BAg-1 (silver), conforming to AWS A5.8/A5.8M

END OF SECTION

SECTION 22 10 01.02 POLYVINYL CHLORIDE DRAIN WASTE AND VENT (PVC-DWV) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe and Fittings	All	PVC-DWV Schedule 40 nonpressure application, Class 12454B conforming to ASTM D2665 and ANSI/NSF Standard 14 system.
Joints	All	Solvent cemented conforming to ASTM D2855 except where connection to equipment may require future removal.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.

END OF SECTION

SECTION 22 10 01.04 ACID-RESISTANT CAST IRON PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe and Fittings	All	High silicone cast iron, no-hub ends, extra heavy grade, conforming to ASTM A518/A518M and ASTM A861.
Joints	All	No-hub type compression coupling, with Teflon inner sleeve, neoprene outer sleeve, and stainless steel shield and clamp assembly.

END OF SECTION

SECTION 22 10 01.06 ACID-RESISTANT POLYPROPYLENE WASTE AND VENT PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	All	Polypropylene, ASTM F1412, Type 1, Schedule 40; resin meeting ASTM D4101. Conforming to ASTM D2447, ASTM D635, and ASTM D2843.
Fittings	All	Polypropylene, ASTM F1412, Type 1, Schedule 40, socket type ends conforming to ANSI B16.12, ASTM D2657, and ASTM D4101.
Joints	All	Socket-weld type, electrically fused.
Manufacturers		R & G Sloane Manufacturing Co., Inc. Celanese Piping Systems, Inc. Orion Fittings, Inc.

END OF SECTION

SECTION 22 10 01.08 DOUBLE CONTAINED PIPE AND FITTINGS HIGH-DENSITY POLYETHYLENE (HDPE)		
Item	**Size**	**Description**
General	All	Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion; shall be of the same type, grade, and class of polyethylene compound and supplied from same raw material supplier. Pipe tubing and fittings manufactured in accordance with ASTM D2239. Preferred SDR 11
Pipe	1/2" to 4"	Cell class ASTM D3350 high-density polyethylene, maximum allowable hoop stress 1,600 psi at 73.4 degrees F. Polyethylene Resin: Conform to Type PE 3408 or better. Provide protection against ultraviolet light degradation using carbon black, not less than 2 percent, well dispersed in resin. Pipe wall thickness shall reflect required SDR* and diameter, as shown in Table 8, ASTM F714. For 3" and larger sizes, ASTM D3035. The containment pipe sizes (corresponding to carrier pipe sizes would be as follows (carrier pipe size first and containment pipe size second): • 2"/4" • 3"/6" • 4"/8" • 6"/10" • 8"/12"

SECTION 22 10 01.08 DOUBLE CONTAINED PIPE AND FITTINGS HIGH-DENSITY POLYETHYLENE (HDPE)		
Item	**Size**	**Description**
		Design Stress Rating: 1600 psi hydrostatic. Pressure Rating (psi) at 100 degrees F SDR* 128 13.5 100 17.0 90 19.0 Identification: Colored stripes extruded into pipe outside surface for identification of type of service, in accordance with APWA Uniform Color Code. *SDR: standard dimension ratio = OD/thickness
Fittings	4" & smaller	Molded fittings, butt fusion joined, conforming to ASTM D3261.
Flanges	All	Van Stone type, cast ASTM A351/A351M, Type 316 stainless steel backing ring, IPP Deltaflex convoluted design or equal for bolting to ANSI B16.1, Class 125; ANSI B16.5, Class 150; and AWWA C207, Class E. Pressure performance of backing ring equal to SDR rating of pipe with safety factor of two. Stub ends same grade HDPE and pressure rating as pipe.
Bolting		Stainless steel, ASTM A193/A193M Grade B8M studs and ASTM A194/A194M Grade 8M hex head nuts. Washers shall be same material as bolts.
Gaskets		Flat ring, 1/8" ethylene propylene rubber (EPR).
Manufacturer		Option to purchase already assembled. For steel pipe, purchase each pipe separately and contractor to install centralizers. JM Eagle PE 3408; Driscoplex 4000/4100 PE 3408.

Note: Manufacturer to use standard steel pipe and weld in the field.

END OF SECTION

SECTION 22 30 00
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

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

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

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's product data.
2. Seismic anchorage and bracing drawings and cut sheets, as required.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required.
2. Component and attachment testing seismic certificate of compliance as required.

1.03 SPECIAL GUARANTEE

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

PART 2 PRODUCTS

2.01 WATER HEATERS

A. IWH-1 - Instantaneous Electric Water Heater:

1. Description: UL listed, tankless with removable cover, replaceable heating element, immersion-type thermostat, replaceable inlet filter, and flow regulator.
2. Capacity: See data sheet at end of section.
3. Manufacturers:
   a. Chronomite Laboratories, Inc.
   b. EEMAX, Inc.
   c. Weben-Jarco Inc.

2.02 SUBMERSIBLE CENTRIFUGAL SUMP PUMPS

A. Simplex, Submersible Sump Pump:

1. Description:
   a. Type: Simplex, heavy-duty, nonclog, close-coupled submersible centrifugal sewage ejector pump.
   b. Volute: Cast iron, foot mounted.
   c. Impeller: Cast iron, double shroud, fully enclosed.

d. Wear Plates: Brass.
e. Motor Enclosure: Cast iron, Buna-N O-ring seals with corrosion-resistant exterior finish.
f. Motor: Continuous-duty, built-in thermal overload protection.
g. Shaft Seals: Tandem, mechanical type.
h. Shaft: Stainless steel.
i. Bearings: Permanently lubricated, ball bearing with B-10 bearing life of 17,500 hours.
j. Electrical: Inner seal chamber with 2 moisture sensing probes and attached power and control cables, with length, voltage, and power requirements as indicated on data sheet at end of section.
k. Controls:
1) Circuit Breakers: Motor rated.
2) Motor Starters: Magnetic with thermal overload protection device.
3) Level Control: Polypropylene-encapsulated mechanical float switch.
4) Leak Detection: Pump seal alarm circuit.

2. Capacity: See data sheet at end of section.
3. Manufacturers:
a. Hydromatic Pumps.
b. Paco Pump.
c. Weil Pump Company, Inc.

B. Duplex, Submersible Sump Pump:

1. Construction:
a. Impeller and Volute: Nonclog design, ASTM A48/A48M, Class 30, cast iron capable of passing 2-inch spherical solid.
b. Electrical: Water-resistant, UL listed and CSA approved electrical power cord.
c. Motor: Sealed, oil-filled, NEMA B design with winding thermal sensors.
d. Bearings and Shaft: Upper and lower thrust bearings, solid Type 303 stainless steel shaft.
e. Seals: Two mechanical seals, carbon rotating seal face and ceramic stationary seal face, and lower seal failure sensor and warning device.
2. Controller:
a. Control Panel: Fabricated steel, NEMA 4 enclosure, door disconnect switch, and bear UL listing mark. Components shall

bear UL recognized marking. Wiring, schematics, and workmanship shall comply with NEC and UL.

3. Wiring and Conduit: Minimum of MTH, 600V rated, 18-gauge with 90 degrees C rating, in accordance with NEC standards. Wire sized in accordance with NEC standards.
4. Motor Protection: Magnetic motor starter, across the line type, UL listing mark, under voltage and over voltage protection with manual reset button mounted in panel door.
5. Level Sensors (Duplex): Automatic pump cycle and alternation. Polypropylene encapsulated mechanical level sensors for pump on, pump off, and override (standby pump on). Additional level sensor shall activate audible-visual panel mounted light and horn. Panel mount, push-to-silence button for deactivating audible alarm.

C. Duplex, Column Type, Sump Pump (Acid-Resistant):

1. Construction:
   a. Impeller and Volute: PVC construction with stainless steel inserts.
   b. Motor Support Bracket: Cast iron, epoxy coated.
   c. Shaft: Stainless steel with PVC sleeve.
   d. Bearings: Lower and intermediate ceramic bearings with vapor seals. Upper bearing shall be external and allow shaft adjustment.
   e. Column: Ribbed PVC construction.
   f. Strainer: PVC construction with 1/4-inch diameter holes.
   g. Motor: Vertical mounted, C-face, open drip-proof (ODP), premium-efficiency, ball bearing design.
2. Sump and Cover Plate: Cylindrical design, PVC construction, vaportight with subplates and openings.
3. Controller:
   a. Float: Adjustable, rising rod, PVC construction, fume-tight design. High-level indicator light, dry contacts for remote alarm, alarm horn, and alarm acknowledge.
   b. Control Panel: NEMA 4 enclosure with fusible disconnect switch, HOA (HAND/OFF/AUTO) selector switch. Panel mounted indicator lights for “power on” and “pump off.”
   c. Motor Protection: Magnetic motor starter with overload protection.
4. Capacity: See data sheet at end of section.
5. Manufacturer: Vanton.

2.03 BACKFLOW PREVENTERS

A. Double Check Backflow Preventer (3/4 Inch through 2 Inches):

1. Description:
   a. Regulatory Compliance: AWWA C510, CSA B64.5, FCCHR of USC Section 10, ASSE 1015, ICC (IPC).
   b. Valve Body: Bronze.
   c. End Connections: Threaded, NPT.
   d. Maximum Working Pressure: 175 psi (350 psi test).
   e. Temperature Range: 32 degrees to 140 degrees F.
   f. Shutoff Valve: Full port, resilient seated, bronze ball valve with bronze ball valve test cock.
   g. TBD. Inlet Strainer: bronze wye strainer, 40-mesh perforated, Type 304 stainless steel.
2. Sizes: See data sheet at end of section.
3. Manufacturers and Products:
   a. Febco; Model 850.
   b. Watts Regulator Company; Model 709.

B. Double Check Backflow Preventer (2-1/2 Inches through 10 Inches):

1. Description:
   a. Regulatory Compliance: AWWA C510, CSA B64.5, FCCHR of USC Section 10, ASSE 1015, ICC (IPC).
   b. Valve Body: Ductile or cast iron, Class 125, epoxy-coated (FDA approved).
   c. End Connections: Flanged.
   d. Maximum Working Pressure: 175 psi (350 psi test).
   e. Temperature Range: 32 degrees to 140 degrees F.
   f. Shutoff Valve: Nonrising stem, resilient seated gate valve with bronze ball valve test cock.
   g. TBD. Inlet Strainer: cast-iron wye strainer, Class 125 flanged, fusion epoxy AWWA C550 coated, perforated stainless steel screen (1/16-inch perforations on 2-1/2 inches to 4 inches; 1/8-inch perforation on 6 inches to 10 inches), threaded cap plug blowout opening.
2. Sizes: See data sheet at end of section.
1. Manufacturers and Products:
   a. Febco; Model 850.
   b. Watts Regulator Company; Model 709.

C. Reduced Pressure Backflow Preventers (1/4 Inch through 1/2 Inch):

1. Description:
   a. Regulatory Compliance: AWWA C511, CSA B64.4, ASSE 1013, ICC (IPC), FM, USC-UL.
   b. Valve Body: Bronze.
   c. End Connections: Threaded, NPT.
   d. Maximum Working Pressure: 175 psi (350 psi test).
   e. Temperature Range: 32 degrees to 140 degrees F.
   f. Shutoff Valve: Full port, resilient seated, bronze ball valve with bronze ball valve test cock.
   g. Accessories: Drain line air gap fitting.
2. Sizes: See data sheet at end of section.
3. Manufacturer and Product: Conbraco Industries; Series 20-400.

D. Reduced-Pressure Backflow Preventers (3/4 Inch through 2 Inches):

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

E. Reduced Pressure Backflow Preventers (2-1/2 Inches Through 10 Inches):

1. Description:
   a. Regulatory Compliance: AWWA C511, CSA B64.4, FCCHR of USC Section 10, ASSE 1013, IAPMO (UPC), SBCCI.
   b. Valve Body: Ductile or cast iron, Class 125, epoxy-coated (FDA approved).
   c. End Connections: Flanged.
   d. Maximum Working Pressure: 175 psi (350 psi test).

e. Temperature Range: 32 degrees F to 140 degrees F.
f. Shutoff Valve: Nonrising stem, resilient seated gate valve with bronze ball valve test cock.
g. TBD. Inlet Strainer: Cast-iron wye strainer, Class 125 flanged, fusion epoxy AWWA C550 coated, perforated stainless steel screen (1/16-inch perforations on 2-1/2 inches to 4 inches; 1/8-inch perforation on 6 inches to 10 inches), threaded cap plug blowout opening.
h. Accessories: Drain line air gap fitting.

2. Sizes: See data sheet at end of section.
3. Manufacturers and Products:
   a. Febco; Model 860.
   b. Watts; Model 909.

2.04 ENVIRONMENTAL ENCLOSURES

A. For Backflow Preventers 3/4 Inch to 3 Inches:

1. Description:
   a. Enclosure shall be factory-assembled unit providing heat and accessibility to the system backflow preventers. Unit shall meet the requirements of NFPA and ASSE for testing of the backflow preventer. Design to protect to minus 30 degrees F. Unit shall be suitable for concrete pad mounting.
   b. Adjustable thermostat shall control electric heaters/cables. Set thermostat to maintain 40 degrees F.
   c. Fiberglass construction, 1-inch-thick, factory applied unicellular nonwicking insulation, minimum R-value of 8, hinged and lockable access doors. Designed for exterior installation.
2. Heating Capacity:
   a. 3/4-Inch to 1-1/2-Inch: 60-watt heater, 120 volt, single-phase.
   b. 2-Inch: 90-watt heater, 120 volt, single-phase.
   c. 3-Inch: 1500-watt heaters, 120 volt, single-phase.
3. Manufacturers and Products:
   a. Hot Box; Series HB, Model TBD.
   b. Watts; Model TBD.

B. For Backflow Preventers 4 inches to 10 Inches:

1. Description:
   a. Enclosure shall be factory-assembled unit providing heat and accessibility to the system backflow preventers. Unit shall meet the requirements of NFPA and ASSE for testing of the backflow

preventer. Design to protect to minus 30 degrees F. Unit shall be suitable for concrete pad mounting.

b. Adjustable thermostat shall control electric heaters. Set thermostat to maintain 40 degrees F.

c. Reinforced 18-gauge aluminum construction, factory applied unicellular nonwicking insulation, minimum R-value of 8, hinged and lockable access doors. Designed for exterior installation.

d. Verify unit length, width, and height with manufacturer based on actual backflow preventer provided.

2. Heating Capacity:
   a. 4 Inches: One 2.0-kW heater, 120 volt, single-phase.
   b. 6 Inches and 8 Inches: Two 1.5-kW heaters, 120 volt, single-phase.
   c. 10 Inches: Two 2.0-kW heaters, 120 volt, single-phase.
3. Manufacturers and Products:
   a. Hot Box; Series HB, Model TBD.
   b. Watts; Model TBD.

2.05 PLATE HEAT EXCHANGERS

A. Acceptable Manufacturers:

1. Alfa Laval.
2. Tranter.
3. Paul Mueller Company, Inc.

B. Design Requirements:

1. Design, fabricate, and test equipment in accordance with the BPVC, Section VIII, Division 1.
2. Design equipment per the requirements in Plate and Frame Heat Exchangers Data Sheet.
3. Thermal design by manufacturer.
4. Design heat exchangers to allow for the future addition of plates for an increased hot-side heating capacity of 50 percent.
5. Design plate and carrying box to permit the removal of any plate in the plate pack without the need to remove any other plates.
6. Plate and frame heat exchangers to include:
   a. Fixed end cover.
   b. Multiple plates.
   c. Movable end cover.
   d. Carrying bars and compression bolts.
   e. Gasket for heat transfer area and portholes.

f. One-piece molded gaskets.
g. Plate pack covered with metal shroud in accordance with OSHA standards.
h. Provide lifting lugs as required for installation and maintenance.

7. Paint heat exchanger using manufacturer's standard painting system.

C. Materials: Fabricate using the materials specified in Plate and Frame Heat Exchangers Data Sheet.

D. Fabrication:

1. Permanently mark plates to identify plate material.
2. Completely fit-up and assemble heat exchangers in manufacturer's shop.
3. Provide permanently attached equipment identification nameplate. At a minimum include the following:
   a. Equipment model number.
   b. Serial number.
   c. Materials of construction.
   d. Number of plates provided and maximum number of plates.

E. Source Quality Control:

1. Factory Testing:
   a. Hydrostatic Testing:
      1) Test exchangers at the manufacturing facility in accordance with BPVC Section VIII, Division 1.
      2) Use water that does not contain more than 100 ppm of chlorine.
      3) Drain and thoroughly dry exchangers immediately after testing. When complete drainage is impossible, flush with water containing not more than 5 ppm chlorides. The use of alcohol or alternate flushing media requires prior review and approval by Engineer.
      4) Provide Contractor a minimum of 2 weeks' written notice prior to testing.

PART 3 EXECUTION

3.01 INSTALLATION

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

3.02 FIELD QUALITY CONTROL

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

B. Startup:

1. In accordance with Section 01 91 14, Equipment Testing and Facility Startup (to be completed later), and Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
2. Piping Systems: Verify that flushing, cleaning, and testing has been completed prior to startup.

3.03 SUPPLEMENTS

A. Supplements listed below, following "End of Section," are a part of this Specification.

1. Instantaneous Water Heater Data Sheet.
2. Simplex, Submersible Sump Pump Data Sheet.
3. Duplex, Submersible Sump Pump Data Sheet.
4. Duplex, Column Type, Sump Pump (Acid Resistant) Data Sheet.
5. Backflow Preventers Data Sheet.
6. Plate and Frame Heat Exchangers Data Sheet.

END OF SECTION

Instantaneous Water Heater					
Tag Number	**Flow Rate (gpm)**	**Temperature Rise (Degrees F)**	**Power (kW)**	**Voltage**	**Manufacturer and Model Number**
WH-01	0.5	40	3.0	120V/1ph	Chronomite, Model S-30L
WH-02	0.5	63	4.6	208V/1ph	Chronomite, Model S-46L
WH-03	1.0	41	6.0	208V/1ph	Chronomite, Model S-60I
WH-04	1.0	48	7.0	208V/1ph	Chronomite, Model S-70I
WH-05	1.0	54	8.0	208V/1ph	Chronomite, Model S-80I
WH-06	1.0	61	9.0	208V/1ph	Chronomite, Model S-90I

Simplex, Submersible Sump Pump						
Tag Number	**Flow Rate (gpm)**	**Pressure (feet head)**	**Motor (hp)**	**Motor Speed (rpm)**	**Power (volts/phase)**	**Manufacturer, Model No.**
SP-01	30	21	1/3	1750	120V/1ph	Weil, 1-1/4” Series 1400
SP-02	50	25	1/2	1750	120V/1ph	Weil, 1-1/2” Series 1410
SP-03	35	10	1/4	1550	120V/1ph	Hydromatic, Model SHEF25
SP-04	30	14	1/3	1550	120V/1ph	Hydromatic, Model SHEF33

Duplex, Submersible Sump Pump

Sump Pump:

Tag Number	Flow Rate (gpm)	Pressure (feet head)	Motor (hp)	Motor Speed (rpm)	Power (volts/phase)	Manufacturer, Model No.
SP-05				1750	120V/1ph	
SP-06				1750	120V/1ph	
SP-07				1750	120V/1ph	
SP-08				1750	120V/1ph	

Sump:

Tag Number	Sump Config (sq/rd)	Sump Size (L x W/dia)	Finished Floor (feet)	Inlet Pipe (feet)	Water Alarm (feet)	Override (feet)	Pump On (feet)	Pump Off (feet)	Bottom of Sump (feet)
SP-09	round	4'-0"	100.00	97.00	96.50	96.00	95.50	92.50	92.00
SP-10	round	5'-0"							
SP-11	square	4'-0" x 4'-0"							
SP-12	square	5'-0" x 5'-0"							

Brake Horsepower Calculator:

Flow =	10 gpm
Pressure =	35 feet head

Duplex, Submersible Sump Pump	
Fluid Specific Gravity =	1.00
Pump Efficiency =	70%
Motor Efficiency =	90%
Brake Horsepower =	0.14 bhp
Note: Brake horsepower calculator should be deleted from the final equipment schedule.	

Duplex, Column Type, Sump Pump (Acid Resistant)								
Sump Pump:								
Tag Number	**Flow Rate (gpm)**	**Pressure (feet head)**	**Motor (hp)**	**Motor Speed (rpm)**	**Power (volts/phase)**	**Manufacturer, Model No.**		
SP-13	20	15	1/4	1750	120V/1ph	Vanton, Model SG-200		
SP-14	60	30	1	1750	120V/1ph	Vanton, Model SG-300		
SP-15	100	10	1/2	1750	120V/1ph	Vanton, Model SG-500		
SP-16	100	30	1-1/2	1750	120V/1ph	Vanton, Model SG-800		
Sump:								
Tag Number	**Sump Config (sq/rd)**	**Sump Size (L x W/dia)**	**Finished Floor (feet)**	**Inlet Pipe (feet)**	**High Water Alarm (feet)**	**Pump On (feet)**	**Pump Off (feet)**	**Bottom of Sump (feet)**
SP-17	round	4'-0"	100.00	97.00	96.50	95.50	92.50	92.00
SP-18	round	5'-0"						
SP-19	square	4'-0" x 4'-0"						
SP-20	square	5'-0" x 5'-0"						
Brake Horsepower Calculator:								
Flow =	100 gpm							
Pressure =	30 feet head							

Duplex, Column Type, Sump Pump (Acid Resistant)	
Fluid Specific Gravity =	1.00
Pump Efficiency =	70%
Motor Efficiency =	90%
Brake Horsepower =	1.20 bhp
Note: 1. Brake horsepower calculator should be deleted from the final equipment schedule. 2. Add a Pump Override column to the Sump Schedule is a duplex system is used.	

Backflow Preventers						
Tag Number	**Valve Type[1]**	**Size (inches)**	**Flow Stream**	**Maximum Operating Flow (gpm)**	**Maximum Pressure Drop (psi)**	**Manufacturer, Model No.**
BFP-01	DC	1/2	W1	3	5	Febco, Model 850
BFP-02	DC	3/4	W1	8	6	Febco, Model 850
BFP-03	DC	1	W1	17	7	Febco, Model 850
BFP-04	DC	1-1/2	W1	45	6	Febco, Model 850
BFP-05	DC	2	W1	75	6	Febco, Model 850
BFP-06	DC	2-1/2	W1	120	5	Febco, Model 850
BFP-07	DC	3	W1	175	5	Febco, Model 850
BFP-08	DC	4	W1	320	3	Febco, Model 850
BFP-09	DC	6	W1	700	3	Febco, Model 850
BFP-10	DC	8	W1	1200	3	Febco, Model 850
BFP-11	DC	10	W1	1900	5	Febco, Model 850
BFP-12	RP	1/4	W1	0.75	10	Conbraco, Series 20-400
BFP-13	RP	3/8	W1	1.5	10	Conbraco, Series 20-400
BFP-14	RP	1/2	W1	3	10	Conbraco, Series 20-400
BFP-15	RP	1/2	W1	3	11	Febco, Model 825Y

Backflow Preventers						
Tag Number	**Valve Type[1]**	**Size (inches)**	**Flow Stream**	**Maximum Operating Flow (gpm)**	**Maximum Pressure Drop (psi)**	**Manufacturer, Model No.**
BFP-16	RP	3/4	W1	8	14	Febco, Model 825Y
BFP-17	RP	1	W1	17	14	Febco, Model 825Y
BFP-18	RP	1-1/2	W1	45	12	Febco, Model 825Y
BFP-19	RP	2	W1	75	12	Febco, Model 825Y
BFP-20	RP	2-1/2	W1	120	11	Febco, Model 825Y
BFP-21	RP	3	W1	175	12	Febco, Model 825Y
BFP-22	RP	4	W1	320	9	Febco, Model 825Y
BFP-23	RP	6	W1	700	10	Febco, Model 825Y
BFP-24	RP	8	W1	1200	11	Febco, Model 825Y
BFP-25	RP	10	W1	1900	12	Febco, Model 825Y

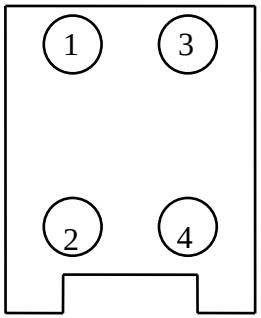
Notes:

1. Valve Type: RP - Reduced Pressure, DC - Double Check.

2. Flow Streams: DIW - Deionized Water, FP - Fire Protection, IRR - Irrigation Water, LCW - Laboratory Cold Water, TWS - Tempered Water Supply, W1 - Potable Water, W2 – Non-potable Water, W3 - Plant Water.

Plate and Frame Heat Exchangers Data Sheet	
Tag Number(s)	HX-1300
Quantity	One
Equipment Name	Glycol / Water Heat Exchanger
Revision Number	0
PERFORMANCE CRITERIA	
Hot Side	
Fluid	Potable Water
Specific Gravity	1.0
Specific Heat	
Flow Rate (gpm)	30
Inlet Temperature (deg. F)	80 deg F
Outlet Temperature (deg. F)	70 deg F
Viscosity at Inlet Temperature (SSU)	31.5
Viscosity at Outlet Temperature (SSU)	31.5
Maximum Pressure Loss (PSID)	5
Cold Side	
Fluid	40% Glycol / Water mix
Specific Gravity	1.07
Specific Heat	0.845
Flow Rate (gpm)	15

Plate and Frame Heat Exchangers Data Sheet				
Inlet Temperature (deg. F)		44 deg F		
Outlet Temperature (deg. F)		54 deg F		
Viscosity at Inlet Temperature (cP)		4.8		
Viscosity at Outlet Temperature (cP)		3.5		
Maximum Pressure Loss (PSID)		5		
DETAILED CRITERIA				
Connection Schedule				
Nozzle/Connection	Location*	Size	Rating	Facing
Hot side inlet		1 ½”	125# Flanged	FF
Hot side outlet		1 ½”	125# Flanged	FF
Cold side inlet		1”	125# Flanged	FF
Cold side outlet		1”	125# Flanged	FF
Drain	N/A			
Materials				
Plates		*		
End Plate		*		
Gaskets		*		
Flanges		*		
Plate Shroud		*		
Carrying Rod		*		

Plate and Frame Heat Exchangers Data Sheet	
Compression Bolts	*
Cleaning and Packaging Level	Potable water service
Testing	
Hydrostatic Testing (Y/N)	Y
Helium Test (Y/N)	N
Halogen Test (Y/N)	N
Witness Required (Y/N)	N
ADDITIONAL COMMENTS	
*Use this diagram to identify connection location 	

Notes:

* - Information provided by Vendor

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 REFERENCES

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

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

1.02 SUBMITTALS

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

1.03 REGULATORY REQUIREMENTS

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fixture Trim:

1. Supply Stops and Traps:
   a. McGuire.
   b. American Standard.
   c. Kohler.
2. Flush Valves: Sloan.

3. Water Closet Seats:
   a. Bemis.
   b. Church.
   c. Olsonite.
4. Lavatory Supply, Tailpiece, and Trap Insulation:
   a. McGuire.
   b. Trap Wrap.
   c. Truebro.

B. Plumbing Fixtures:

1. Water Closets, Lavatories, and Urinals:
   a. American Standard.
   b. Kohler.
   c. Eljer.
2. Faucet Fittings:
   a. Sinks:
      1) Chicago.
      2) T&S Brass.
   b. Lavatories:
      1) Chicago.
      2) Symmons.
3. Stainless Steel Sinks:
   a. Elkay.
   b. Just.

C. Drainage Products:

1. General:
   a. Smith.
   b. Wade.
   c. Zurn.
2. Acid Resistant:
   a. Enfield.
   b. R&G Sloane.
   c. T&C Plastic Drain Co.

D. Plumbing Specialties:

1. Shock Arresters:
   a. Smith.
   b. Sioux Chief.
   c. Precision Plumbing Products.

2. Trap Primers:
   a. Precision Plumbing Products.
   b. Smith.
   c. Wade.
3. Pressure/Temperature Relief Valves:
   a. Cash-Acme.
   b. Kunkle Valve.
   c. Watts.
4. Pressure Gauges:
   a. Ashcroft.
   b. Marsh.
   c. Marshalltown.
5. Thermometers:
   a. Trerice.
   b. Weksler.
6. Automatic Washer Supplies:
   a. Guy Gray.
   b. Symmons.

2.02 GENERAL

A. Fixture Trim: Provide plumbing fixture trim where applicable on fixtures.

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

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

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

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

2.03 MATERIALS

A. Fixture Trim:

1. Supply Stop:
   a. Flexible supply with heavy cast brass, loose key, 1/2-inch IPS by 3/8-inch outside diameter tubing angle stop to wall with escutcheon plate; chrome-plated finish.
   b. Provide stop with stuffing box.
   c. Manufacturer: McGuire Manufacturing Company, Inc.

2. Trap:
   a. Chrome-plated, 17-gauge, semicast P-trap with compression ring cast brass waste and vent connection and cleanout.
   b. 1-1/2 inches for lavatories and drinking fountains.
   c. 1-1/2 inches for sinks.
   d. Manufacturer: McGuire Manufacturing Company, Inc.
3. Water Closet and Urinal Flush Valves: Sloan Valve Co., Royal Continental, low flush, quiet action with screwdriver stop and vacuum breaker.

B. Plumbing Fixtures:

1. WC-1, Water Closet:
   a. Fixture: American Standard Companies, Inc.; Afwall, Model 2257.103 wall hung, siphon jet, vitreous china closet bowl, with elongated trim, 1-1/2 inch top spud.
   b. Exposed Faucet: Sloan; Model Royal #111 escutcheon, seat bumper, integral screwdriver stop and vacuum breaker. Maximum 1.6 gallon flush volume.
   c. Wall mount carrier: JR Smith, adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, anchor foot on back side of single fixture support, threaded fixture studs with nuts, and washers and cap nuts.
2. UR-1, Urinal:
   a. Fixture: American Standard Companies, Inc.; Washbrook, Model 6501.010 white vitreous china, wall hung siphon jet urinal with flushing rim, shields, integral trap, 3/4 inch top spud.
   b. Exposed Faucet: Sloan; Model 186-1 with escutcheon, screwdriver stop, and vacuum breaker. Maximum 1.0 gallon volume.
   c. Wall Mount Carrier: JR Smith or approved equal.
3. LAV-1, Lavatory (Counter Set, Oval):
   a. Fixture: 20 inches by 17 inches, vitreous china, self-rimming. American Standard Companies, Inc.; Aqualyn, Model 0476.028.
   b. Faucet: Chicago Faucet Co.; Model 2200-4CP with 0.5-gpm flow restricter.
   c. Trim: 3/8-inch supply stop with loose key, 17-gauge chrome-plated cast brass P-trap.
   d. Insulation: McGuire Manufacturing Company, Inc.; Prowrap antimicrobial PVC resin seamless insulation for trap, tailpiece, and hot and cold water supply piping.

e. Strainer: McGuire Manufacturing Company, Inc.; Model 155A chrome-plated grid strainer with tailpiece.
f. Circular, Sentry Model SN2008.

4. S-1, Sink (Counter, Stainless Steel, Double Compartment):
   a. Fixture: 21 inches by 33 inches overall by 8 inches deep, 18-gauge, Type 304 stainless steel, three-hole punch, self-rimming, undercoated, ledge-type. Just Mfg. Co.; Model DL-2133-A-GR.
   b. Faucet: Chicago Faucet Co.; Model 1201A, double handle.
   c. Trim: 1-1/2-inch outside diameter, 17-gauge chrome-plated cast tailpiece and cast brass P-trap with cleanout, and 1/2-inch wall supply stop with loose key.
   d. Strainer: Just Mfg. Co.; Model J-35, stainless steel crumb-type.
5. SSH-1, Safety Shower/Eyewash Combination:
   a. Model: Haws Drinking Faucet Co.; Model 8346.
   b. Shower: ABS plastic deluge.
   c. Eyewash: Stainless steel bowl with aerated eye/face wash.
   d. Valve: Stay open.
   e. Support: Freestanding, 1-1/4-inch galvanized pipe standard, stanchion, and floor flange.
   f. Alarms: Magnetically operated proximity switches.
   g. Factory applied CRP (corrosive atmospheres coating).
6. SSH-2, Safety Shower/Eyewash Combination (Freeze-proof):
   a. Model: Haws Drinking Faucet Co.; Model 8317CTFPT.
   b. Shower: ABS plastic deluge.
   c. Eyewash: Stainless steel bowl with aerated eye/face wash.
   d. Valve: Stay open.
   e. Support: Freestanding, 1-1/4-inch galvanized pipe standard, stanchion, and floor flange, cable heated and insulated.
   f. Alarms: Magnetically operated proximity switches.
7. SSH-3, Safety Shower/Eyewash Combination (Frost-proof):
   a. Model: Haws Drinking Faucet Co.; Model 8330FP.
   b. Shower: Stainless steel deluge.
   c. Eyewash: Stainless steel aerated eye/face wash, dust cover, and stainless steel bowl.
   d. Valve: Stainless steel, freeze-proof, stay open with stainless steel push-plates and rods.
   e. Bury Depth: 24 inches.
   f. Support: Freestanding, 1-1/4-inch stainless steel pipe standard, stanchion, and floor flange.
   c. Alarms: Magnetically operated proximity switches.

8. SSH-4, Safety Shower/Eyewash Combination (All Stainless Steel):
   a. Model: Haws Drinking Faucet Co.; Model 8330.
   b. Shower: Stainless steel deluge.
   c. Eyewash: Stainless steel aerated eye/face wash and stainless steel bowl.
   d. Valve: Stay open.
   e. Support: Freestanding, 1-1/4-inch stainless steel pipe standard, stanchion, and floor flange.
   f. Alarms: Magnetically operated proximity switches.
9. SSH-5, Safety Shower/Eyewash Combination (All PVC):
   a. Model: Haws Drinking Faucet Co.; Model 8336.
   b. Shower: PVC deluge.
   c. Eyewash: PVC aerated eye/face wash and PVC bowl.
   d. Valve: Stay open.
   e. Support: Freestanding, 2-1/2 inches, Schedule 80, PVC pipe standard, stanchion, and floor flange.
   f. Alarms: Magnetically operated proximity switches.
10. SSH-6, Safety Shower/Eyewash Combination (Enclosed):
   a. Model: Haws Drinking Faucet Co.; Model 8605.
   b. Shower: ABS plastic deludge.
   c. Eyewash: Chrome-plated brass spray nozzles.
   d. Valve: Stay open.
   e. Enclosure: Molded fiberglass on three sides, top, and bottom with 3-inch drain.
   d. Alarms: Magnetically operated proximity switches.

C. Drainage Products:

1. CO-1, Cleanout (Exterior):
   a. Material: Taper thread, bronze plug, heavy-duty, scoriated cast-iron top.
   b. Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 4263.
2. CO-2, Cleanout:
   a. Material: Taper thread, bronze plug, scoriated nickel bronze top.
   b. Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 4023.
3. FCO-1, Floor Cleanout (Finished Areas):
   a. Material: Tapered thread, bronze plug with round adjustable scoriated secured nickel bronze top.
   b. Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 4103S.
4. FD-1, Floor Drain (Finished Areas):
   a. Materials: Cast-iron body, adjustable nickel bronze strainer.

b. Options: Jay R. Smith Mfg. Co.; Model 2696, trap primer connection, vandalproof screws.
c. Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 2005T-U-round.

5. FS-1, Floor Sink:
a. Materials: Cast-iron body and removable strainer.
b. Manufacturer and Product: Josam, Model 49500-2 Series.
c. Size: 10 by10, 2-inch outlet.

D. HB-1 Hose Valves (Bib): J.R. Smith; Figure No. 5670.

E. Plumbing Specialties:

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

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

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

B. Plumbing Fixtures, Mounting Heights:

1. Standard rough-in catalogued heights, unless shown otherwise on Drawings.
2. Caulk fixtures in contact with finished walls with waterproof, white, nonhardening sealant which will not crack, shrink, or change color with age. See Section 07 92 00, Joint Sealants.

C. Exact fixture location and mounting arrangement shall be as indicated on toilet room elevations and details as shown on Drawings.

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

E. Drainage Products:

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

F. Plumbing Specialties:

1. Shock Arresters:
   a. Install PDI-certified and rated shock arresters, sized and located in accordance with PDI WH-201 and as shown on Drawings.
   b. Install adjacent to equipment wherein quick closing valves are installed.
   c. Install at each emergency safety shower.
   d. Shock arresters to have access panels or to be otherwise accessible.
2. Drain P-Trap Priming:
   a. Pipe: Type K, soft copper.
   b. Trap and prime floor drains and hub drains, unless shown otherwise on Drawings. No attempt has been made to show trap primer valve locations or trap primer pipe routing.
   c. Field route trap primer piping during installation of floor drains and hub drains, and install trap primer valves in mechanical rooms, janitor rooms, or other locations acceptable to Engineer.
   d. Priming System: Complete with connection to serving process water system.
3. Trap Priming Valves:
   a. Floor drain traps primed with priming valves, 1/2-inch copper to floor drain.
   b. Two traps maximum primed from one priming valve or as recommended by manufacturer. Locate in mechanical spaces or janitor’s rooms and as indicated on Drawings.
   c. Provide shutoff valve ahead of priming valves.
4. Thermometers and Pressure Gauges:
   a. Arrange devices to facilitate use and observation.
   b. Install in orientation that will allow clear observation from ground level.

c. Provide pressure gauges with block valves.
d. Install thermometers in thermowells.

G. Caulk penetrations of exterior walls with weatherproof sealant in accordance with Section 07 92 00, Joint Sealants.

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

3.03 FIELD QUALITY CONTROL

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

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

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

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing, adjusting, and balancing of air systems.
2. Testing, adjusting, and balancing of hydronic refrigerating systems.
3. Testing, adjusting, and balancing of potable water delivery systems.
4. Measurement of final operating condition of HVAC systems.
5. Sound measurement of equipment operating conditions.
6. Vibration measurement of equipment operating conditions.

1.02 REFERENCES

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

1. Associated Air Balance Council (AABC): MN-1, National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): 11, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
3. Natural Environmental Balancing Bureau (NEBB): Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.03 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed later): Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on forms prepared following NEBB Report forms format.

D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and Copy of NEBB Certificate of Conformance Certification.

F. Submit draft copies of report for review prior to final acceptance of Project.

G. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.04 CLOSEOUT SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed later): Closeout procedures.

B. Project Record Documents: Record actual locations of flow measuring stations.

C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

B. Maintain one copy of each document on site.

C. Prior to commencing Work, calibrate each instrument to be used.

1.06 QUALIFICATIONS

A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum ten years documented experience certified by NEBB.

B. Perform Work under supervision of NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.07 PRE-INSTALLATION MEETINGS

A. Section 01 30 00, Administrative Requirements (to be completed later): Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 SEQUENCING

A. Section 01 10 00, Summary (to be completed later): Work sequence.

B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.09 SCHEDULING

A. Section 01 30 00, Administrative Requirements (to be completed later): Coordination and project conditions.

B. Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Section 01 30 00, Administrative Requirements (to be completed later): Coordination and project conditions.

B. Verify systems are complete and operable before commencing work. Verify the following:

1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.

11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.

3.02 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.03 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space.

C. Hydronic/Water Systems: Adjust to within plus or minus 10 percent of design.

3.04 ADJUSTING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed later): Testing, adjusting, and balancing.

B. Verify recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

E. Report defects and deficiencies noted during performance of services, preventing system balance.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

3.05 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. At modulating damper locations, take measurements and balance at extreme conditions.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inch positive static pressure.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

O. On fan powered VAV boxes, adjust airflow switches for proper operation.

3.06 WATER SYSTEM PROCEDURE

A. Adjust water systems, after air balancing, to obtain design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.

C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.07 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:

1. Air Handling Units.
2. Air Inlets and Outlets.
3. Potable Water Distribution System.

B. Report Forms

1. Title Page:
   a. Name of Testing, Adjusting, and Balancing Agency.

b. Address of Testing, Adjusting, and Balancing Agency.
c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency.
d. Project name.
e. Project location.
f. Project Architect.
g. Project Engineer.
h. Project Contractor.
i. Project altitude.
j. Report date.

2. Summary Comments:
   a. Design versus final performance.
   b. Notable characteristics of system.
   c. Description of systems operation sequence.
   d. Summary of outdoor and exhaust flows to indicate building pressurization.
   e. Nomenclature used throughout report.
   f. Test conditions.
3. Electric Motors:
   a. Manufacturer.
   b. Model/Frame.
   c. HP/BHP and kW.
   d. Phase, voltage, amperage; nameplate, actual, no load.
   e. RPM.
   f. Service factor.
   g. Starter size, rating, heater elements.
   h. Sheave Make/Size/Bore.
4. V-Belt Drive:
   a. Identification/location.
   b. Required driven RPM.
   c. Driven sheave, diameter and RPM.
   d. Belt, size and quantity.
   e. Motor sheave diameter and RPM.
   f. Center to center distance, maximum, minimum, and actual.
5. Air Cooled Condenser:
   a. Identification/number.
   b. Location.
   c. Manufacturer.
   d. Model number.
   e. Serial number.
   f. Entering DB air temperature, design and actual.
   g. Leaving DB air temperature, design and actual.
   h. Number of compressors.

6. Cooling Coil Data:
    a. Identification/number.
    b. Location.
    c. Service.
    d. Manufacturer.
    e. Air flow, design and actual.
    f. Entering air DB temperature, design and actual.
    g. Entering air WB temperature, design and actual.
    h. Leaving air DB temperature, design and actual.
    i. Leaving air WB temperature, design and actual.
    j. Water flow, design and actual.
    k. Water pressure drop, design and actual.
    l. Entering water temperature, design and actual.
    m. Leaving water temperature, design and actual.
    n. Saturated suction temperature, design and actual.
    o. Air pressure drop, design and actual.
7. Potable Water System Data (Remedy Produced Water Building):
    a. Identification/number.
    b. Location.
    c. Service.
    d. Device manufacturers.
    e. System Water Flow, Design, and Actual:
        1) All system devices closed.
        2) One safety shower operational.
        3) One safety shower and one lab sink operational.
    f. Entering makeup water temperature, design, and actual.
    g. Leaving water temperature from storage tank, design, and actual.
    h. Recirculation water temperature back to storage tank, design, and actual.
    i. Glycol water flow and temperature to heat exchanger, design, and actual.
    j. Glycol water flow and temperature from heat exchanger, design, and actual.
    k. Glycol water pressure drop across heat exchanger, design, and actual.
8. Air Moving Equipment:
    a. Location.
    b. Manufacturer.
    c. Model number.
    d. Serial number.
    e. Arrangement/Class/Discharge.
    f. Air flow, specified and actual.
    g. Return air flow, specified and actual.

h. Outside air flow, specified and actual.
i. Total static pressure (total external), specified and actual.
j. Inlet pressure.
k. Discharge pressure.
l. Sheave Make/Size/Bore.
m. Number of Belts/Make/Size.
n. Fan RPM.

9. Return Air/Outside Air Data:
   a. Identification/location.
   b. Design air flow.
   c. Actual air flow.
   d. Design return air flow.
   e. Actual return air flow.
   f. Design outside air flow.
   g. Actual outside air flow.
   h. Return air temperature.
   i. Outside air temperature.
   j. Required mixed air temperature.
   k. Actual mixed air temperature.
   l. Design outside/return air ratio.
   m. Actual outside/return air ratio.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C547, Standard Specification for Mineral Fiber Pipe Insulation.
   c. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
   d. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
   e. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   g. G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
   h. G22, Standard Practice for Determining Resistance of Plastics to Bacteria.
3. Association of the Nonwoven Fabric Industry (INDA). IST 80.6, Water Resistance (Hydrostatic Pressure).
4. National Fire Protection Association (NFPA):
   a. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   b. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   c. 259, Standard Test Method for Potential Heat of Building Materials.
5. Underwriters Laboratories, Inc. (UL).

1.02 DEFINITIONS

A. Cold Air Ductwork: Designed to convey mechanically cooled air or return ducts in such systems.

B. Warm Air Ductwork: Designed to convey mechanically heated air or return ducts in such systems.

1.03 SUBMITTALS

A. Action Submittals: Product description, list of materials and thickness for each service or equipment scheduled, locations, and manufacturer's installation instructions.

B. Informational Submittals: Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.04 QUALITY ASSURANCE

A. Materials furnished under this Specification shall be standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

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

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

1.05 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Stamp or Label:

1. Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Project Site for use must have manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
2. Insulation packages and containers shall be marked "asbestos-free."

PART 2 PRODUCTS

2.01 GENERAL

A. Insulation exterior shall be cleanable, grease-resistant, nonflaking, and nonpeeling.

B. Insulation shall conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.

C. Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

D. Fire Resistance:

1. Insulation, adhesives, vapor barrier materials and other accessories, except as specified herein, shall be noncombustible.
2. Use no fugitive or corrosive treatments to impart flame resistance.
3. Flame proofing treatments subject to deterioration resulting from the effects of moisture or high humidity are not acceptable.
4. Materials including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with ASTM E84 (NFPA 255) methods.

E. Materials exempt from fire-resistant rating:

1. Nylon anchors.
2. Treated wood inserts.

F. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:

1. Polyurethane insulation.
2. PVC casing.
3. Fiberglass-reinforced plastic casing.

2.02 PIPE INSULATION

A. Type P1—Fiberglass (ASTM C547, Type 1 (Minus 20 Degrees F to 500 Degrees F):

1. Fiberglass, UL-rated, preformed, sectional rigid, minimum 4 pounds per cubic foot (pcf) density, K factor 0.23 maximum at 75 degrees F mean, with factory-applied all-service jacket (ASJ) composed of reinforced kraft paper and aluminum foil laminate. Jacket shall have self-sealing lap to facilitate closing longitudinal and end joints.
2. Manufacturers and Products:
    a. CertainTeed; Preformed Pipe Insulation.
    b. Johns Manville; Micro-Lok AP-T.
    c. Owens/Corning; Fiberglas Pipe Insulation.
    d. Knauf; Crown Pipe Insulation.

B. Type P2—Calcium Silicate (ASTM C533, 1,200 Degrees F, Maximum):

1. Calcium silicate, minimum 12 pcf density, K factor 0.46 maximum at 300 degrees F mean, without factory-applied jacket.
2. Manufacturers and Products:
    a. Owens/Corning Fiberglass; Kaylo 10.
    b. Johns Manville; Thermo-12 Gold.
    c. Calsilite; 1,200-degree thermal insulation.

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

1. Flexible, closed cell elastomeric.
2. Nominal 6 pcf density, K factor 0.27 maximum at 75 degrees F mean.
3. Water vapor transmission 0.1 perm-inch, or less.
4. Manufacturers and Products:
    a. Armacell; AP Armaflex.
    b. Nomaco; K-Flex LS.
    c. Rubatex; R-180-FS.

D. Type P4—Cellular Glass:

1. Cellular glass, closed cell, rigid, nominal 8 pcf density, maximum K factor 0.33 at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures to 900 degrees F.
2. Manufacturer and Product: Pittsburgh-Corning; Foamglas.

2.03 DUCT INSULATION

A. Type D1—Blanket (ASTM C553, Type 1, Class B3):

1. Fiberglass, nominal 1 pcf density blanket, K factor 0.31 maximum at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures to 250 degrees F.
2. Manufacturers and Products:
   a. CertainTeed; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Owens/Corning Fiberglass; Soft R.
   d. Knauf; Ductwrap.

B. Type D2—Board:

1. Fiberglass, minimum 2.75 pcf density board, K factor 0.23 maximum at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures from 0 degree F to 450 degrees F.
2. Manufacturers and Products:
   a. CertainTeed; CertaPro Commercial Board.
   b. Knauf; Duct Slab.
   c. Owens/Corning Fiberglass; TIW.
   d. Johns Manville; Ductboard.

C. Type D3—Liner (ASTM C1071, Type 1):

1. Fiberglass, nominal 1.5 pcf density liner, K factor 0.25 maximum at 75 degrees F mean, black composite coated surface exposed to airstream to prevent erosion of glass fibers, for temperatures to 250 degrees F.
2. Liquid water repellency rating not less than 4 when tested in accordance with INDA IST 80.6.
3. Potential heat value not exceeding 3,500 Btu/lb when tested in accordance with NFPA 259 and meeting the classification of “Limited Combustible” as defined by NFPA 90A.
4. Maximum rated velocity not less than 6,000 fpm when tested in accordance with ASTM C1071.
5. Resistant to microbial growth using a “no growth criteria” when tested in accordance with ASTM C1139, ASTM G21, and ASTM G22.
6. Manufacturers and Products:
   a. CertainTeed; Toughgard.
   b. Johns Manville; Linacoustic (rectangular), Spinacoustic (Round).
   c. Knauf; Acoustic Duct Liner.

2.04 EQUIPMENT INSULATION

A. Type E1—Elastomeric (ASTM C534):

1. Flexible, closed-cell elastomeric, nominal 6 pcf density, K factor 0.27 maximum at 75 degrees F mean.
2. Manufacturers and Products:
   a. Armstrong; Armaflex II.
   b. Nomaco; Therma-Cel.
   c. Rubatex; R-180-FS.

B. Type E2—Board:

1. Fiberglass, minimum 2.75 pcf density board, K factor 0.23 maximum at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures from 100 degrees F to 850 degrees F.
2. Manufacturers and Products:
   a. CertainTeed; CertaPro Commercial Board.
   b. Knauf; Duct Slab.
   c. Owens/Corning Fiberglass; TIW.
   d. Johns Manville; 1000 Series Spin-Glass.

2.05 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, white, for straight run piping and fitting locations, temperatures to 159 degrees F.
2. Manufacturers and Products:
   a. Johns Manville; Zeston.
   b. Ceel-Co; 550.

B. Type F2—Paint:

1. Acrylic latex paint, white, and suitable for outdoor use.
2. Manufacturers and Products:
   a. Armstrong; WB Armaflex finish.
   b. Rubatex; 374, white finish.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.016-inch thickness, with smooth mill finish.

2. Moisture Barrier: Provide factory applied moisture barrier, consisting of 40-pound kraft paper with 1-mil-thick low-density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, etc.
4. Manufacturer and Product: RPR Products; INSUL-MATE.

PART 3 EXECUTION

3.01 APPLICATION OF PIPING INSULATION

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

S. Placement:

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

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

U. Vapor Barrier:

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

3.02 INSTALLATION OF DUCTWORK INSULATION

A. General: Install insulation products in accordance with the manufacturer's written instructions and in accordance with recognized industry practices.

B. Install insulation materials with smooth and even surfaces.

C. Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.

E. Seal longitudinal and circumferential joints with FSK tape, and finish with fiberglass mesh fabric embedded in vapor barrier mastic.

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

G. Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

H. Refer to Section 23 31 13, Metal Ducts and Accessories, for installation of internal duct liner.

3.03 INSTALLATION OF EQUIPMENT INSULATION

A. Application Requirements: Insulate where external surface temperature of equipment is below ambient temperature in the space, including surfaces that have a recognized possibility for condensation.

B. Install equipment thermal insulation products in accordance with manufacturer's written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

C. Install insulation materials with smooth and even surfaces and on clear and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

D. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

E. Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.

F. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture-saturated units.

G. Avoid using scrap pieces of insulation where larger sheets will fit.

3.04 INSTALLATION OF INSULATION FINISH SYSTEMS

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

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

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

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

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

F. Caulk and seal all exterior joints to make watertight.

3.05 PIPING INSULATION REQUIREMENTS

A. Refrigeration Suction:

1. Type P3, elastomeric.
2. 1/2-inch thickness for pipe sizes up to 1 inch.
3. 3/4-inch thickness for pipe sizes over 1 inch.

B. Refrigeration Hot Gas Reheat:

1. Type P3, elastomeric.
2. 3/4-inch thickness.

C. Stack:

1. Type P1A.
2. 2-inch thickness for temperatures up to 700 degrees F.

3. 3-inch thickness for temperatures over 700 degrees F.

D. Pipe Hangers:

1. Type P1, Fiberglass: UL-rated, preformed rigid pipe insulation inserts of thickness equal to adjoining insulation, 10 inches in length, with factory-applied, vinyl-coated and embossed vapor barrier jacket with self-sealing lap.
2. Type P3, Elastomeric: Rigid insulation section with 9-inch-long, 16-gauge galvanized steel saddle.

3.06 DUCTWORK INSULATION REQUIREMENTS

A. Mechanically Cooled and Heated Supply Air;

1. Type D1, blanket.
2. 1-inch thickness.

B. Mechanically Cooled and Heated Supply and Return Air, within 5 Feet of Air Handling Unit:

1. Type D3, liner.
2. 1-inch thickness.

C. Outside Air Intake:

1. Type D1, blanket.
2. 1-1/2-inch thickness.

D. Sheet Metal Plenums:

1. Type D3, liner.
2. 1-inch thickness.

E. Air Distribution Devices: Refer to Section 23 37 00, Air Outlets and Inlets, for requirements.

3.07 INSULATION FINISH REQUIREMENTS

A. Piping, Duct, and Equipment Insulation (Concealed Areas): Factory finish.

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

C. Ductwork Insulation (Exposed to View, Indoors): Factory finish.

D. Equipment Insulation (Exposed to View, Indoors): Type F2, paint (for use with Type P3, elastomeric).

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

3.08 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 760, Performance Rating of Solenoid Valves for Use with Volatile Refrigerants.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): 15, Safety Standard for Refrigeration Systems.
3. American Society of Mechanical Engineers (ASME):
   a. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   b. B31.5, Refrigeration Piping and Heat Transfer Components.
4. American Welding Society (AWS):
   a. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   b. BRH, Brazing Handbook.
5. ASTM International (ASTM): B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
6. National Electrical Manufacturers Association (NEMA).
7. Underwriters Laboratories Inc. (UL).

1.02 DEFINITIONS

A. ACR: Air conditioning and refrigeration.

B. NRTL: National Recognized Testing Laboratory.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings in 1/4-inch scale for refrigerant piping showing pipe and tube sizes, flow capacities location, elevations, fittings, accessories, and piping connections.

2. Manufacturer's data on refrigerant piping, piping products, thermostatic expansion valves, solenoid valves, hot-gas bypass valves, filter dryers, strainers, pressure regulating valves and accessories.

B. Informational Submittals:

1. Welding certificates.
2. Field quality control; test report.

C. LEED Submittals:

1. Documentation required indicating compliance with Fundamental Refrigerant Management—EA Prerequisite 3.
2. Documentation required indicating compliance with Enhanced Refrigerant Management—EA Credit 4.

1.04 QUALITY ASSURANCE

A. Safety Code Compliance: Comply with applicable portions of ASHRAE 15.

B. Brazing: Comply with applicable requirements of ASME B31.5 pertaining to brazing of refrigerant piping for shop and Project Site locations.

C. Installer: A firm with at least 5 years of successful installation experience on projects with refrigerant piping similar to that required for this Project.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Refrigerant piping shall be cleaned, dehydrated, and sealed when delivered.

B. Store piping in clean and protected area with end caps in place.

PART 2 PRODUCTS

2.01 MATERIALS

A. Material and dimensional requirements for field assembled refrigerant piping, valves, fittings and accessories shall conform to ASHRAE 15 and ASME B31.5, except as hereinafter specified.

B. Piping, 3 Inches and Smaller: Copper, Type ACR tube, ASTM B280, copper No. 122, hard-drawn temper. Brazed joints required.

C. Fittings for Copper Tube: Wrought-copper/bronze solder-joint fittings in accordance with ASME B16.22.

D. Pipe Insulation: Refer to Section 23 07 00, HVAC Insulation.

2.02 MISCELLANEOUS PIPING PRODUCTS

A. Brazing Materials:

1. Except as otherwise indicated, provide 15 percent silver alloy brazing material for copper to copper and copper to brass fittings.
2. Comply with AWS A5.8M/A5.8 for brazing filler materials.

B. Refrigerant Specialties:

1. Refrigerant Suction Line Filter-Dryer:
   a. Provide steel shell, corrosion-resistant finish filter-dryer, with molded felt core with 10-micron particle retention, in size and working pressure indicated, with copper connectors, and access valve (not applicable for heat pump system).
   b. Operating Temperature Rating: 240 degrees F.
   c. Working Pressure: 500 psi.
   d. Provide size recommended by refrigeration equipment manufacturer.
2. Refrigerant Liquid Line Dryer:
   a. Provide refrigerant liquid line filter-dryer for all units.
   b. Operating Temperature Rating: 240 degrees F.
   c. Working Pressure: 500 psi.
   d. For heat pumps, provide biflow directional types (not required if included with air-conditioning equipment).
   e. Provide size recommended by refrigeration equipment manufacturer.

C. Refrigerant Valves:

1. Globe and Check Valves: Listed and labeled by an NRTL.
   a. Shutoff Valves:
      1) Forged brass, packed, back seating winged seal cap, 300 degrees F (140 degrees C) temperature rating 500 psi working pressure.
      2) Maximum Opening Pressure: 0.5 psig.
      3) Valve required only if shutoff service valves are not included with package air-conditioning equipment.
   b. Manufacturers:
      1) Henry Technologies.
      2) Parker Hannifin Corp.

2. Solenoid Valve: Listed and labeled by an NRTL.
    a. Two-Way Solenoid Valves: Forged brass, designed to conform to AHRI 760, normally closed, Teflon valve seat, NEMA 1 solenoid enclosure, 24 volts, 60-Hz, UL Listed, 1/2-inch conduit adapter, 250 degrees F (121 degrees C) temperature rating 500 psi working pressure.
    b. Provide valve only if recommended by air-conditioning equipment manufacturer.
    c. Manual Operator: Provide optional manual operator to open valve.
    d. Manufacturers:
        1) Alco Controls Div.; Emerson Electric Co.
        2) Automatic Switch Co.
        3) Parker Hannifin Corp.
3. Thermostatic Expansion Valve:
    a. Body Bonnet and Seal Cap: Forged brass or steel.
    b. Diaphragm, Piston, Closing Spring and Seat Insert: Stainless steel.
    c. Capillary and Bulb: Copper tubing filled with refrigerant.
    d. Suction Temperature: 40 degrees F.
    e. End Connections: Socket or flare.
    f. Working Pressure: 700 psig.
    g. Manufacturers:
        1) Henry Technologies.
        2) Parker Hannifin Corp.
        3) Danfoss Group Global.
4. Safety Relief Valve:
    a. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
    b. Seat Disk: Polytetrafluoroethylene.
    c. Working Pressure: 500 psig.
    d. Operating Temperature: 240 degrees F, maximum.
    e. Manufacturers:
        1) Henry Technologies.
        2) Parker Hannifin Corp.
        3) Danfoss Group Global.

D. Refer to Section 40 05 15, Piping Support Systems, for piping shields and piping support requirements.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING SYSTEM

A. Install piping products in accordance with manufacturer's written instructions, applicable requirements of ASME B31.5, ASHRAE 15, and in accordance with recognized industry practices to ensure products serve intended function.

B. Install dryers on liquid and suction lines.

C. Refrigerant Piping:

1. Cut pipe accurately to measurements established at Site and work into place without springing or forcing.
2. Install piping with sufficient flexibility to adequately provide for expansion and contraction as a result of temperature fluctuation inherent in its operation.
3. Where pipe passes through building structure, pipe joints shall not be concealed, but located where they may be readily inspected.
4. Run pipe to be insulated as shown and as required with sufficient clearance to permit application of insulation.
5. Run piping as shown on Drawings, taking care to avoid interference with other piping, conduit or equipment. Except where specifically indicated otherwise, run piping plumb, and straight and parallel to walls and ceilings.
6. Trapping of lines shall not be permitted, except where indicated.
7. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
8. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.
11. Install refrigerant piping in protective conduit where installed belowground.
12. Install accumulator in suction line near condensing unit.
13. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
14. Slope refrigerant piping as follows:
    a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
    b. Install horizontal suction lines with a uniform slope downward to compressor.

c. Install traps and double risers to entrain oil in vertical runs.
d. Liquid lines may be installed level.

D. Pipe Sleeves:

1. Provide pipe sleeves of suitable size for pipe and tubing that penetrate building structure.
2. Secure sleeves in position and location before and during construction. Space between pipe and sleeves, or between insulation and pipe sleeves, shall be not less than 1/4 inch between outside of pipe or insulation, and inside wall of sleeves.
3. Sleeves for uninsulated pipes shall have ends flush with finished wall surfaces; provide pipe or tubing as above with outside perimeter of pipe caulked to sleeve.
4. Extend sleeves for insulated pipes 1/2 inch from wall faces and caulk to sleeve on both sides.
5. Seal terminal ends of pipe insulation with mastic.
6. Extend sleeves for lines passing through floors 3 inches above finished floor slab and caulk to slab.

E. Braze cap (seal) ends of piping when not connected to mechanical equipment.

3.02 SOLDER JOINTS

A. Solder joints shall not be used for joining refrigerant piping systems.

3.03 BRAZED JOINTS

A. Braze copper piping with silver solder complying with AWS A5.8M/A5.8.

B. Brazed Joints:

1. Construct joints according to AWS *Brazing Handbook* Chapter “Pipe and Tube”.
2. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
3. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

C. Inside of tubing and fittings shall be free of flux.

D. Clean parts to be joined with emery cloth and keep hot until solder has penetrated full depth of fitting and extra flux has been expelled.

E. Cool joints in air and remove flame marks and traces of flux.

F. During brazing operation, prevent an oxide film from forming on inside of tubing by slowly flowing dry nitrogen to expel air.

G. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

3.04 PIPE HANGERS

A. Refer to Section 40 05 15, Piping Support Systems, for piping shields and piping support requirements.

3.05 EQUIPMENT CONNECTIONS

A. Connect refrigerant piping to mechanical equipment in the manner shown, and comply with equipment manufacturer's instructions where not otherwise indicated.

3.06 FIELD QUALITY CONTROL

A. General:

1. Notify Engineer at least 48 hours before testing is performed.
2. Furnish equipment required for tests.
3. Group as many systems together as possible when testing in order to consolidate number of test inspections.

B. Leak Test:

1. Prior to initial operation, clean and test refrigerant piping in accordance with ASME B31.5.
2. Perform initial test with dry nitrogen to 300 psig minimum using soap solution to test joints.
3. Evacuate system after initial test and charge system with refrigerant or dry nitrogen, 20 percent refrigeration mixture to 600 psig minimum.
4. Upon completion of initial system test, test factory, as well as field, refrigerant piping joints with electronic-type leak detector to acquire a leak-tight refrigerant system.
    a. If leaks are detected, remove entire refrigerant charge for the system, replace defective pipe or fitting, and retest entire system as specified above.

C. Evacuation, Dehydration, and Charging:

1. After system is found to be without leaks, evacuate system using reliable gauge and vacuum pump capable of pulling a vacuum of at least 1-mm Hg absolute (29.88-inch Hg gage).
2. Evacuate system with vacuum pump until temperature of 35 degrees F (2 degrees C) is indicated on vacuum dehydration indicator.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
4. Maintain vacuum on system for minimum of 12 hours after closing valve between vacuum pump and system. If system holds vacuum for 12 hours it is ready for charging.
5. Break vacuum with refrigerant gas or dry nitrogen gas, allowing pressure to build up to 2 psi (15 kPa).
6. Install new filter-dryer core in charging line.
7. Repeat evacuation procedure and complete charging of system; provide full operating charge.

3.07 ADJUSTING

A. General:

1. Adjust high-pressure and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
2. Adjust setpoint temperature of air-conditioning or chilled-water controllers to system design temperature.
3. Perform following adjustments according to manufacturer’s written instructions before operating refrigeration system:
   a. Open shutoff valves in condenser water circuit.
   b. Verify compressor oil level is correct.
   c. Open compressor suction and discharge valves.
   d. Open refrigerant valves, except bypass valves that are used for other purposes.
   e. Check open compressor-motor alignment and verify lubrication for motors and bearings.

B. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13
METAL DUCTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Movement and Control Association (AMCA): 500, Test Methods for Louvers, Dampers and Shutters.
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook.
3. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
4. Association of the Nonwoven Fabrics Industry (INDA): IST 80.6, Water Resistance (Hydrostatic Pressure).
5. ASTM International (ASTM):
    a. A36/A36M, Standard Specification for Carbon Structural Steel.
    b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
    c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    d. A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.
    e. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    f. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
    g. A568/A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
    h. A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    i. A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment.
    j. A924/A924M, Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Process.

k. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
l. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
m. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
n. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
o. C916, Standard Specification for Adhesives for Duct Thermal Insulation.
p. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
q. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
r. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
s. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

6. National Air Duct Cleaners Association (NADCA): General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.
7. National Fire Protection Association (NFPA):
   a. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
   b. 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   c. 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
   d. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   e. 259, Standard Test Method for Potential Heat of Building Materials.
   f. 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Duct Construction Standards.

b. Guidelines for Seismic Restraints of Mechanical Systems.
c. Fibrous Glass Duct Construction Standards.
d. Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
e. HVAC Air Duct Leakage Test Manual.

9. Underwriters Laboratories Inc. (UL):
a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.
b. 214, Standard for Tests for Flame-Propagation of Fabrics and Films.
c. 555, Standard for Safety Fire Dampers.
d. 555S, Standard for Safety Smoke Dampers.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. CFM: Cubic feet per minute.
2. FPM: Feet per minute.
3. PCF: Pounds per cubic foot.
4. WC: Water column.

B. Sealing Requirements: For the purpose of duct systems sealing requirements specified in this section, the following definitions apply:

1. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.
2. Joints, duct surface connections including:
a. Girth joints.
b. Branch and subbranch intersections.
c. Duct collar tap-ins.
d. Fitting subsections.
e. Louver and air terminal connections to ducts.
f. Access door, and access panel frames and jambs.
g. Duct, plenum, and casing abutments to building structures.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Rectangular, Rigid Round, and Oval Ductwork:
      1) Schedules of duct systems, materials, joints, sealing, gage and reinforcement.
      2) SMACNA Figure Numbers for each shop fabricated item.
      3) Reinforcing details and spacing.
      4) Seam and joint construction details.
      5) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
   b. Ductwork Accessories:
      1) Manufacturer's product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, and finishes, including the following items:
         a) Fittings and volume control damper installation (both manual and automatic) details.
         b) Duct liner.
         c) Sealing materials.
         d) Dampers; include leakage, pressure drop, and maximum back pressure data.
         e) Duct-mounted access panels and doors.
         f) Flexible ducts.
         g) Sheet metal fasteners.
2. Duct Fabrication Drawings:
   a. Drawn after actual job measurements are obtained.
   b. Drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Drawings.
   c. Include the following features:
      1) Fabrication, assembly, and installation details including plans, elevations, sections, details of components, and attachments to other work.
      2) Duct layout, indicating pressure classifications, and sizes in plan view.
      3) Duct material and thickness.
      4) Fittings and volume control damper installation (both manual and automatic) details.
      5) Reinforcing details and spacing.

6) Seam and joint construction details.
7) Penetrations through fire-rated and other partitions.
8) Duct accessories and control devices such as automatic dampers, airflow monitors, terminal units, smoke detectors, regulators, air distribution devices, etc.
9) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
10) Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installation.
11) Coordination with ceiling suspension members.
12) Spatial coordination with other systems installed in same space with duct systems.
13) Coordination of ceiling- and wall-mounted access doors and panels required for access to dampers and other operating devices.
14) Coordination with ceiling-mounted lighting fixtures, air outlets, and inlets.
15) Coordination of ductwork with sprinkler piping and other mechanical and electrical services, and equipment.

3. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing (to be completed).

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing (to be completed).
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing (to be completed).
3. Sound Attenuators Certified Test Data:
   a. Dynamic insertion loss.
   b. Self-noise power levels.
   c. Static pressure loss.
   d. Dimensions and weights.
4. Record Drawings: Include duct systems routing, fittings details, and installed accessories and devices.

1.04 QUALITY ASSURANCE

A. Industry Standards:

1. Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA Duct

Construction Standards relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.

2. Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.
3. NFPA Compliance: NFPA 90A and NFPA 90B.

B. Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

C. Suppliers of duct and fitting components shall provide on request the following information:

1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
2. Laboratory performance data for fittings, including zero-length dynamic losses.

D. Installer shall be a firm with at least 3 years' experience of successful installation on ductwork systems similar to that required for this Project.

E. Changes or alterations to layout or configuration of duct system shall be:

1. Specifically approved in writing by Engineer.
2. Proposed layout shall provide original design results, without increasing system total pressure.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork from dirt, water, and debris. During storage on Job Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

B. Deliver sealant materials to Site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

C. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

D. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 PRODUCTS

2.01 SCHEDULES

A. Ductwork Schedule: Refer to Drawings.

2.02 GENERAL

A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

C. Ductwork Interior Surfaces:

1. Smooth.
2. No sheet metal parts, tabs, angles, or other items may project into air ducts, unless otherwise specified.
3. Seams and joints shall be external.

2.03 SHEET METAL MATERIALS

A. Construct metal duct systems from galvanized steel

B. Where no specific ductwork materials are indicated in Specifications or on Drawings, galvanized steel sheet metal shall be basis of Contract.

C. Galvanized Steel Ductwork:

1. Comply with ASTM A653/A653M and ASTM A924/924M.
2. Product Name: Steel Sheet, Zinc Coated (Galvanized Steel).
3. Sheet Designation: CS Type B.
4. Applicable Specification: ASTM A653/A653M.
5. (Zinc) Coating Designation: G90.
6. Coating designation in accordance with Test Method A, ASTM A90/A90M and ASTM A924/A924M.
7. Provide mill-phosphatized finish for ducts exposed to view and for ducts scheduled to be painted.
8. Provide sheet metal packaged and marked as specified in ASTM A700.

D. Exposed Ductwork: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

E. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

2.04 DUCT SEALING MATERIALS

A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

2.05 DUCTWORK FASTENERS

A. General:

1. Rivets, bolts, or sheet metal screws.
2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

B. Self-Drilling Screws:

1. Galvanized Steel Ductwork System: Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated carbon steel with zinc electroplated finish.

2.06 DUCTWORK PRESSURE CLASS

A. Construct duct systems to pressure classifications indicated as follows:

1. Supply Ducts: 2-inch WC.
2. Return Ducts: 2-inch WC, negative pressure.
3. Exhaust Ducts: 2-inch WC, negative pressure.

B. Where no specific duct pressure designations are indicated in Specifications or on Drawings, 2-inch WC pressure class shall be basis of Contract.

2.07 RECTANGULAR DUCTWORK

A. Fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible unless specified otherwise.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20-gauge or less, with more than 10 square feet of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

C. Duct sheet metal gages as specified on 2013 CMC.

2.08 RECTANGULAR DUCTWORK FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. Elbows:

1. Fit square-turn elbows with vane side rails.
2. Shop fabricate double-blade turning vanes of same material as ductwork.
3. Fabricate with equal inlet and outlet.
4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.
5. Manufacturers and Products:
    a. Elgen; All-Tight.
    b. Duro-Dyne; Type TR.

2.09 RECTANGULAR DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections to rectangular duct mains shall be made using with factory fabricated, field installed taps, with spin-in or mechanical fastened tap to main duct connections.

2.10 RECTANGULAR DUCTWORK INSULATION LINER

A. Location: Provide ductwork with internal insulation liner where indicated on Drawings or in Ductwork Schedule.

B. Material:

1. Fiberglass, nominal 1.5 pcf density liner, K factor 0.25 maximum at 75 degrees F mean.
2. Black composite coating on surface exposed to airstream to prevent erosion of glass fibers, for temperatures to 250 degrees F.
3. Liquid water repellency rating not less than 4.0 when tested in accordance with INDA IST 80.6.
4. Potential heat value not exceeding 3,500 Btu per hour per pound when tested in accordance with NFPA 259 and meeting classification of "Limited Combustible" as defined by NFPA 90A.
5. Maximum rated velocity not less than 6,000 fpm when tested in accordance with ASTM C1071.
6. Resistant to microbial growth using a "no growth criteria" when tested in accordance with ASTM C1139.
7. Manufacturers and Products:
   a. CertainTeed; Toughgard.
   b. JohnsManville; Linacoustic RC.
   c. Knauf; Duct Liner M.

C. Thickness: Minimum 1 inch or greater.

D. R-Value: Minimum R-8 per T24 requirement.

E. Liner Adhesive: In accordance with NFPA 90A and ASTM C916.

F. Mechanical Fasteners:

1. Same material as ductwork, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.
2. Provide fasteners that do not damage liner when applied as recommended by manufacturer, that do not cause leakage in duct, and will indefinitely sustain 50-pound tensile dead load test perpendicular to duct wall.
3. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
4. Adhesive for Attachment of Mechanical Fasteners: In accordance with Fire Hazard Classification of duct liner system.

G. Liner Application:

1. Ductwork liner shall be applied at time of ductwork manufacture in an approved sheet metal workshop.

2. Adhere single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.
3. Apply coat of adhesive to liner facing in direction of airflow not receiving metal nosing.
4. Butt transverse joints without gaps and coat joint with adhesive.
5. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.
6. Longitudinal Joints:
   a. Shall not occur except at corners of ducts, unless size of duct and standard liner product dimensions make longitudinal joints necessary.
   b. Apply adhesive coating on longitudinal seams in ducts exceeding 2,500 fpm air velocity.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter, at 3 inches from transverse joints, and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing airstream with metal nosing that are either channel or “Z” profile or are integrally formed from duct wall at the following locations:
   a. Fan discharge.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts.
9. Seal insulation edges.
10. Repair abrasions or tears with mastic.

2.11 RIGID ROUND DUCTWORK

A. Construct rigid round ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Basic Round Diameter: As used in this Article, is inside diameter of size of round duct.

C. Where space limitations prevent use of round duct or where shown on Drawings, provide ductwork of flat oval construction hydraulically equivalent to round ductwork.

D. Fabricate round ducts with spiral seam construction, except where diameters exceed 72 inches. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams.

E. Snaplock seams may only be used for duct systems of construction pressure classification less than 2-inch WC

2.12 RIGID ROUND DUCTWORK FITTINGS

A. Construct rigid round ductwork fittings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless otherwise specified.

B. 90-Degree Tees, Laterals, and Conical Tees: Fabricate to conform to SMACNA manual with metal thicknesses specified for longitudinal seam straight duct.

C. Diverging Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

D. Elbows:

1. Fabricate in stamped (die-formed), pleated, or segmented (gored) construction 1.5 times elbow diameter. Two piece segment elbows are not allowed, except with turning vanes.
2. Segmented Elbows: Fabricate with welded construction.
3. Round Elbows 8 Inches and Smaller:
    a. Stamped elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees configuration.
    b. Fabricate nonstandard bend angle configurations or nonstandard sized (for example, 3-1/2 inches and 4-1/2 inches) elbows with segmented construction.
4. Round Elbows 9 Inches Through 14 Inches:
    a. Segmented or pleated elbows for 30, 45, 60, and 90 degrees.
    b. Fabricate nonstandard bend angle configurations or nonstandard sized (for example, 9-1/2 inches and 10-1/2 inches) elbows with segmented construction.

2.13 ROUND DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections (taps) to round duct mains shall be made using factory fabricated fittings.

2.14 ROUND DUCTWORK INSULATION LINER

A. Location: Provide round ductwork with internal insulation liner where indicated on Drawings or in Ductwork Schedule.

B. Material:

1. Fiberglass, nominal 4.0-pcf density, K factor 0.23 maximum at 75 degrees F mean.
2. Black composite coating on surface exposed to air stream, to prevent erosion of glass fibers.
3. Suitable for temperatures up to 250 degrees F.
4. Noise Reduction Coefficient: Minimum 0.75 for 1.0-inch thickness, in accordance with ASTM C423.
5. Liquid water repellency rating not less than 4.0 when tested in accordance with INDA IST 80.6.
6. Potential heat value not exceeding 3,500 Btu per hour per pound when tested in accordance with NFPA 259 and meeting classification of "Limited Combustible" as defined by NFPA 90A.
7. Maximum rated velocity not less than 6,000 fpm when tested in accordance with ASTM C1071.
8. Resistant to microbial growth using a "no growth criteria" when tested in accordance with ASTM C1139.
9. Manufacturers and Products:
   a. CertainTeed.
   b. Johns Manville; Spiracoustic Plus.
   c. Knauf.

C. Thickness: Minimum 1.0 inch or greater thickness.

D. R-Value: Minimum R-8 per T24 requirement.

E. Liner Application:

1. Install liner in accordance with manufacturer's instructions.
2. In Straight Duct Sections: Apply at time of ductwork manufacture in an approved sheet metal workshop, or field install.
3. In Duct Fittings: Apply at time of ductwork manufacture in an approved sheet metal workshop only.
4. Install single layer of indicated thickness of duct liner. Multiple layers of insulation to achieve indicated thickness is prohibited.
5. Fastening: Interference fit.
6. Seal insulation edges.
7. Repair abrasions or tears with mastic.

2.15 INSULATED FLEXIBLE DUCT

A. Fabricate in accordance with:

1. UL 181, Class 1.
2. NFPA 90A and NFPA 90B.

B. Construction:

1. Outer Jacket: Fire retardant reinforced metalized vapor barrier jacket with reinforced cross-hatched scrim having a permeance of not greater than 0.1 perm when tested in accordance with ASTM E96/E96M, Procedure A.
2. Inner Liner: Tri-laminate of aluminum foil, fiberglass, and aluminized polyester.
3. Reinforcing: Galvanized steel wire helix, mechanically locked to and encapsulated by inner liner fabric.
4. Insulation:
   a. Factory insulated with fiberglass insulation.
   b. R-value: 6.0 minimum at a mean temperature of 75 degrees F.
5. Internal Working Pressure: Rating shall be minimum 4-inch WC positive and 5-inch WC negative, with bursting pressure of at least 2-1/2 times working pressure.
6. Air Velocity Rating: 4,000 fpm, minimum.

C. Environment: Suitable for continuous operation at temperature range of minus 20 degrees F to plus 200 degrees F.

D. Manufacturers and Products:

1. Flex-Master; Type 5M.
2. Thermaflex; Type M-KC.
3. Hart & Cooley; Type F216.

2.16 DUCTWORK HANGERS AND SUPPORTS

A. General:

1. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.
2. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.

3. Wire hangers are not acceptable.
4. Hanger Spacing:
    a. Ducts Up to 60 inches in Largest Dimension: 10 feet, maximum.
    b. Ducts Over 61 inches in Largest Dimension: 8 feet, maximum.

B. Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:

1. Galvanized Steel Ductwork:
    a. Indoors: Carbon steel, zinc electroplated.
    b. Outdoors: Carbon steel, hot-dipped galvanized after fabrication.
2. Aluminum Ductwork Indoors and Outdoors:
    a. Carbon steel, hot-dipped galvanized after fabrication.
    b. Non-metallic pad between lower attachment and ductwork, to achieve dielectric separation.
3. Stainless Steel Ductwork Indoor and Outdoors: Stainless steel, same ASTM Grade as ductwork.

C. Building Attachments:

1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
3. Upper Attachment (Concrete):
    a. Drive pin fastener and expansion nail anchor may be used for ducts up to 18-inch maximum dimension.
    b. Threaded stud fastener may be used for ducts up to 36-inch maximum dimension.
    c. Concrete attachments shall be made of steel.

D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fasteners.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.17 DUCTWORK FLEXIBLE CONNECTIONS

A. General:

1. Factory fabricated metal-edged fabric flexible connectors for commercial or industrial applications.
2. Sheet metal permanently secured to fabric with double fabric fold, double metal crimp.
3. Comply with NFPA 90A and NFPA 90B requirements.
4. Airtight and waterproof.

B. Materials:

1. Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
2. Metal Edges: Construct from same material as ductwork, unless otherwise noted.
3. Fabric:
   a. Comply with NFPA 701 or UL 214 (except Teflon coated).
   b. Woven polyester or nylon for most applications.
   c. Woven fiberglass for high temperature applications.
   d. Coating: Neoprene.

C. Construction:

1. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA Manual.
2. Standard Metal Edged Connectors: Strip of fabric 3 inches wide attached to two strips of 3-inch-wide sheet metal.
3. Wide Metal Edged Connectors: Strip of fabric 4 inches wide attached to two strips of 4-inch-wide sheet metal.
4. Extra Wide Metal Edged Connectors: Strip of fabric 6 inches wide attached to two strips of 6-inch-wide sheet metal.

D. Manufacturers and Products:

1. Ductmate; PROflex, Commercial.
2. Ventfabrics.
3. Duro-Dyne.

2.18 DUCT INSPECTION DOORS

A. General:

1. Insulated, gasketed, and at least 15 inches by 15 inches when duct dimensions are large enough.
2. On ductwork where largest side dimension is less than 16 inches, furnish inspection doors at least 8 inches by 8 inches.
3. Complete with necessary hardware and either Amerlock 10 or Ventlock No. 100 latches, and Ventlock Series No. 100 hinges.
4. Fabricated of same material as ductwork

B. Round Spin-in Type Access Doors:

1. Size: 18-inch and 24-inch diameter will be acceptable in lieu of comparable size square or rectangular access doors specified herein.
2. Complete with insulation, spin-in frame, inner door, attachment cable, gaskets, three latches, and pull ring.
3. Manufacturer and Product: Flexmaster; Inspector Series.

C. Manufacturers:

1. Ventlok.
2. Duro-Dyne.
3. Flexmaster.

2.19 MANUAL DAMPERS

A. Butterfly Manual Dampers:

1. Fabricate from two gauges heavier than duct in which installed, of same material as ductwork.
2. Align operating handle with damper blade.
3. Provide 2-inch standoff bracket for insulated duct systems.
4. Damper Manufacturers:
   a. Ruskin.
   b. American Warming and Ventilating.
5. Operator Manufacturers and Products:
   a. Accessible Ductwork: Ventlok; Type 620 or 635.
   b. Accessible Insulated Ductwork: Ventlok; Type 639.
   c. Concealed Ductwork: Ventlok; Type 677 with extended operating rod and concealed regulator with plain cover.

B. Manual Opposed-Blade Balancing Dampers:

1. Externally operated gang airfoil, damper blades.
2. Fabricate from same material as ductwork.
3. Stainless steel or nylon sleeve bearings.
4. Construction shall have interlocking edges and maximum 10-inch blade width.
5. Manufacturers and Products:
   a. Ruskin; CD102.
   b. American Warming and Ventilating; Model VC-31.

2.20 BACK DRAFT DAMPERS

A. General: Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.

B. Steel Frame, Nonmetallic Blades:

1. Fabrication:
   a. Frame: 2 inches by minimum 18-gauge (51 mm by minimum 1.6 mm) galvanized steel with windstops to reduce backflow.
   b. Blades:
      1) Style: Single piece, independent.
      2) Action: Parallel.
      3) Material: Noncombustible, neoprene coated fiberglass.
      4) Orientation: Horizontal.
      5) Width: Maximum 6 inches (152 mm).
   c. Rear Bird Screen: Galvanized expanded metal.
   d. Mounting:
      1) Suitable for mounting in vertical or horizontal airflow up positions.
      2) Configured for positions as shown on Drawings.
   e. Finish: Mill galvanized.
2. Performance Data:
   a. Temperature Rating: Withstand minus 30 degrees to 200 degrees F (minus 34 degrees to 93 degrees C).
   b. Maximum Back Pressure: 4-inch WC (1.0 kPa).
   c. Maximum System Air Velocity: 1,000 fpm (5.1 m/s).
   d. Maximum Spot Air Velocity: 1,200 fpm (6.1 m/s).
3. Accessories:
   a. Duct Transition Connection Round or Rectangular per plan.
   b. Factory Sleeve: Minimum 20-gauge (1.0 mm) thickness, minimum 8 inch (203 mm) length

c. Screen:
1) Type: Bird.
2) Location: Front with sleeve.
3) Material: Galvanized steel.

4. Manufacturers and Products:
a. Ruskin; Model NMS2.
b. Vent Products, Co.

2.21 MISCELLANEOUS ACCESSORIES

A. Louver and Grille Blank-Off Sections:

1. Fabricate from 20-gauge sheets of same material as louver/grille.
2. Line with sound attenuation/insulating material.
3. Shop-prime and paint outside face of blank-off section with two coats of flat black exterior paint.

B. Auxiliary Drain Pans:

1. Dimensions: Minimum 6 inches larger in both dimensions than equipment it is serving and 2 inches high, minimum.
2. Construction: 16-gauge stainless steel with welded joints. Pans shall be watertight and have hemmed edges.
3. Drain Connection:
a. Minimum 1-inch IPS or as shown on Drawings.
b. Locate at lowest point of drain pan.
c. In lieu of drain connection, float switch may be installed. Float switch shall shut down air handling equipment upon sensing water.

C. Accessories Hardware:

1. Instrument Test Holes:
a. Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.
b. Size to allow insertion of pitot tube and other testing instruments.
c. Provide in length to suit duct insulation thickness.
2. Flexible Duct Clamps:
a. Stainless steel band with cadmium-plated hex screw to tighten band with worm-gear action.
b. Provide in sizes from 3 inches to 18 inches to suit duct size.
3. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

2.22 DUCTWORK IDENTIFICATION

A. Painted Identification Materials:

1. Stencils: Standard metal stencils, prepared for required applications with letter sizes generally comply with recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4-inch high letters for ductwork and not less than 3/4-inch-high letters for access door signs and similar operational instructions.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
3. Identification Paint: Standard identification enamel of colors indicated or in accordance with ASME A13.1 for colors for systems not identified herein.

B. Plastic Duct Markers

1. General: Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color code:
   a. Black text on yellow background: Odorous Air.
   b. White text on blue background.
   c. For other hazardous exhausts, use colors and designs recommended by ASME A13.1.

C. Nomenclature: Include the following:

1. Direction of air flow.
2. Duct service (supply, return, exhaust).

D. Manufacturers:

1. W.H. Brady, Co.
2. Seton Identification Products.
3. Craftmark.
4. Brimar Industries, Inc.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Miscellaneous:

1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.
2. Install ductwork using manufacturer's recommended adhesives, cement, sealant, and insulation accessories.
3. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth.
4. Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

B. Ductwork Location:

1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.
2. Avoid diagonal runs wherever possible.
3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.
4. In general, install as close to bottom of structure as possible.
5. For ductwork concealed above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.
6. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
7. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

C. Penetrations:

1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
2. Clearances:
   a. For uninsulated ducts, allow 1-inch clearance between duct and sleeve, except at grilles, registers, and diffusers.
   b. For insulated ducts, allow 1-inch clearance between insulation and sleeve, except at grilles, registers, and diffusers.

3. Closure Collars:
   a. Minimum 4 inches wide on each side of walls or floors where sleeves or prepared openings are installed.
   b. Fit collars snugly around ducts and insulation.
   c. Same gauge and material as duct.
   d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
   e. Use fasteners with maximum 6-inch centers on collars.
4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

D. Concealment:

1. Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.
2. Do not encase horizontal runs in solid partitions, except as specifically shown.
3. Limit clearance to 1 inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.

E. Coordination with Other Trades:

1. Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
2. Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.
3. Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.
4. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

F. Shower Room and Toilet Room Exhaust Ductwork:

1. Joints and Seams: Seal watertight.
2. Slope branch ducts downward to grille.

G. Fume Hood, Laboratory, and Chlorine Room Exhaust Ductwork:

1. Seal joints and seams with chemical-resistant mastic.
2. Rivet butt joints with minimum of eight pop rivets.

3.02 RECTANGULAR DUCTWORK

A. General:

1. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.
2. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

B. Low Pressure Taps:

1. Use bell mouth or conical fittings with integral locking quadrant damper. Spin-in fitting shall be sealed at duct tap with a gasket or sealed with sealant as specified for medium pressure ductwork.
2. Determine location of spin-in after outlet location is determined.
3. Fitting shall be securely attached to shaft to prevent damper from rotating around shaft.

C. Fittings:

1. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.
2. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.
3. Make offsets with maximum angle of 45 degrees.
4. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

D. Rectangular Ductwork Transverse Joints:

1. Install each run with a minimum of joints.
2. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
3. Mechanical Joint Option:
   a. Construct transverse joints with Ductmate 25/35 duct connector systems, Ductmate W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system. Slip-on duct flange connectors shall have integral sealant pocket with permanently flexible sealant.
   b. When using Ductmate W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the Ductmate W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.

c. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.
d. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.
e. Conform to SMACNA Class A sealing requirements.

3.03 RIGID ROUND OR OVAL DUCTWORK

A. General: Except where interrupted by fittings, install round ducts in lengths as long as possible to minimize joints.

B. Rigid Round or Oval Ductwork Joints:

1. Rigid round ductwork joints shall be in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless otherwise specified.
2. Single and Double Wall Supply and Return System Joints:
   a. Less than 36 Inches: Slip coupling.
   b. 36 Inches and Larger: Flanged connector, Van Stone, or welded companion flange type.
3. Single and Double Wall Exhaust and Return System Joints:
   a. Spiral Seam Duct: Welded flanged connector.
   b. Longitudinal Seam Duct: Van Stone flange connector.

3.04 INSULATED FLEXIBLE DUCT

A. Installation:

1. Where shown, between branch duct and ceiling diffusers and grilles.
2. Without sags, kinks, sharp offsets, or elbows.
3. As straight and taut as possible.

B. Connection: Connect flexible ductwork to round collars, air distribution devices, and terminal units in accordance with flexible duct manufacturer's recommendations.

C. Length:

1. Maximum length of low-pressure flexible duct (construction pressure class up to 2-inch WC) to be 8 feet.
2. Maximum length of medium pressure flexible duct (construction pressure class up to 4-inch WC) to be 4 feet.

D. Flexible ductwork shall not pass through wall, floor, or fire resistant rated assembly.

3.05 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.

D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

E. Support vertical ducts at maximum interval of 16 feet and at each floor.

F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

G. In new construction, install concrete insert prior to placing concrete.

H. Install seismic restraints on ductwork systems and sway bracing as described in SMACNA Guidelines for Seismic Restraints of Mechanical Systems.

3.06 FLEXIBLE CONNECTIONS

A. Flexible Collars and Connections:

1. Use between fans and ducts.
2. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.
3. For rectangular ducts, lock flexible connections to metal collars.

3.07 DAMPERS

A. General:

1. Inspection:
   a. Inspect areas to receive dampers.
   b. Notify Engineer of conditions that would adversely affect installation or subsequent utilization of dampers.

c. Do not proceed with installation until unsatisfactory conditions are corrected.

2. Install dampers at locations indicated on Drawings and in accordance with manufacturer's installation instructions.
3. Install square and level.
4. Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.
5. Damper blades and hardware shall operate freely without obstruction.
6. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
7. When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.
8. Head and sill shall have stops.
9. Suitable for installation in mounting arrangement shown.
10. Do not compress or stretch damper frame into duct or opening.

B. Manual Dampers:

1. Provide balancing dampers for grilles and diffusers as indicated on Drawings in branch duct as near main as possible.
2. Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

C. Back Draft Dampers:

1. Install dampers square and free from racking with blades running horizontally.
2. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.08 ACCESS DOORS

A. Ductwork: Install access doors in ductwork, in accordance with manufacturer's instructions, at each:

1. Duct mounted fire damper.
2. Duct mounted smoke or ionization detector.
3. Electric duct heater.
4. Booster coil.
5. Humidifier.
6. Motorized damper.
7. Sail switch.
8. Turning vane.

9. Volume damper.
10. Automatic damper.
11. Temperature controller.
12. Coil, on both upstream and downstream side.

3.09 MISCELLANEOUS ACCESSORIES

A. Auxiliary Drain Pans:

1. Under equipment for which pan is shown on Drawings and under all horizontal air handling units located above ceilings and piping located in ceiling space directly above computer facility areas; furnish and install auxiliary drain pans.
2. Route drain lines to nearest floor or hub drain independent of any other drain.
3. Slope drain pans toward drain connection to promote drainage.

B. Louver and Grille Blank-Off Sections: Attach airtight to louver or grille and install to allow for easy removal.

C. Inspection Plates and Test Holes:

1. Where required in ductwork for balance measurements.
2. Test holes shall be airtight and noncorrosive with screw cap and gasket.
3. Extend cap through insulation.

3.10 DUCT SEALING

A. Seal duct seams and joints in accordance with SMACNA requirements.

B. If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

C. Seal externally insulated ducts prior to insulation installation.

D. Provide additional duct sealing as required to comply with Article Ductwork Leakage Testing.

E. Seal all audible leaks.

3.11 DUCTWORK LEAKAGE TESTING

A. General:

1. Tests shall be conducted on completed ductwork systems.
2. Testing of partial installations or limited sections of ductwork will not be acceptable.
3. All ductwork leakage test procedures and results shall be submitted to Engineer for review.
4. Engineer shall retain the right to witness some or all ductwork leakage testing procedures.
5. Contractor shall notify Engineer in writing at least 5 working days prior to ductwork testing.

B. Leakage Criteria:

1. Assemble and install ductwork with maximum leakage limited as follows:
2. Constant Volume Systems:
    a. Supply Ductwork:
        1) Operating Pressure: 0- to 2-inch WC.
            a) Allowable Leakage: 2 percent of design airflow.
        2) Operating Pressure: 3-inch and over WC.
            a) Allowable Leakage: 1 percent of design airflow.
    b. Return Ductwork:
        1) Operating Pressure: All.
        2) Allowable Leakage: 2 percent of design airflow.]

C. Leakage Testing Method:

1. Contractor shall be responsible for providing all necessary test fans and calibrated measuring devices to accomplish ductwork leakage test and to demonstrate that ductwork systems leakage rate is less than maximum rate specified.
2. Pressure testing shall be accomplished using a pressure blower with a calibrated orifice and manometer.
3. Blower shall maintain system design static pressure during test.
4. Perform testing in accordance with procedures given in SMACNA HVAC Air Duct Leakage Test Manual.

3.12 BALANCING OF AIR SYSTEMS

A. Perform air balancing in accordance with requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.13 PROTECTION OF INSTALLED WORK

A. Open ends of installed ductwork systems shall be covered to prevent dust, foreign objects and water from entering ductwork.

B. Ductwork systems shall not be used for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

3.14 CLEANING

A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

C. If duct systems are found to contain construction debris at time of construction completion Contractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

3.15 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification:

1. Ductwork Schedule.

END OF SECTION

DUCTWORK SCHEDULE

SYSTEM	SERVICE	SECTION	SMACNA DUCT CONSTRUCTION CRITERIA			SMACNA LEAKAGE TESTING CRITERIA				APPLICABLE REMARKS
			PRESSURE CLASS (IN W.G.)	MATERIALS OF CONSTRUCTION	SEAL CLASS	QUANTITY TO TEST PERCENT	TEST PRESSURE IN W.G.	LEAKAGE CLASS (CL)	LEAKAGE FACTOR (F) CFM/100 SF	
AHU-XXX AIR HANDLER VARIABLE AIR VOLUME	SUPPLY AIR	AIR HANDLER TO TERMINAL	4	GALVANIZED STEEL	A					
	SUPPLY AIR	TERMINAL TO DIFFUSERS	2	GALVANIZED STEEL	A					
	OUTDOOR AIR	ALL	-2	GALVANIZED STEEL	A					
	RETURN AIR	ALL	-2	GALVANIZED STEEL	A					
AHU-XXX AIR HANDLER CONSTANT AIR VOLUME	SUPPLY AIR	ALL	2	GALVANIZED STEEL	A					
	OUTDOOR AIR	ALL	-2	GALVANIZED STEEL	A					
	RETURN AIR	ALL	-2	GALVANIZED STEEL	A					
EF-XXX EXHAUST FAN	EXHAUST AIR	FROM EXHAUST GRILLE TO FAN	-2	GALVANIZED STEEL	A					
	EXHAUST AIR	FROM FAN TO OUTLET	2	GALVANIZED STEEL	A					
EF-XXX	EXHAUST AIR	ALL	-2	FIBERGLASS REINFORCED PLASTIC (FRP)	A					A
MISCELLANEOUS	TRANSFER AIR	ALL	-1	316 STAINLESS STEEL	A					
SYSTEMS NOT ADDRESSED ABOVE	ALL	ALL	2	GALVANIZED STEEL	A					

REMARKS:

A: REFER SECTION 23 31 16.16, THERMOSET FIBERGLASS-REINFORCED PLASTIC DUCTS AND ACCESSORIES

B:

SECTION 23 34 00
HVAC FANS

PART 1 GENERAL

1.01 REFERENCES

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

1. Acoustical Society of America (ASA): S2.19, Mechanical Vibration—Balance Quality Requirements of Rigid Rotors—Part 1, Determination of Permissible Residual Unbalance.
2. Air Movement and Control Association International (AMCA):
   a. 99, Standards Handbook.
   b. 201, Fans and Systems.
   c. 203, Field Performance Measurement of Fan Systems.
   d. 204, Balance Quality and Vibration Levels for Fans.
   e. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   f. 300, Reverberant Room Method for Sound Testing of Fans.
   g. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
5. ASTM International (ASTM):
   a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
   c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   d. D3363, Standard Test Method for Film Hardness by Pencil Test.
   e. D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA): 45, Standard on Fire Protection for Laboratories Using Chemicals.

8. Occupational Safety and Health Act (OSHA).
9. Society for Protective Coatings (SSPC):
    a. SP 3, Power Tool Cleaning.
    b. SP 5, White Metal Blast Cleaning.
    c. SP 6, Commercial Blast Cleaning.
    d. SP 10, Near-White Blast Cleaning.
10. Underwriters Laboratories Inc. (UL): 507, Safety Standard for Electric Fans.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. SWSI: Single Width, Single Inlet.
9. TEFC: Totally Enclosed, Fan Cooled.
10. UV: Ultra Violet.
11. XP: Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Provide following for specified products:
    a. Identification as referenced in Contract Documents.
    b. Manufacturer’s name and model number.
    c. Descriptive specifications, literature, and drawings.
    d. Dimensions and weights.
    e. Fan sound power level data (reference 10 to power minus 12 watts) at design operating point.
    f. Fan Curves:
        1) Performance Curves Indicating:
            a) Relationship of flow rate to static pressure for various fan speeds.
            b) Brake horsepower curves.
            c) Acceptable selection range (surge curves, maximum revolutions per minute).

d) Static pressure, capacity, horsepower demand and overall efficiency required at duty point, including drive losses.

2) For variable air volume applications, indicate operating points at 100, 80, 60 and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure, and brake horsepower.

g. Capacities and ratings.
h. Construction materials.
i. Fan type, size, class, drive arrangement, discharge, rotation, and bearings.
j. Wheel type, diameter, maximum revolutions per minute for fan class, operating revolutions per minute, and tip speed.

2. Motor data, including service factor and operating horsepower, as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
   a. Fan shaft first critical speed.
   b. Belt service factor.
   c. Drive assembly horsepower rating.
   d. Sheave horsepower rating.
   e. Power and control wiring diagrams, including terminals and numbers.
   f. Factory run test and vibration test reports.
   g. Vibration isolation.
   h. Factory finish system.
   i. Color selection charts where applicable.
   j. Corrosion protection coating product data.
3. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
4. “Or Equal” Equipment:
   a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on Drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.
   b. Where submitted equipment results in change to ductwork and equipment configuration shown on Drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
2. Recommended procedures for protection and handling of products prior to installation.
3. Manufacturer's installation instructions.
4. Manufacturer's Certificate of Compliance in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed), for the following:
   a. Motors specified to be premium efficient type.
   b. FRP fans.
5. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing (to be completed).
6. Test reports.
7. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data (to be completed).
8. Include as-built version of equipment schedules.

1.01 QUALITY ASSURANCE

A. Performance Ratings: Tested in accordance with AMCA 210.

B. Sound Ratings: Tested in accordance with AMCA 300.

C. Fabrication: In accordance with AMCA 99.

1.02 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, and special tools:

Item	Quantity
Vee Belts	Two complete sets per unit
Special tools required to maintain or dismantle	One complete set for each different size unit

1. Delivery: In accordance with Section 01 61 00, Common Product Requirements (to be completed).

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES

A. Some specific equipment requirements are listed in Equipment Schedule. Refer to Article Supplement.

2.02 GENERAL

A. Spark Resistant Construction: Fans required to be spark resistant shall comply with requirements of AMCA 99-0401.

B. Operating Limits: Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408.

C. Acoustical Levels: Equipment selections shall produce sound power levels in each octave band no greater than shown in Equipment Schedule.

D. Fan Drives:

1. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.
2. Furnish multiple drive belts where motor horsepower is 2 hp or larger.
3. Sheaves:
    a. Capable of providing 150 percent of motor horsepower.
    b. Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.
4. Drive Adjustment:
    a. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
    b. Provide trial and final sheaves, as well as drive belts, as required.
5. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.
6. Provide speed test openings at shaft locations.
7. Belts: Oil and heat resistant, nonstatic type.
8. Motors:
    a. Motors 20 hp or Smaller:
        1) Variable pitch V-belt sheaves allowing at least 20 percent speed variation.
        2) Final operating point shall be at approximate sheave midpoint.
    b. Motors Larger than 20 hp: Fixed-pitch sheaves.

c. Furnish motors for V-belt drives with adjustable rails or bases.

9. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.
10. Belt and Shaft Guards:
    a. Easily removable and to enclose entire drive assembly, meeting federal, OSHA, and State of California requirements.
    b. Guard faces of expanded metal having minimum 60 percent free area for ventilation.
    c. Bright yellow finish.

E. Finishes:

1. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.
    a. Parts cleaned and chemically pretreated with phosphatizing process.
    b. Alkyd enamel primer.
    c. Air dry enamel topcoat.
2. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.
3. Stainless Steel Parts: Finished smooth and left unpainted.
4. Fiberglass Parts: Finished in accordance with Paragraph Fiberglass Material.

2.03 WALL FAN, PROPELLER, HEAVY DUTY

A. General: Factory-assembled wall propeller fan; including housing, propeller, drive assembly, motor, and accessories.

B. Housing:

1. Material: Metal components constructed from steel.
2. Panel:
    a. Minimum 14-gauge sheet metal construction.
    b. Integral formed venturi orifice.
    c. Continuously welded corners.
    d. Bolted to frame.
3. Frame:
    a. Minimum 14-gauge metal construction.
    b. Continuously welded joints.
    c. Reinforced motor baseplate.

C. Propeller:

1. Cast aluminum construction.
2. Hub keyed and mechanically locked to shaft.

D. Shaft, Bearings, Drive:

1. Shaft:
   a. Turned, ground, and polished carbon steel.
   b. Keyed for sheave installation.
2. Bearings:
   a. Grease lubricated, precision antifriction ball, self-aligning, sealed pillow block style.
   b. Mounted in cast iron pillow block housing.
   c. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
3. Drives:
   a. In accordance with Paragraph Fan Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: Belt.

E. Accessories: Provide as follows:

1. Disconnect: Factory-installed, nonfused, NEMA Type 12.
2. Propeller-Side Guard: Galvanized steel construction.
3. Motor-Side Guard: Galvanized steel construction.
4. Weather Hood:
   a. Heavy-gauge galvanized steel construction, to match fan and accessory size.
   b. Galvanized steel expanded metal bird screen.
5. Wall Housing:
   a. Allows fan mounting on interior or exterior wall.
   b. Heavy-gauge galvanized steel construction.
6. Shutters, Gravity Operated:
   a. Welded steel frame.
   b. Extruded aluminum blades.
   c. Felt edge seals.
   d. Oil impregnated bronze bushings.
   e. Reverse flange for building exterior mounting. Standard flange for indoor mounting.

F. Manufacturers and Products:

1. Aerovent; Model BP (Belt).
2. New York Blower; Model NYC.
3. Hartzell; Model Series 02.

2.04 CORROSION PROTECTION COATING

A. General:

1. Factory-applied corrosion protection coating for application to fan components and accessories, where required by this section.
2. Quality Control:
   a. Verify dry film thickness before final baking.
   b. Finished coating system shall be free from voids, checks, cracks, and blisters.
3. Surface Cleaning: Clean parts to be coated as follows:
   a. Immerse parts in heated cleaning solution to remove lubricants, machining oils, and residual factory contamination.
   b. Follow with immersion in potable water bath to neutralize and remove cleaning solution.
   c. Chemical Pretreatment: Immerse parts in heated chemical solution, iron phosphate for steel, clear/yellow chromate for aluminum.

B. Baked Enamel:

1. Material: Alkyd modified urea-melamine single component baking enamel.
2. Surface Preparation: Clean surface to SSPC SP 3.
3. Application: Standard air-pressurized spray equipment.
4. Curing: Oven baked at a metal temperature not to exceed 300 degrees F.
5. Finished Thickness: 1-mil to 2-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   a. Impact Resistance: 10-inch pounds, ASTM D2794 test method.
   b. Pencil Hardness: 2H, ASTM D3363 test method.
   c. Service Temperature: Maximum 230 degrees F, continuous.

C. Baked Polyester:

1. Material: Polyester.
2. Surface Preparation: Sandblast surface to SSPC SP 5.
3. Application: Electrostatic spray.

4. Curing: Oven baked at a metal temperature not to exceed 400 degrees F.
5. Finished Thickness: 1.5-mil to 2.5-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
    a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
    b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
    c. Impact Resistance: 100-inch pounds, ASTM D2794 test method.
    d. Pencil Hardness: 2H, ASTM D3363 test method.
    e. Service Temperature: Maximum 230 degrees F, continuous.

D. Air-Dry Epoxy:

1. Material: Two-part catalyzed epoxy.
2. Surface Preparation: Clean surface to SSPC SP 3.
3. Application: Standard air-pressurized spray equipment.
4. Curing: Air dry.
5. Finished Thickness: 4-mil to 6-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
    a. Salt Spray Test: Minimum 1,500-hour duration, ASTM B117 test method.
    b. Pencil Hardness: H-2H, ASTM D3363 test method.
    c. Service Temperature: Maximum 150 degrees F, continuous.

E. Baked Epoxy:

1. Material: Epoxy.
2. Surface Preparation: Sandblast surface to SSPC SP 10.
3. Application: Electrostatic spray.
4. Curing: Oven baked at a metal temperature not to exceed 400 degrees F.
5. Finished Thickness: 2.5-mil to 3.5-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
    a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
    b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
    c. Impact Resistance: 100 inch pounds, ASTM D2794 test method.
    d. Pencil Hardness: 2H, ASTM D3363 test method.
    e. Service Temperature: Maximum 230 degrees F, continuous.

F. Air Dry Phenolic:

1. Material:
   a. Phenolic resin, Heresite VR-500 Series or equal.
   b. For outdoor applications, apply an UV resistant topcoat, Heresite UC-5500 or equal.
2. Surface Preparation: Sandblast surface to SSPC SP 6.
3. Application: Standard air-pressurized spray equipment.
4. Curing: Air dry.
5. Finished Thickness: 4-mil to 6-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   a. Salt Spray Test: Minimum 500-hour duration, ASTM B117 test method.
   b. Humidity Resistance: Minimum 500-hour duration, ASTM D2247 test method.
   c. Service Temperature: Maximum 180 degrees F, continuous.

G. Baked Phenolic:

1. Material: Phenolic resin, Heresite P-403 or equal.
2. Surface Preparation: Sandblast surface to SSPC SP 5.
3. Application: Standard air-pressurized spray equipment.
4. Curing: Oven baked at a metal temperature not to exceed 400 degrees F.
5. Finished Thickness: 5-mil to 7-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
   b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
   c. Impact Resistance: 100-inch pounds, ASTM D2794 test method.
   d. Pencil Hardness: 2H, ASTM D3363 test method.
   e. Service Temperature: Maximum 250 degrees F, continuous.

H. Baked Epoxy Phenolic:

1. Material:
   a. Baking cross-linked epoxy-phenolic.
   b. For outdoor applications, apply an UV-resistant topcoat.
2. Surface Preparation: Sandblast surface to SSPC SP 5.
3. Application: Electrostatic or conventional compressed air spray equipment.
4. Curing: Oven baked at a metal temperature not to exceed 400 degrees F.
5. Finished Thickness: 6-mil to 8-mil dry film thickness.

6. Performance: Coating shall meet or exceed following criteria:
   a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
   b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
   c. Impact Resistance: 160-inch pounds, ASTM D2794 test method.
   d. Pencil Hardness: 3H, ASTM D3363 test method.
   e. Service Temperature: Maximum 350 degrees F, continuous.

2.05 MOTORS

A. General:

1. Fan motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction Motors.
2. Provide integral self-resetting overload protection on single-phase motors.
3. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
4. Motors shall not operate into service factor in any case.

B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Winding Thermal Protection: None.
3. Space Heater: No.
4. Number of Speeds: Single.
5. Number of Windings: One.
6. Motor Efficiency: Premium efficient.
7. Shaft Type: Solid, carbon steel.
8. Mounting: As required for fan arrangement.
9. Service Factor: 1.15.

2.06 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved block type equipment identification number indicated in this Specification and as shown on Drawings.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.07 SOURCE QUALITY CONTROL

A. General:

1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
3. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA 203, Appendix L.

B. Testing Provisions:

1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
2. Center punch fan shaft to accommodate tachometer readings.

C. Acoustical Levels:

1. Perform noise tests in accordance with AMCA 300 and AMCA 301.
2. Fan sound power levels (dB, Reference 10^{-12} Watts) shall be no greater than scheduled values.

D. Balancing:

1. Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.
2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.

E. Vibration Test:

1. Each fan furnished with 5-horsepower or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.

2. Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
   a. Belt Drive (except Vane Axial): 0.15 inch per second peak velocity.
   b. Belt Drive Vane Axial: 0.08 inch per second peak velocity.
   c. Direct Drive: 0.08 inch per second peak velocity.
3. Written records of run test and vibration test shall be made available upon request.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install fans level and plumb.

B. Labeling:

1. Label fans in accordance with Article Accessories.
2. Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.

C. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

D. Equipment Support and Restraints:

E. Refer to Section 23 81 00, Unitary Air-Conditioning Equipment.

3.02 FIELD QUALITY CONTROL

A. Functional Tests:

1. Verify blocking and bracing used during shipping are removed.
2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify cleaning and adjusting are complete.
5. Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system; align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.

8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:

1. Starting Procedures:
   a. Energize motor and adjust fan to indicated revolutions per minute.
   b. Measure and record motor voltage and amperage.
2. Operational Test:
   a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
   c. Test and adjust control safeties.
   d. Replace damaged and malfunctioning controls and equipment.

3.03 MANUFACTURER'S SERVICES

A. Not required.

3.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Balancing:

1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
2. Replace fan and motor sheaves as required to achieve design airflow.

E. Vibration Testing:

1. Perform field testing on rotating equipment, where specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, to determine actual operating vibration.

2. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.
    a. Vibration readings as measured at actual rotational speed shall not exceed the following values:
        1) Belt Drive, Flexibility Mounted: 0.25 inch per second peak velocity.
        2) Belt Drive, Rigidly Mounted: 0.16 inch per second peak velocity.

3.05 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.06 FAN SCHEDULE

A. Fan Schedule shown on Drawings.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 880, Air Terminals.
2. ASTM International (ASTM): C636/C636M, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
3. Underwriters Laboratories Inc. (UL).

1.02 DEFINITIONS

A. NC: Noise Criteria; background sound rating method for indoor sound.

B. VAV: Variable air volume.

C. WC: Water column.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s data and descriptive literature for products specified.
   b. Furnish the following information for each type of diffuser, register, and grille furnished.
      1) NC sound data.
      2) Static pressure loss data.
      3) Throw data.

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES

A. Refer to Mechanical Drawing M-08-04.

2.02 CEILING DIFFUSERS

A. Premium Louvered Face Diffusers (CD1):

1. Construction: As follows:
   a. Material: Aluminum. Provide Aluminum construction for diffusers located in locker, toilet, or shower rooms.
   b. Finish: Baked white enamel.
   c. Neck: Round.
2. Removable core section of louvers.
3. Continuous sponge rubber gasket at face flange.
4. Performance: As follows:
   a. Distribution Pattern: As shown on Drawings.
   b. Maximum Pressure Drop: 0.15 inches WC.
   c. Sound: Maximum NC30.
5. Manufacturers and Products:
   a. Krueger; Model 5SHR (aluminum).
   b. Carnes; Type SE (aluminum).
   c. Titus; Model TDCA-AA (aluminum).

2.03 SUPPLY GRILLES AND REGISTERS

A. Supply Grilles and Registers (SG1, SR1):

1. Construction: As follows:
   a. Material: Aluminum.
   b. Finish: Baked white enamel.
   c. SR Register Accessories:
      1) Gang-operated opposed-blade volume control damper.
      2) Material to match grille.
2. Adjustable front horizontal and rear vertical vanes on 3/4-inch centers.
3. Continuous sponge rubber gasket at face flange.
4. 1-inch minimum flat rectangular frame.
5. Performance: As follows:
   a. Maximum Pressure Drop: 0.15 inch WC.
   b. Sound: Maximum NC30.
6. Manufacturers and Products:
   a. Krueger; 880/5880 Series.
   b. Titus; 300 Series.

2.04 RETURN, EXHAUST AND TRANSFER GRILLES AND REGISTERS

A. Louvered Return, Exhaust and Transfer Grilles and Registers (RG1, RR1, EG1, ER1, TG1):

1. Construction: As follows:
   a. Material: Aluminum.
   b. Finish: Baked white enamel.
   c. RR and ER Register Accessories:
      1) Gang-operated opposed-blade volume control damper.
      2) Material to match grille.
2. Fixed horizontal louvers set at 35 degrees to 45 degrees.
3. 1-inch minimum flat, rectangular frame.
4. Manufacturers and Products:
   a. Krueger; S80/S580H Series.
   b. Carnes; Type RAAAH.
   c. Titus; 350 Series.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to architectural reflected ceiling plans for coordination of locations of ceiling-mounted air outlets and inlets with ceiling grids and lighting. Where locations of devices shown on mechanical drawings do not agree with locations that are shown on architectural reflected ceiling plans, reflected ceiling plans shall take precedence. If air outlets or inlets are shown on mechanical drawings, but are not shown on architectural reflected ceiling plans, devices shall be located as near as possible to locations shown on mechanical drawings when coordinating with ceiling.

B. Install diffusers, grilles, and registers tight on their respective mounting surfaces, level, plumb, and true with room dimensions.

END OF SECTION

SECTION 23 81 00
UNITARY AIR-CONDITIONING EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. Air Moving and Conditioning Association (AMCA): Bulletin 300, Setup No. 1.
3. American Gas Association (AGA).
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   a. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   b. 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
5. American Society of Mechanical Engineers (ASME): BPVC Section IX, Welding and Brazing Qualifications.
6. ASTM International (ASTM):
   a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   b. D2370, Standard Test Method for Tensile Properties of Organic Coatings.
   c. D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
   d. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   e. G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
7. Canadian Standards Association (CSA).
8. ETL Testing Laboratories (ETL).
9. International Organization for Standardization (ISO):
   a. 9001, Quality Management Systems - Requirements.
   b. 13256-1, Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps.
10. National Electrical Manufacturers Association (NEMA).

11. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials
12. Underwriters Laboratories Inc. (UL): 94, Safety Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Air Conditioning.
2. COP: Coefficient of Performance.
3. DX: Direct Expansion.
4. EER: Energy Efficiency Ratio.
5. HP: Heat Pump.
6. IR: Infra Red.
7. LED: Light Emitting Diode.
8. PSC: Permanent Split Capacitor.
9. PTAC: Packaged Terminal Air Conditioner.
10. SPST: Single Pole, Single Throw.
11. TXV: Thermostatic Expansion Valve.
12. UV: Ultraviolet.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed later).
   b. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for all products specified.
   c. Manufacturer’s standard finish color selection for enclosure finishes.
   d. Complete performance data that will indicate full compliance with Specification:
      1) Include fan sound power level data (ref. 10 to 12 watts) at design operating point, based on AMCA Bulletin 300, Setup No. 1.
      2) Include heating and cooling performance data at design operating conditions.

e. Air Pressurization Unit: Documentation that media filter modules are UL rated Class 1.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Division 1 sections.
2. Manufacturer's documentation that media filter modules rated UL Class 1.
3. Manufacturer's Certificate of Compliance, for heat pumps, air-conditioning units, and motors.
4. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement or details shown to equipment furnished.
5. Sample copy of guarantee.
6. Test reports.
7. Operation and Maintenance Data in conformance with Section 01 78 23, Operation and Maintenance Data (to be completed later).
   a. Include wiring and control diagrams for equipment.
   b. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Heating and Cooling Equipment: Minimum operating efficiencies, defined as COP and EER, as specified in ASHRAE 90.1.

B. Unit shall be rated (when matched with appropriate outdoor unit) per AHRI 210/240.

C. Units shall be certified by UL and CSA, and shall be UL or ETL listed and labeled.

D. Cooling performance rated in accordance with AHRI testing procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

B. Protection of Equipment:

1. Box, crate, or otherwise protect from damage and moisture during shipment, handling, and storage.

2. Protect from exposure to corrosive fumes and keep thoroughly dry at all times.
3. Store motors, drives, electrical equipment, and other equipment with antifriction or sleeve bearings in weathertight and heated storage facilities prior to installation.
4. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

1.06 SPECIAL GUARANTEE

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

1.07 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following materials:

Item	Quantity
Fan Belts	One complete set for each belt-driven fan.
Filters	One complete set per unit.

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements (to be completed later).

PART 2 PRODUCTS

2.01 GENERAL

A. Specified components of this section, including insulation, facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Multiple Compressor Units:

1. Provide completely independent refrigeration circuits and controls.

2. Indoor unit air coils shall have intermingled circuits, unless specified otherwise.

2.02 EQUIPMENT SCHEDULES

A. Refer to Article Supplement.

2.03 SPLIT SYSTEM IN-CEILING CASSETTE AC UNIT, DUCTLESS

A. General:

1. Split system, indoor, DX, ductless, fan coil AC unit, complete with DX coil, fan, fan motor, piping connectors, electrical controls, condensate pump, and hanging brackets.
2. Suitable for use with air conditioner or heat pump outdoor unit.
3. Indoor unit shall be of the same manufacturer as the associated outdoor unit.

B. Unit Cabinet:

1. Constructed of zinc-coated steel.
2. Fully insulated.
3. Discharge and inlet grilles, high-impact polystyrene.
4. Adjacent room cooling to be provided by a simple knockout in cabinet side panel.

C. Evaporator Fan:

1. Centrifugal, direct-drive blower type with air intake in center of unit and discharge on perimeter.
2. Air louvers shall be adjustable for 2-, 3-, or 4-way discharge.
3. Motors:
   a. Totally enclosed and permanently lubricated with inherent protection.
   b. Three-speed.

D. DX Evaporator Coil:

1. Copper tube with aluminum fins and galvanized steel tube sheets.
2. Fins bonded to tubes by mechanical expansion.
3. Condensate Drip Pan: Locate under coil with drain connection for hose attachment to remove condensate.

E. Internal Condensate Pump:

1. To remove condensate from drain pan when gravity drainage cannot be used.
2. Lift capability of condensate pump shall be 18 inches.

F. Controls:

1. Refrigerant Metering:
   a. Factory installed refrigerant metering device.
   b. Heat Pump Applications: Reverse flow bypass refrigerant metering device with internal check valves.
2. 24-volt wall-mounted thermostat with three fan speed selections and auto/manual switch.
3. Automatic restart after power failure at same operating conditions as at failure.
4. Float control in condensate sump to shut unit down in case of pump malfunction.
5. Evaporator coil freeze protection.

G. Air Filters: Filter tracks and cleanable filters, accessible from below with 1/4-turn fastener.

H. Accessories: Provide in Equipment Schedule.

I. Manufacturers and Products:

1. Carrier; 40QK Series.
2. Enviromaster International; Model CAH.
3. Mitsubishi; Mr. Slim.

2.04 SPLIT SYSTEM HIGH WALL AC UNIT, DUCTLESS

A. General:

1. Split system, indoor, DX, ductless, fan coil AC unit, complete with DX coil, fan, fan motor, piping connectors, electrical controls, and microprocessor control system.
2. Suitable for use with air conditioner or heat pump outdoor unit.
3. Indoor unit shall be of the same manufacturer as the associated outdoor unit.

B. Unit Cabinet:

1. High-impact plastic or painted galvanized steel.
2. Fully insulated.
3. Discharge and inlet grilles, high-impact polystyrene.

C. Evaporator Fan:

1. Tangential direct-drive blower type with air intake at upper front face of unit and discharge at bottom front.
2. Air Sweep:
   a. Provide automatic, motor-driven horizontal air sweep as standard.
   b. Air sweep operation shall be user selectable.
   c. Vertical direction may be manually adjusted and horizontal air sweep may be manually set.
3. Motor:
   a. Open drip-proof, permanently lubricated ball bearing with inherent overload protection.
   b. Minimum three speed.

D. DX Evaporator Coil:

1. Copper tube with aluminum fins and galvanized steel tube sheets.
2. Fins bonded to tubes by mechanical expansion.
3. Condensate Drip Pan:
   a. Locate under coil with drain connection for hose attachment to remove condensate.
   b. Provide internal trap and auxiliary drip pan under coil header.

E. Controls:

1. Refrigerant Metering:
   a. Factory installed refrigerant metering device.
   b. Heat Pump Applications: Reverse flow bypass refrigerant metering device with internal check valves.
2. Automatic restart after power failure at same operating conditions as at failure.
3. Timer function to provide a minimum 15-hour timer cycle for system AUTO/START/STOP.
4. Temperature-sensing controls shall sense return air temperature. Provide indoor air high discharge temperature shutdown.
5. Indoor coil freeze protection.
6. Wireless infrared remote control to enter set points and operating conditions.

7. Filter status indication after 250 hours of indoor fan operation.
8. Test mode button to run self-diagnostics and aid in troubleshooting.
9. AUTO/STOP features shall have integral setback control.
10. Automatic air sweep control provides ON or OFF activation of air sweep louvers.
11. Dehumidification mode provides increased latent removal capability by modulating fan speed and set point temperature.
12. Fan only operation provides room air circulation when no cooling is required.
13. Diagnostics to provide continuous checks of unit operation and warn of possible malfunctions. Error message shall be displayed at unit and at remote controller.
14. Fan Speed Control: User-selectable for high, medium, low or microprocessor automatic operation during all operating modes.
15. Time delay shall prevent compressor restart in less than 3 minutes.
16. Provide outdoor unit high temperature protection to detect excessive outdoor unit discharge temperatures.
17. Automatic heating-to-cooling changeover to provide automatic heating and cooling operation. Control shall include deadband to prevent rapid mode cycling.
18. Manual defrost button to initiate defrost cycle from handset.
19. Demand defrost shall be provided and shall minimize defrost cycles by internally adjusting defrost timing based on frost accumulation.
20. Provide indoor coil high temperature protection to detect excessive indoor discharge temperature when unit is in heat pump mode.

F. Air Filters: Filter track with factory-supplied cleanable filters.

G. Accessories: Provide as scheduled in Equipment Schedule.

H. Manufacturers and Products:

1. Carrier; 40QN Series.
2. EnviroAir; Model ECW.
3. Mitsubishi; Mr. Slim.
4. Trane; Model MCW.

2.05 SPLIT SYSTEM UNDER-CEILING AC UNIT, DUCTLESS

A. General:

1. Split system, indoor, DX, ductless, ceiling-suspended fan coil, complete with DX coil, fan, fan motor, piping connectors, electrical controls, and hanging brackets.

2. Suitable for use with air conditioner or heat pump outdoor unit.
3. Indoor unit shall be of the same manufacturer as the associated outdoor unit.

B. Unit Cabinet:

1. Zinc-coated bonderized steel, finished with baked enamel paint.
2. Inlet grilles of high-impact polystyrene.
3. Mounting brackets.

C. Evaporator Fan:

1. Centrifugal blower type with air intake in bottom rear of unit and discharge in front.
2. Automatic, motor-driven vertical air sweep system.
3. Motors: Permanently lubricated ball bearing with inherent overload protection.

D. DX Evaporator Coil:

1. Copper tube with aluminum fins and galvanized steel tube sheets.
2. Fins bonded to tubes by mechanical expansion.
3. Condensate Drain Pan: Under coil with drain connection for hose attachment to remove condensate.

E. Controls:

1. Refrigerant Metering:
   a. Factory installed refrigerant metering device.
   b. Heat Pump Applications: Reverse flow bypass refrigerant metering device with internal check valves.
2. 24-volt wall-mounted electromechanical thermostat with three fan speed selections and an auto/manual switch.
3. Evaporator coil freeze protection.
4. Automatic restart after power failure at same operating conditions as at failure.
5. Filter status indication after 250 hours of indoor fan operation.
6. Automatic air sweep control to provide ON or OFF activation of air sweep louvers.
7. Cooling mode to provide modulating fan speed based on difference between temperature set point and space temperature.
8. Fan only operation to provide room air circulation when no cooling is required.

9. Fan Speed Control: User-selectable for high, medium, low, or automatic operation during all operating modes.
10. Time delay shall prevent compressor restart in less than 3 minutes (adjustable).
11. Automatic heating-to-cooling changeover to provide automatic heating and cooling operation. Control shall include deadband to prevent rapid mode cycling.

F. Air Filters: Filter track with factory-supplied cleanable filters.

G. Accessories: Provide as scheduled in Equipment Schedule.

H. Manufacturers and Products:

1. Carrier; 40QA Series.
2. Enviromaster International; Model CHP.
3. Mitsubishi; Mr. Slim.

2.06 ELECTRICAL

A. General:

1. Units shall include high and low voltage terminal block connections.
2. Control voltage to indoor unit fan shall be 24 volts.
3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.
4. Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit, unless otherwise noted.

B. Motors:

1. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.
2. Unless otherwise stated, electric motors shall comply with the following:
   a. Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.
   b. Enclosure: ODP, unless specified otherwise.
   c. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
   d. Winding Thermal Protection: Manufacturer’s standard.
   e. Space Heater: Manufacturer’s standard.
   f. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer’s standard.

g. Efficiency: Minimum efficiency per Section 26 20 00, Low-Voltage AC Induction Motors.

2.07 ACCESSORIES

A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type equipment identification number indicated in this Specification.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Quantity as recommended by manufacturer.

2.08 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Direct expansion coils leak tested underwater with 200-psig air. Pressure tested to 450 psig.
2. Electric heating coils tested with 2,000-volt dielectric test.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with manufacturer’s recommendations, and these Specifications.
2. Set and install equipment so equipment is level and properly supported.
3. Ensure piping connections to equipment do not cause strain on equipment.
4. Ensure vibration isolation has been installed per manufacturer’s instructions and isolation devices are performing satisfactorily.
5. Install safety devices as recommended by manufacturer and required by code.

B. Seal outside air intake watertight to roof curb.

C. Isolate sheet metal duct connections from portions of unit not internally spring-isolated from fans, or other vibrating or rotating equipment.

D. Inspect internal casing insulation, seal exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

E. Filters:

1. Install set of filters in each unit before operating and leave in place during startup and testing to keep equipment and ductwork clean.
2. Do not operate units until filters are installed. If operated without filters, completely clean ductwork, coils, and interior of units.

F. Lubricate unsealed bearings prior to startup.

3.02 FIELD QUALITY CONTROL

A. Initial equipment testing and startup shall be made by authorized representative of unit manufacturer.

B. Air-cooled outdoor unit shall not be started without complete prestart checkout of entire refrigerant piping system and charging of system with refrigerant as recommended by equipment manufacturer.

C. Field Testing: Manufacturer shall provide factory-trained representative employed by equipment manufacturer to perform the following services. Supervision only, of Contractor personnel, will not be acceptable.

1. Leak test.
2. Refrigerant pressure test.
3. Evacuate (if required).
4. Dehydrate (if required).
5. Charge condensing unit with refrigerant and oil (if required).

3.03 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed later), for the following:

1. Inspect installation including external interlock, power connections; supervise initial operation, calibration of operating and safety controls and supervise electrical testing including insulation resistance of motors and voltage balance between phases during starting and running.

2. Test Report:
   a. Submit test reports unit is in safe and proper operating condition.
   b. Contain pressure and control settings, meg readings, voltage readings per phase during START and RUN, suction temperature and pressure, liquid temperature and pressure.
   c. List minor discrepancies to be corrected which do not affect safe and reliable operation.
   d. One copy of report shall be left in unit control panel.
3. One copy of bound installation operation and maintenance service, and parts brochures, including applicable serial numbers, full unit description, parts ordering sources, shall be placed in unit control panel at time of starting.
4. Training of Owner's personnel for specified equipment.

3.04 ADJUSTING AND CLEANING

A. Air System Balancing: As specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

B. Install set of filters at time of final cleaning.

3.05 SUPPLEMENT

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

1. Ductless Split System DX Indoor Units Schedule.

END OF SECTION

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS SCHEDULE

SYMBOL				AHU-702 (Lab)			
LOCATION					AHU-710 (MCC)	AHU-720 (MCC)	
TYPE				HIGH WALL	HIGH WALL	HIGH WALL	
FAN DATA	SUPPLY AIR		CFM	848	848	848	
	OUTSIDE AIR		CFM	0	0	0	
	EXTERNAL STATIC PRESS.		IN W.G.				
DX COOLING DATA	TOTAL		BTU/HR	33,200	33,200	33,200	
	SENS.		BTU/HR				
	ENTERING AIR TEMP.	DEG. F	DB	90	90	90	
		DEG. F	WB	73	73	73	
	COND. TEMP.		DEG. F				
DX HEATING DATA	TOTAL		BTU/HR	35,200	35,200	35,200	
	ENTERING AIR TEMP.	DEG. F	DB	60	60	60	
	COND. TEMP.		DEG. F				
ELECTRIC HEATING DATA	kW			N/A	N/A	N/A	
	STEPS						
	VOLT						
	PH						
FAN MOTOR DATA	FLA			0.76	0.76	0.76	
	VOLT			230	230	230	
	PH			1	1	1	
ELECTRICAL DATA	# CONN.						
	MCA			1	1	1	
	BREAKER			25	25	25	
	VOLT			230	230	230	
	PH			1	1	1	
	FACTORY INSTALLED DISCONNECT?			N/A	N/A	N/A	
DIMENSIONS	WIDTH		INCHES	46 1/16	46 1/16	46 1/16	
	DEPTH		INCHES	11 5/8	11 5/8	11 5/8	
	HEIGHT		INCHES	14 3/8	14 3/8	14 3/8	
	MAXIMUM WEIGHT		LBS				
MANUFACTURER	Mitsubishi						
MODEL NO.	MSZ-D36NA						
APPLICABLE REMARKS:	A, C, D, F			A, C, D, F	A, C, D, F	A, C, D, F	

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT
B: OUTSIDE AIR DUCT CONNECTION
C: WALL MOUNT THERMOSTAT MOUNTING KIT
D: INTERNAL CONDENSATE PUMP
E: FRESH AIR INTAKE AND POWER VENTILATION KIT
F: SUPPLY AIR GRILLE GUARD

SECTION 26 05 02
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The following list of components and areas of work is a summary of the Work required on Drawings and Specifications. The list is not comprehensive of the total work required nor is it in any specific order. It is merely being provided as an aid to the Bidder. Work not listed herein, but described in the plans or specifications, is also part of the overall scope of work.

B. Power distribution system including:

1. Step up and step down transformers.
2. Power distribution panels.

C. Motor Control Centers (MCCs).

D. Control Panel(s):

1. Contractor shall remove PLCs from control panels and provide to Owner's Representative upon completion of factory testing. Purpose is for Owner's Representative to complete program testing.
2. Provide sunshades for all control panels that are exposed to direct sunlight.

E. PLC and SCADA:

1. Hardware, software, configuration, and programming of the SCADA system is by Owner's Representative (not in Contract).
2. Setup, configuration, programming, and integration of the Remedy plant, extraction wells, and freshwater wells Programmable Logic Controllers used in this Project will be by Owner's Representative (not in contact).
3. Contractor shall furnish and remove PLCs from Control Panels and provide to Owner's Representative upon completion of factory testing. Purpose is for Owner's Representative to complete program testing.
4. PLCs will be returned to Contractor for re-installation into control panels at the beginning of pre-operational testing.

F. PLC and Operator Interface (OI):

1. Configuration and programming of the PLC and Operator Interface is by Application Programmer, an Owner's Representative, (not in Contract).
2. Procurement of PLC and Operator Interface is by Contractor. Contractor shall furnish Operator Interface to Owner's Representative 8 weeks prior to factory testing. Purpose is for Application Programmer to complete OI configuration and testing.
3. Application programmer will bring the OI for insertion into the control panel during factory test.
4. Contractor shall facilitate the installation of the OI by having the door mounting hole, power, and network connections ready.
5. Coordinate with Owner's Representative to furnish tag database in timely fashion to facilitate OI configuration.

G. Communications System: Contractor to coordinate, configure, test, and place communications system(s) into operation.

H. Instrumentation:

1. Mounting supports or other accessories as detailed and as recommended by the instrument manufacturer for the application.
2. Contractor shall calibrate, configure, and test all instrumentation and document results.
3. Provide sunshades for all instruments that are exposed to direct sunlight.

I. Conduit: Support systems, wire, and grounding system, for equipment interconnection, and operation.

J. Facility Lightning Protection System: Design, furnish, and install, per specifications for each new building plus shade structures on Project.

K. Process piping, shut off, sample and calibration valves, drains, pressure reducers, and calibration equipment for connection of instrumentation.

L. Trenching, backfilling, compaction, and resurfacing for all new underground conduit routes, concrete pads, and pull boxes.

M. Coordination and equipment for connection of power utility and telephone services per utility drawings and standards.

N. Site electrical devices, lights, and receptacles.

O. Seismic anchorage design calculations and conforming installation.

P. System Startup, Calibration, Testing, and Documentation:

1. The Application Programmer (defined in Electrical Specifications [Electrical General].) and/or Construction Manager will be actively engaged in operational testing and commissioning. These efforts shall be combined efforts of the Application-Programmer/Construction-Manager/Engineer and Contractor.
2. The Contractor shall facilitate test as outlined herein such that hardware, software and application programming are tested completely and all applicable test documentation is completed.
3. The Contractor shall assume that a minimum of 300 hours will be required to assist in this task.
4. Sufficient time shall be allocated in the construction schedule for troubleshooting, testing, startup, and verification of application programming in front of associated construction milestones. For instance, if a pump station is required to be operational prior to a date certain, then the schedule shall allocate time for these activities. The time necessary depends on the system to be started and shall be coordinated with the Owner's Representative or Application Programmer during construction scheduling early in the Project.

1.02 RELATED SECTIONS

A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.03 REFERENCES

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

1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
2. National Electrical Manufacturers Association (NEMA):
3. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. Z535.4, Product Safety Signs and Labels.
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. Underwriters Laboratories, Inc. (UL).

1.04 ELECTRIC SERVICE DIVISION OF RESPONSIBILITY

A. Incoming aerial electrical service facilities provided by the serving utility as part of its normal obligation to customers is work provided outside this Contract. Under this Contract provide customer required service provisions and electrical work including, but not limited to, primary duct system, metering components and associated conduit. Schedule and coordinate work of serving utility as required to provide electric service to the Work.

B. Incoming telephone service facilities provided by the serving utilities as part of their normal obligation to customers is work provided outside this Contract. Under this Contract provide customer required service provisions and electrical work.

C. Interior telecommunications central and station equipment (telephone instruments, telephone switches, data switches, and hubs, servers, software, etc.) is work provided outside this Contract. Under this Contract provide raceways, outlet, and junction boxes, cover plates, and pull wires, as indicated.

1.05 SUBMITTALS

A. Requirements described herein are specific to electrical submittals and are secondary to those described in other general specifications sections. Any additional requirements described here that are beyond those described in those sections shall be provided as described. Conflicts shall be resolved by giving priority to general specifications.

B. The Contractor shall ensure that the System Integrator and/or equipment suppliers provide the submittal documentation required in this section. Submittals shall be neat, orderly, complete (without unneeded parsing), and indexed.

1. Like equipment shall be submitted complete in a single submittal. For instance, all general electrical materials shall be in a single submittal. All instrumentation, all control panels, or all MCCs and so on shall be submitted complete where possible.
2. Submittals that are broken down without sufficient cause will be rejected for future inclusion into a combined submittal.
3. Do not separate submittals by area.
4. Do not separate submittals by specification division.
5. Submittals for work scope covered in this Contract are expected to be as follows. This list is intended to be a guideline and not to be specific of

all submittals required. Project circumstances or lead times or availability will each impact the order and division of submittals.

a. General electrical materials – conduit, wire, labels, etc.
b. Power Distribution and MCC Motor Controls.
c. PLC Control Panels and Pump control panels.
d. Seismic Calculations.
e. Instrumentation.
f. Communications Panels.
g. SCADA Hardware.
h. Factory and Field Testing forms and procedures.
i. Interconnection Diagrams.
j. Installation details or procedures.
k. O&M Manuals.

C. The Contractor shall coordinate submittals with the work so that Project will not be delayed. This coordination shall include scheduling the different categories of submittals, so that one will not be delayed for lack of coordination with another. Time extensions will not be allowed due to failure to properly schedule submittals.

D. No material or equipment shall be delivered to the jobsite until the submittal for such items has been reviewed by the Engineer and marked “no exceptions noted” or “make corrections noted.”

E. The equipment specifications have been prepared on the basis of the equipment first named in the Specifications. The Contractor shall note that the second named equipment, if given, is considered acceptable and equal equipment, but in some cases additional design, options, or modifications may be required to meet Specifications or functional installation.

F. Exceptions to the Specifications or Drawings or equipment or procedures submitted as “equal” to specified equipment shall be clearly identified in a letter at the front of the submittal. Submittal data for “equal” equipment or procedures shall contain sufficient details so a proper evaluation may be made by the Engineer. The Contractor is responsible for verifying proper application/operation of substituted equipment.

G. The opinion of the Engineer will be the final determination whether a substitution request meets the design intent.

H. Deviations from the Contract Documents shall **not** be incorporated into the work without prior written approval of the Engineer. A “Change Order” directive from the Engineer is required prior to incorporating any deviation

from the Contract Documents that has costs associated. The cost differential associated with this Change Order must be negotiated with the Engineer to amend the Contract to reflect the costs or savings.

1.06 QUALIFICATIONS AND REQUIRED WORK SCOPE

A. Electrical Contractor:

1. Management and installation of the entire electrical and control system required for this Project shall be by an Electrical Contractor meeting qualifications as defined herein.
2. Electrical Contractor shall select, furnish, and install all commodity electrical materials (conduit, wire, supports, fittings, ductbanks, etc.) that are generally not “custom” or uniquely manufactured for this Project. Custom electrical panels, controls, and instrumentation shall be furnished by Systems Integrator.
3. Shall be competent in and familiar with management and subcontracting of specialty electrical and instrumentation supply and engineering work as requires of a Systems Integrator as described herein.
4. Electrical Contractor must be competent in performance, supervision, and coordination of work required and performed by equipment suppliers and Systems Integrator (Subcontractors).
5. If the Electrical Contractor listed in bid documents is deemed not qualified by the Engineer, the bids that include that Electrical Contractor will be rejected at the Engineer’s sole discretion and the next qualified bidder selected.
6. The Electrical Contractor (EC) shall meet the following minimum qualifications:
    a. Has a current C10 Electrical Contractor’s License issued by the State of California Department of Consumer Affairs.
    b. EC shall be regularly engaged in similar industrial power and controls electrical contracting for the Water and Wastewater Industry.
    c. EC shall have successfully performed work of similar or greater complexity (as measured in contract value on industrial power and controls projects) on at least three previous projects.
    d. EC shall carry all insurances as defined and required by the special provisions and as required by law.

e. EC shall be competent in methods and materials execution and selection associated in the type of electrical and instrumentation work specified in this division.
   1) EC shall be familiar with and understand codes and requirements from NFPA 70, NFPA 110, and all other governing national or local codes as required for work scope as described on Drawings and Specifications.
   2) EC shall know and understand common terms and abbreviations used in this Industry. Not all terms and abbreviations will be defined on Drawings and Specifications.

f. EC shall comply with State law which requires that all personnel installing electrical components are certified by the State of California as “Electrician” or “Electrician Trainee.” Apprentices may install electrical components only under direct supervision of a certified Electrician.

g. EC shall have sufficient qualified personnel to staff the Project and meet the construction schedule as defined by the Contract requirements or as approved during the submittal process.

B. System Integrator:

1. Systems Integrator shall be a subcontractor of the Electrical Contractor and must be competent in performance, supervision, and coordination of Work required in this Contract.
2. This includes, but is not limited to, all work necessary to select, furnish, construct, supervise installation, configure, calibrate, test, and place into operation all transmitters, instruments, programmable controllers, control panels, motor controls, alarm equipment, communications, monitoring equipment, and accessories.
3. The System Integrator shall have on staff a Project Engineer with 3 years prior experience on similar sized projects. This Project Engineer shall coordinate the technical aspects of this Project and prepare the Submittals and Drawings. The Project Engineer shall attend all coordination meetings when specifically requested by the Engineer.
4. The System Integrator (SI) shall meet the following minimum qualifications:
   a. SI shall be regularly engaged providing electrical and control systems for the Municipal Water and Wastewater Industry.
   b. SI shall be capable of labeling all electrical panels as manufactured or customized by the System Integrator with

appropriate UL label prior to factory testing or shipment to Project Site.

c. SI shall have successfully completed work of similar or greater complexity and on similar facilities on at least ten previous projects under the present company name.

d. SI shall be actively engaged in the following disciplines for the last 5 consecutive years.

1) Design and manufacturing of custom Control Panels, Motor Controls Centers, and associated devices and equipment as specified in this division.

2) Programming and commissioning of SCADA, PLC, and Operator Interface hardware.

3) Instrumentation: Selection, purchase, calibration, startup, and commissioning.

4) Testing, calibration, startup, and commissioning of control systems as applied to the Water and Wastewater industry.

5. If the System Integrator does not meet the requirements above and cannot demonstrate through submittal process that it is qualified, then the System Integrator will be rejected and a replacement System Integrator must be submitted.

C. Application Programmer:

1. The Applications Programming work is not in Contract and will be owner furnished. The Applications Programmer will be a subconsultant of the Construction Manager or a part of the Construction Manager's team.
2. The Application Programmer shall have on staff a PLC Programmer with no less than 7 years prior experience performing new installation PLC programming on water treatment plant projects.
3. The Application Programmer shall have on staff a SCADA Programmer with no less than 5 years prior experience performing new installation SCADA configuration and programming on water treatment plant projects.
4. The PLC Programmer shall be the lead project manager for the Application Programmer and shall coordinate the Project onsite installation and testing work and prepare the control descriptions and Drawings. The Project Engineer shall attend all coordination meetings when specifically requested by the Engineer.
5. The PLC Programmer and the SCADA programmer shall not be the same person and both shall be continuous staff of the Application

Programmer. A minimum of two persons shall be required to perform Application Programming over the duration of the Project.

1.07 QUALITY ASSURANCE

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

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

C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

1.08 ENVIRONMENTAL CONDITIONS

A. The following areas are classified hazardous (Class I, Division 2, Group D) due to the potential for accumulation of hazardous concentrations of combustible gases, and for exposure to corrosive environment. Use materials and methods required for such areas.

1. MW-20 Bench and Transwestern (TW) Bench Process Equipment Buildings, as shown on Drawings.

B. The following areas are classified nonhazardous, wet, and corrosive (NEMA 4X). Use materials and methods required for such areas.

1. Inside of wet wells and tanks.

C. The following areas are classified nonhazardous and wet (NEMA 4). Use materials and methods required for such areas.

1. Building interior process areas.
2. Belowgrade vaults.

D. The following areas are classified as indoor and dry (NEMA 1):

1. All other Building interior nonprocess areas either divide by enclosed walls and doors from process areas or located 20 feet from process equipment.
2. Electrical Rooms.

E. The following areas are classified as outdoor and wet (NEMA 3R).

1. Outdoor abovegrade areas.
2. Within shade structures.

PART 2 PRODUCTS

2.01 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 122 degrees F.

C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range stated in Section 01 61 00, Common Product Requirements (to be completed).

D. Equip panels installed outdoors in direct sun with sun shields.

E. Electrical ratings of materials and equipment that are reduced by increased elevation shall be derated as required for Site elevation specified in Section 01 61 00, Common Product Requirements (to be completed).

2.02 EQUIPMENT FINISH

A. Manufacturer’s standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with Section 09 90 00, Painting and Coating.

2.03 NAMEPLATES AND TAGS

A. Equipment Exterior Nameplates: Nameplate material shall be rigid laminated black plastic with beveled edges and white lettering; except for caution, warning, and danger nameplates the color shall be red with white lettering. The size of the nameplate shall be as shown on Drawings. No letters are allowed smaller than 3/16 inch. All nameplates located outdoors shall be UV resistant. Securely fasten nameplates in place using two stainless steel screws type, Type 316L, if the nameplate is not an integral part of the device. Epoxy cement or glued on nameplates will not be acceptable. Engrave the nameplates with the inscriptions as approved by the Engineer in the submittal.

1. For each major piece of electrical equipment provide a manufacturer's nameplate showing the Contract specified name and number designation, and pertinent ratings such as voltage, number of phases, ratings, etc.
2. For each device with a specific identity (pushbutton, indicator, instrument, etc.) mounted on the exterior or deadfront of a piece of equipment provide a nameplate with the inscription as shown in the Contract Documents.
3. Where no inscription is indicated in the Contract Documents, furnish nameplates with an appropriate inscription providing the name and number of device.
4. Install Safety Signs in accordance with the latest OSHA requirements.
    a. Entrances to Electrical Rooms and Stations: Danger Sign requirements, ELECTRICAL ROOM, HIGH VOLTAGE (define voltage, example 480 V ac) KEEP OUT, AUTHORIZED PERSONNEL ONLY.
    b. Equipment Enclosures, Cable Tray and Wireway Where 120V ac or Higher and 50V dc and Higher Exist: Danger Sign requirements, HIGH VOLTAGE (define voltage, example 480V ac) AUTHORIZED PERSONNEL ONLY.
    c. Equipment such as Motor Control Centers, Control Panels, etc., Where More than One Source may be Present in an Enclosure or Cubicle: Danger Sign requirements, VOLTAGE (define voltage, example 120V ac control voltage or 480V ac power) FROM MULTIPLE SOURCES IN THIS ENCLOSURE.
    d. Equipment such as Switchboards, Switchgear, Panelboards, and Motor Control Centers: Warning Sign requirements, WARNING, SERVICE ENTRANCE DISCONNECT FOR 1 OF ___ (define quantity) SERVICES TO THIS BUILDING. OTHER SERVICE ENTRANCE DISCONNECTS ARE LOCATED AT (define locations).
5. Caution, warning and danger nameplates shall be red with white lettering.

B. Equipment Interior Nameplates: Nameplate material shall be clear plastic with black machine printed lettering as produced by a KROY or similar machine; except caution, warning, and danger nameplates shall have red lettering. The size of the nameplate tape shall be no smaller than 1/2 inch in height with 3/8 inch lettering unless otherwise approved by the Engineer. Securely fasten nameplates in place on a clean surface using the adhesion of the tape. For each device with a specific identity (relay, module, power supply, fuse, terminal block, etc.) mounted in the interior of a piece of equipment provide a

nameplate with the inscription as shown in the Contract Documents. Where no inscription is indicated in the Contract Documents, furnish nameplates with an appropriate inscription providing the name and number of device used on the Submittal Drawings. Stamp the nameplates with the inscriptions as approved by the Engineer in the Submittal.

C. Equipment Tags: When there is no space or it is impractical to attach an engraved plastic nameplate with screws, as is the case with most field devices and instruments, the Contractor shall attach a tag to the equipment with the same inscriptions as specified above in Paragraph A. The tag shall be made from stainless steel material and the size of the nameplate shall be no smaller than 3/8-inch high by 2-inch width with 3/16-inch machine printed or engraved lettering unless otherwise approved by the Engineer. The tag shall be attached to the equipment with stainless steel wire of the type normally used for this purpose.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.

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

D. Keep openings in boxes and equipment closed during construction.

E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.02 CONSTRUCTION METHODS

A. Equipment shall be assembled and wired by the manufacturer prior to shipment. Field modifications or changes are not allowed without a written "Change Order" to the Contract. Field changes, however large or small, shall be executed using the components, materials, wiring, labeling, and assembly methods identical to that of the original supplied equipment.

B. Electrical plugs, receptacles, cords, and connectors required to power or interface the equipment and panels shall be furnished and installed by the Contractor.

C. Factory as-built drawings for each custom manufactured control panel or MCC shall be shipped with the equipment and placed inside in waterproof envelopes.

3.03 EQUIPMENT FABRICATION

A. All electrical equipment, including custom manufactured equipment, shall meet the requirements of Underwriters Laboratories (UL) and bear the appropriate label. Panels shall be affixed with UL label prior to shipment and be built in accordance with the UL guidelines and procedure that corresponds to the UL label. Custom control equipment shall bear a UL-508 label, minimum, with additional UL labels as required per intended service.

B. Panel cutouts for devices (i.e., indicating lights, switches) shall be cut, punched, or drilled and smoothly finished with rounded edges. Exposed metal from cutouts that are made after the final paint finish has been applied shall be touched up with a matching paint prior to installing device.

C. Equipment doors shall swing freely and close and latch with proper alignment.

D. Component within the electrical equipment shall be securely mounted on an interior subpanel or backpan and arranged for easy servicing. Mounting bolts and screws shall be front mounted for device removal without special tools or removal of entire mounting panel.

E. A ground bus shall be provided in each enclosure or cabinet. It shall have provisions for connecting a minimum of ten grounding conductors. Screw type lugs shall be provided for connection of grounding conductors. All grounding conductors shall be sized as shown on plans or in accordance with NEC Table 250-95, whichever is larger.

F. Bolts and screws for mounting devices on doors shall have a flush head which blends into the device or door surface. No fastening devices shall project through the outer surfaces of equipment.

3.04 WORKMANSHIP

A. All work in this division shall conform to the codes and standards outlined herein.

B. Installation shall be performed by qualified personnel providing first class workmanship per Electrical Specifications [Electrical General, Qualifications].

C. Maintain equipment installed (or to be installed) in new condition. Protect equipment from damage while in Contractor care from dust, water, or mishaps that are typical to construction sites.

D. Confirm that equipment and materials are correct for their intended duty and will be installed per manufacturer guidelines. Equipment and components found to be installed inconsistent with manufacturer guidelines and/or these specifications will not be acceptable and subject to removal and replacement.

E. Upon completion of daily work, remove excess materials, scraps, and debris from the work area and from the inside of equipment.

F. Upon notification, stop work on any portion of the installation that is determined to be noncompliant with Contract or being installed by unqualified personnel.

G. Perform all work to correct improper installations at Contractor expense.

H. Equipment furnished under this Contract or provided to Contractor for installation shall be installed in accordance with manufacturer's instructions, installation calculations, and Contract Documents.

3.05 EQUIPMENT SHIPMENT AND STORAGE

A. Shipment: Any equipment whose destination (jobsite) is more than 25 miles from the factory shall be carefully protected for shipping. All openings shall be protected by plywood securely fastened to the framework of the equipment. Equipment shall be adequately covered during local delivery.

B. Storage: From the time of receipt until the equipment is installed and energized, the equipment shall be considered in storage. While in storage, a 120-volt, single-phase source of power shall be made available and connected to space heaters in all items of equipment so equipped. Equipment not provided with space heaters shall be provided with a light bulb or electric heater while in storage to prevent moisture condensation. Unless stored indoors, it shall be a least 1 foot abovegrade covered with at least two layers of heavy polyethylene plastic sheets and anchored to prevent damage by high winds. All equipment shall be protected from dust and moisture prior to and during construction.

3.06 DAMAGED PRODUCTS

A. Damaged products that cannot be repaired to new condition shall be replaced with new products. All equipment and materials shall be in like-new condition at startup and commissioning.

B. Any equipment furnished outside of contract to the Contractor shall be repaired or replaced if damaged while in the Contractor's care. The Contractor shall pay for the parts and/or services of the original equipment manufacturer (OEM) to troubleshoot, asses, and repair damaged equipment.

C. Minor cosmetic damage shall be repaired by spray painting, after properly preparing the surface, all scratches or defects in the finish of the equipment. Only identical paint furnished by the equipment manufacturer shall be used for such purposes.

3.07 ANCHORING AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements for seismic criteria given in Section 01 61 00, Common Product Requirements (to be completed).

3.08 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Homerun circuits shown on Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:

1. Power circuits from loads in same general area to same source location (such as: panelboard, switchboard, low voltage motor control center).
   a. Lighting Circuits: Combine no more than three circuits to a single raceway. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   b. Receptacle Circuits, 120-Volt Only: Combine no more than three circuits to a single raceway. Provide a separate neutral conductor for each circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   c. All Other Power Circuits: May not be combined.

3.09 CLEANING AND TOUCHUP PAINTING

A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

B. Touchup Paint:

1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

3.10 PROTECTION FOLLOWING INSTALLATION

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

B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

END OF SECTION

SECTION 26 05 04
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
   c. E814, Method of Fire Tests of Through-Penetration Fire Stops.
2. Canadian Standards Association (CSA).
3. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
   c. C12.1 Code for Electricity Metering.
   d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   e. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   f. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. Underwriters Laboratories Inc. (UL):
   a. 98, Standard for Enclosed and Dead-Front Switches.
   b. 248, Standard for Low Voltage Fuses.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.

f. 943, Standard for Ground-Fault Circuit-Interrupters.
g. 1059, Standard for Terminal Blocks.
h. 1479, Fire Tests of Through-Penetration Fire Stops.

1.02 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
   a. Control devices.
   b. Control relays.
   c. Circuit breakers.
   d. Fused switches.
   e. Nonfused switches.
   f. Timers.
   g. Fuses.
   h. Magnetic contactors.
   i. Uninterruptible power supplies.
   j. Neutral grounding resistors.
   k. Firestopping.
   l. Enclosures: Include enclosure data for products having enclosures.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing (to be completed later).

B. Informational Submittals: Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing (to be completed later).

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:

1. Circuit breakers and motor circuit protectors shall be manufactured by Eaton Cutler-Hammer, Square D, G.E., Siemens, or equal.
2. Circuit breakers shall be the bolt-on type. The use of tandem or dual circuit breakers in a normal single-pole space to provide the number of poles or spaces specified are not acceptable. All multiple-pole circuit breakers shall be designed so that an overload on one pole automatically causes all poles to open.
3. Each 480-volt circuit breaker shall have a minimum interrupting capacity of 42,000 amperes or as otherwise shown on Drawings. Each

120- or 208- or 240-volt breaker shall be rated for a minimum 10,000 amperes interrupting capacity. Breakers shall be sized as shown on Drawings and as necessary for the supplied equipment.

4. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.
5. Circuit breakers shall be operated by a single toggle-type handle and shall have a quick-make, quick-break switching mechanism. An automatic trip of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and have flash reduction arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
6. Circuit breakers below 100-ampere trip or are 100-ampere frame or less shall have thermal-magnetic (TM) trip units and inverse time-current characteristics unless protecting full voltage or solid state reduced voltage motor starters.
7. Circuit breakers protecting full voltage or solid state reduced voltage motor starters shall be motor circuit protector (MCP) breakers with adjustable magnetic trip unless otherwise noted on the drawings.
8. All circuit breakers 101-ampere through 2,500-ampere trip shall have (MPT) microprocessor-based, RMS sensing trip technology with ground fault protection.
9. Circuit breakers shall be UL listed for series application.
10. Where indicated circuit breakers shall be current limiting.
11. Where indicated provide UL listed circuit breakers for applications at 100 percent of their continuous ampere rating in their intended enclosure.

B. Trip Units – Molded Case Circuit Breakers Below 400 Amperes:

1. The trip unit shall be Eaton type Digitrip 310 or approved equal.
2. Each molded case circuit breaker microprocessor-based tripping system (MPT) shall consist of three current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.
3. An adjustable trip setting dial mounted on the front of the trip unit, or interchangeable ratings plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not

interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

4. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
   a. Adjustable long-time setting (set by adjusting the trip setting dial or rating plug).
   b. Adjustable short-time setting and delay with selective curve shaping.
   c. Adjustable instantaneous setting.
   d. Adjustable ground fault setting and delay.
5. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
6. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override.
7. Furnish internal ground fault protection with adjustable settings. Provide neutral ground fault sensor for four-wire loads.
8. Breakers shall have built-in test points for testing the long-time delay, instantaneous, and ground fault functions of the breaker by means of a test set.

C. Trip Units – Molded Case Circuit Breakers – 400 to 1,200 Amperes:

1. The trip unit shall be Eaton type Digitrip OPTIM 550 – Programmable or approved equal.
2. Each circuit breaker microprocessor-based tripping system (MPT) shall consist of three current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached. The trip unit shall be Eaton type OPTIM or approved equal.
3. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed-type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

4. System coordination shall be provided by the following microprocessor-based programmable time/current curve shaping adjustments:
   a. Programmable long-time pickup settings in 1-percent increments, with plus or minus 5 percent band tolerance.
   b. Programmable long-time delay with selectable I^2t or I^4t curve shaping.
   c. Programmable short-time settings (dependent on long-time setting) in 1-percent increments, with plus or minus 5 percent band tolerance.
   d. Programmable short-time delay with selectable flat or I^2t curve shaping.
   e. Programmable instantaneous pickup settings in 1-percent increments.
   f. Programmable ground fault pickup settings trip or alarm in 1-percent increments.
   g. Programmable ground fault delay with selectable flat or I^2t curve shaping.
5. The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
6. When the instantaneous setting has been deselected, a selectable discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.
7. Internal ground fault protection or alarm settings if specified shall not exceed 1,200 amperes. Provide neutral ground fault sensor for four-wire loads.
8. The trip unit shall have an information system that utilizes battery backed-up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. The LEDs shall be complemented by trip event information stored in nonvolatile memory after a trip event. A trip reset button shall be provided to turn off the LED indication and reset the memory after an automatic trip. A test pushbutton shall energize an LED to indicate battery status.
9. A red LED shall be provided on the face of the trip unit and preset to flash on and off when an adjustable high-load level is exceeded. A time-delay shall be provided to avoid nuisance alarms. The microprocessor-based trip units shall be capable of monitoring the following data:
   a. Instantaneous value of phase, neutral and ground current.
   b. Minimum and maximum current values.
   c. Average demand current.
   d. System diagnostic information such as alarms and cause of trip.

e. Approximate level of fault current that initiated an automatic trip operation.

10. The trip unit shall contain test capability. Testing shall be carried out by using a handheld programmer, a breaker interface module or a remote computer to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in either the “Trip” or “No Trip” test mode. Provide an auxiliary power module to allow the breaker trip unit to be tested with a 120-volt external power source.
11. A handheld programming unit shall be provided to set/change the network communication breaker address for each device, set the system baud rate, distribution frequency, display breaker information, and display monitored values. In addition, provide password protection for programming time/current setpoints and to perform functional testing of phase and ground trip characteristics. The programmer shall be self-powered by an internal battery. Provide as a minimum one handheld programming unit per assembly.
12. The monitored data shall be displayed by a handheld programmer, a breaker interface module, or a remote computer.
13. Circuit breakers, 1,200-ampere frame and below, shall be provided with a 24V dc power supply mounted within the assembly. In addition, provide a minimum of one auxiliary switch and one bell alarm, each with Form C contacts in each breaker. Provide additional auxiliary switches, bell alarms, shunt trips, and undervoltage releases where indicated on Drawings.
14. Circuit breakers, 1,600-ampere frame and above, shall be provided with a power/relay module to supply control power. Internal relays shall provide contacts for remote indication of the mode of trip (long-delay, short-circuit, ground fault) and high load.

D. Trip Units – Molded Case Circuit Breakers – Above 1,200 Amperes:

1. The trip unit shall be Eaton type Digitrip OPTIM 750 – Programmable or approved equal.
2. Each circuit breaker microprocessor-based tripping system (MPT) shall consist of three current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.

3. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed-type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
4. System coordination shall be provided by the following microprocessor-based programmable time/current curve shaping adjustments:
    a. Programmable long-time pickup settings in 1-percent increments, with plus or minus 5 percent band tolerance.
    b. Programmable long-time delay with selectable I^2t or I^4t curve shaping.
    c. Programmable short-time settings (dependent on long-time setting) in 1-inch increments, with plus or minus 5 percent band tolerance.
    d. Programmable short-time delay with selectable flat or I^2t curve shaping.
    e. Programmable instantaneous pickup settings in 1-percent increments.
    f. Programmable ground fault pickup settings trip or alarm in 1-percent increments.
    g. Programmable ground fault delay with selectable flat or I^2t curve shaping.
5. The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
6. When the instantaneous setting has been deselected, a selectable discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.
7. Furnish ground fault protection. Provide neutral ground fault sensor for four-wire loads.
8. The trip unit shall have an information system that utilizes battery backed-up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. The LEDs shall be complemented by trip event information stored in nonvolatile memory after a trip event. A trip reset button shall be provided to turn off the LED indication and reset the memory after an automatic trip. A test pushbutton shall energize an LED to indicate battery status.

9. A red LED shall be provided on the face of the trip unit and preset to flash on and off when an adjustable high-load level is exceeded. A time-delay shall be provided to avoid nuisance alarms. The microprocessor-based trip units shall be capable of monitoring the following data:
   a. Instantaneous value of phase, neutral and ground current.
   b. Minimum and maximum current values.
   c. Average demand current.
   d. System diagnostic information such as alarms and cause of trip.
   e. Approximate level of fault current that initiated an automatic trip operation.
10. The trip unit shall contain test capability. Testing shall be carried out by using a handheld programmer, a breaker interface module, or a remote computer to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in either the “Trip” or “No Trip” test mode. Provide an auxiliary power module to allow the breaker trip unit to be tested with a 120-volt external power source.
11. A handheld programming unit shall be provided to set/change the network communication breaker address for each device, set the system baud rate, distribution frequency, display breaker information, and display monitored values. In addition, provide password protection for programming time/current setpoints and to perform functional testing of phase and ground trip characteristics. The programmer shall be self-powered by an internal battery. Provide one handheld programming unit.
12. The monitored data shall be displayed by a handheld programmer, a breaker interface module or a remote computer.
13. Circuit breakers, shall be provided with one auxiliary switch for open and close, each with Form C contacts. Provide additional auxiliary switches, shunt trips, and undervoltage releases where indicated on Drawings.
14. Trip unit shall include zone interlocking capability for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream circuit breaker, and allow the circuit breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the preset time delay.

2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. UL 98 listed for use and location of installation.

B. NEMA KS 1.

C. Short Circuit Rating: 200,000 amps RMS symmetrical with Class R, Class J, or Class L fuses installed.

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

E. Connections:

1. Mechanical lugs, except crimp compression lugs where shown.
2. Lugs removable/replaceable.
3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.

F. Fuse Provisions:

1. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
2. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.

B. Enclosures: See Article Enclosures.

C. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. NEMA KS 1.

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

C. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.

D. Enclosures: See Article Enclosures.

E. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.04 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

1. Current-limiting, with 200,000 ampere rms interrupting rating.
2. Provide to fit mountings specified with switches.
3. UL 248.

B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:

1. Class: RK-1.
2. Type: Dual element, with time delay.
3. Manufacturers and Products:
   a. Bussmann; Types LPS-RK (600 volts) and LPN-RK (250 volts).
   b. Littelfuse; Types LLS-RK (600 volts) and LLN-RK (250 volts).

C. Power Distribution, Ampere Ratings 601 Amps to 6,000 Amps:

1. Class: L.
2. Double O-rings and silver links.
3. Manufacturers and Products:
   a. Bussmann; Type KRP-C.
   b. Littelfuse, Inc.; Type KLPC.

D. Cable Limiters:

1. 600V or less; crimp to copper cable, bolt to bus or terminal pad.
2. Manufacturer and Product: Bussmann; K Series.

E. Ferrule:

1. 600V or less, rated for applied voltage, small dimension.
2. Ampere Ratings: 1/10 amp to 30 amps.
3. Dual-element time-delay, time-delay, or nontime-delay as required.
4. Provide with blocks or holders as indicated and suitable for location and use.
5. Manufacturers:
   a. Bussmann.
   b. Littlefuse, Inc.

2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Light: Push-to-test. LED, full voltage.

D. Pushbutton Color:

1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbutton and selector switch lockable in OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum.
2. Engraving: Enamel filled in high contrasting color.
3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
4. Letter Height: 7/64-inch.

G. Manufacturers and Products:

1. Heavy-Duty, Oil-Tight Type:
   a. General Electric Co.; Type CR 104P.
   b. Square D Co.; Type T.
   c. Eaton/Cutler-Hammer; Type 10250T.
   d. Allen Bradley; 800T.
2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   a. Square D Co.; Type SK.
   b. General Electric Co.; Type CR 104P.
   c. Eaton/Cutler-Hammer; Type E34.
   d. Crouse-Hinds; Type NCS.
   e. Allen Bradley; 800H.

2.06 TERMINAL BLOCK, 600 VOLTS

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system, allowing use of preprinted or field-marked tags.

J. Terminal blocks shall be physically separated into groups by the level of signal and voltage served. Power and control wiring above 100 volts shall have a separate group of terminal blocks from terminal blocks for wiring below 100 volts, intermixing of these two types of wiring on the same group of terminal blocks is not allowed.

K. Provide a ground terminal or connection point for each grounding conductor.

L. Provide a separate common or neutral terminal for every two (maximum) inputs and/or outputs.

2.07 GENERAL PURPOSE

A. Terminal blocks shall be Allen Bradley 1492-W4, Entrelec M4/6, or approved equal.

B. Provide quantity of general purpose terminal blocks as required per Drawings, Specifications, and field terminations.

2.08 GROUNDING

A. Grounding blocks shall be Allen Bradley 1492-WG4, Entrelec, or approved equal.

2.09 SENSOR BLOCKS

A. Sensor blocks shall be Allen Bradley 1492-WTS3, Entrelec, or approved equal.

B. Furnish two sensor blocks for each analog input.

2.10 MAGNETIC CONTROL RELAY

A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.

B. NEMA ICS 2, Designation: A300 (300 volts).

C. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable from 0.2 second to 60 seconds (minimum).
2. Field convertible from ON delay to OFF delay and vice versa.

D. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

E. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Type M-300.
2. General Electric Co.; Type CR120A.
3. IDEC; Type RR.

2.11 TIME DELAY RELAY

A. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.

B. NEMA ICS 2 Designation: B150 (150 volts).

C. Solid-state electronic, field convertible ON/OFF delay.

D. One normally open and one normally closed contact (minimum).

E. Repeat accuracy plus or minus 2 percent.

F. Timer adjustment from 1 second to 60 seconds, unless otherwise indicated on Drawings.

G. Manufacturers and Products:

1. Square D Co.; Type F.
2. Eaton/Cutler-Hammer.

3. General Electric Co.
4. IDEC; Type RTE.

2.12 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 hour to 99,999.9 hours, nonreset type.

C. Mounting: Semiflush panel.

D. Manufacturers and Products:

1. General Electric Co.; Type 240, 2-1/2-inch Big Look.
2. Eagle Signal Controls; Bulletin 705.

2.13 MAGNETIC CONTACTOR

A. UL listed.

B. Electrically operated, electrically held.

C. Main Contacts:

1. Power driven in one direction with mechanical spring dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated as shown.
4. Poles: As shown.

D. Control: As shown.

E. Auxiliary Contacts: One normally open and one normally closed, rated 7200VA make, 720VA break, at 600V, A600 per NEMA ICS 5.

F. Enclosures: See Article Enclosures.

D. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Freedom.
2. General Electric Co.; CR 353.
3. Square D Co.; Class 8910.

2.14 UNINTERRUPTIBLE POWER SUPPLY SYSTEM (UPS)

A. General:

1. Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
2. Type: Continuous-duty, online, double conversion, power isolated.
   a. Major Parts: Rectifier, inverter, battery charger, sealed batteries, automatic bypass, control and monitor electronics.

B. Performance:

1. Capacity: Wattage as noted on Contract Drawings.
2. Input Power:
   a. 208Y/120V ac three-phase, four-wire, 60-Hz, unless otherwise noted.
   b. Connections: Manufacturer’s standard, unless otherwise noted.
3. Output Power:
   a. 208/120V ac three-phase, four-wire, 60-Hz, unless otherwise noted.
   b. Connections: Manufacturer’s standard, unless otherwise noted.
4. Online Efficiency: 85 percent minimum, unless otherwise noted.
5. Backup Runtime:
   a. Full Load: 15 minutes minimum, unless otherwise noted.
   b. Half Load: 30 minutes minimum, unless otherwise noted.
   c. Include provisions for future expansion of battery capacity via manufacturer’s standard battery packages.
6. Continuous no-break power with no measurable transfer time.
7. Sine-Wave Output Voltage Total Harmonic Distortion (THD): Plus or minus 6 percent or less.
8. Input Voltage Range: Plus 15 percent, minus 20 percent.
9. Output Voltage Regulation: Plus or minus 3 percent nominal.
10. Operating Temperature: 0 to 40 degrees C (32 to 104 degrees F).
11. Operating Relative Humidity: 5 to 95 percent without condensation.
12. Lightning and Surge Protection:
    a. Pass lightning standard IEEE C62.41 Categories A and B tests.
    b. 2,000 to 1 attenuation of input spike.
13. Features:
    a. Bypass Switches: Provide external maintenance bypass switch that will completely isolate power from the UPS without interruption of power to the loads being served.

b. Provide output contacts rated 5 amperes at 120V ac for communicating the following statuses and alarms to the plant control system:
   1) On Utility Power status.
   2) On Battery Power status.
   3) UPS FAIL Alarm.

14. Enclosures: Tower, unless otherwise noted.
15. Manufacturer and Product:
    a. Cutler Hammer-Eaton; Powerware.
    b. Or approved equal.

2.15 PHASE MONITOR RELAY

A. Features:

1. Voltage and phase monitor relay shall drop out on low voltage, voltage unbalance, loss of phase, or phase reversal.
2. Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.
3. Adjustable trip and time delay settings.
4. Transient Protection: 1,000V ac.
5. Mounting: Multipin plug-in socket base.

B. Manufacturer and Product: Diversified SLA, Automatic Timing and Controls; SLD Series.

2.16 INTRINSIC SAFETY BARRIER

A. Provides a safe energy level for exposed wiring in a Class I, Division 1 or Division 2 hazardous area when circuit is connected to power source in nonhazardous area.

B. Rating: Power source shall be rated 24 volts dc, nominal, with not more than 250 volts available under fault conditions.

C. Contact Rating: 5 amps, 250 volts ac.

D. Mounting: Rail or surface.

E. Manufacturers and Products:

1. MTL, Inc.; Series 2000 or Series 3000.
2. R. Stahl, Inc.

2.17 SWITCHBOARD MATTING

A. Provide matting having a breakdown of 20 kV minimum.

B. Manufacturer: U.S. Mat and Rubber Company.

2.18 FIRESTOPS

A. General:

1. Provide UL 1479 classified hourly fire-rating equal to, or greater than, the assembly penetrated.
2. Prevent the passage of cold smoke, toxic fumes, and water before and after exposure to flame.
3. Sealants and accessories shall have fire-resistance ratings as established by testing identical assemblies in accordance with ASTM E814, by Underwriters Laboratories Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

B. Firestop System:

1. Formulated for use in through-penetration firestopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.
2. Fill, Void, or Cavity Material: 3M Brand Fire Barrier Caulk CP25, Putty 303, Wrap/Strip FS195, Composite Sheet CS195 and Penetration Sealing Systems 7902 and 7904 Series.
3. Two-Part, Foamed-In-Place, Silicone Sealant: Dow Corning Corp. Fire Stop Foam, General Electric Co. Pensil 851.
4. Fire Stop Devices: See Section 26 05 33, Raceway and Boxes for Electrical Systems, for raceway and cable fittings.

2.19 ENCLOSURES

A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.

B. Color: Manufacturer’s standard color (gray) baked-on enamel, unless otherwise shown.

C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

D. Enclosure Selections: Except as shown otherwise, provide electrical enclosures according to the following table:

Enclosures			
Location	**Finish**	**Environment**	**NEMA 250 Type**
Indoor	Finished	Dry	1
Indoor	Unfinished	Dry	1
Indoor	Unfinished	Industrial Use	12
Indoor and Outdoor	Any	Wet	4
Indoor and Outdoor	Any	Denoted “WP”	3R
Indoor and Outdoor	Any	Wet and Corrosive	4X 316 Stainless Steel
Indoor and Outdoor	Any	Hazardous Gas	7
Indoor and Outdoor	Any	Hazardous Dust	9

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer’s recommendations.

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Unless otherwise shown, install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Unless otherwise shown, install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas.

3.03 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.

B. Channel Type: Per Section 26 05 33, Raceway and Boxes for Electrical Systems.

3.04 INTRINSIC SAFETY BARRIERS

A. Install in compliance with ISA RP12.06.01.

B. Arrange conductors such that wiring from hazardous areas cannot short to wiring from nonhazardous area.

C. Stencil “INTRINSICALLY SAFE CIRCUIT” on all boxes enclosing barriers.

3.05 SWITCHBOARD MATTING

A. Install 36-inch width at switchgear, switchboard, motor control centers, and panelboards.

B. Matting shall run full length of all sides of equipment that have operator controls or afford access to devices.

3.06 FIRESTOPS

A. Install in strict conformance with manufacturer’s instructions. Comply with installation requirements established by testing and inspecting agency.

B. Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide firestops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs.

END OF SECTION

SECTION 26 05 05
CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

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

1. Association of Edison Illuminating Companies (AEIC): CS 8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 kV through 46 kV.
2. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. B3, Standard Specification for Soft or Annealed Copper Wire.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV Through 500 kV.
   b. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   c. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500000 V.
4. Insulated Cable Engineer's Association, Inc. (ICEA):
   a. S-58-679, Standard for Control Cable Conductor Identification.
   b. S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables.
   c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
5. National Electrical Manufacturers' Association (NEMA):
   a. CC 1, Electric Power Connectors for Substations.
   b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
   c. WC 70, Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.

d. WC 71, Standard for Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy.
e. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
7. Telecommunications Industry Association (TIA): TIA-568-C, Commercial Building Telecommunications Cabling Standard.
8. Underwriters Laboratories Inc. (UL):
   a. 13, Standard for Safety for Power-Limited Circuit Cables.
   b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
   c. 62, Standard for Safety for Flexible Cord and Cables.
   d. 486A-486B, Standard for Safety for Wire Connectors.
   e. 486C, Standard for Safety for Splicing Wire Connectors.
   f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
   g. 854, Standard for Safety for Service-Entrance Cables.
   h. 1072, Standard for Safety for Medium-Voltage Power Cables.
   i. 1277, Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   j. 1569, Standard for Safety for Metal-Clad Cables.
   k. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Wire and cable.
   b. Wire and cable accessories.
   c. Cable fault detection system.
2. Manufactured Wire Systems:
   a. Product data.
   b. Rating information.
   c. Dimensional drawings.
   d. Special fittings.
3. Cable Pulling Calculations:
   a. Ensure submitted and reviewed before cable installation.

b. Provide for the following cable installations:
   1) Medium voltage cable runs that cannot be hand pulled.
   2) Individual and multiconductor 600-volt cable sizes larger than 2 AWG that cannot be hand pulled.
   3) Power and control conductor, and control, fiber optic, and instrumentation cable installations routed through ductbanks.

B. Informational Submittals:

1. Certified Factory Test Report for conductors 600 volts and below.
2. Certified Factory Test Report per AEIC CS 8, including AEIC qualification report for conductors above 600 volts.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

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

B. Terminations and Splices for Conductors above 600 Volts: Work shall be done by journeyman lineman with splicing credentials or electrician certified to use materials approved for cable splices and terminations.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 70.

B. Conductor Type:

1. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN-2, except for sizes No. 6 and larger, with XHHW-2 insulation.

D. Direct Burial and Aerial Conductors and Cables:

1. Type USE/RHH/RHW insulation, UL 854 listed, or Type RHW-2/USE-2.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

E. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

2.02 CONDUCTORS ABOVE 600 VOLTS

A. EPR Insulated Cable:

1. Extrusion: Single-pass, triple-tandem, of conductor screen, insulation, and insulation screen.
2. Type: 5, 8, and 15 kV, shielded, UL 1072, Type MV-105.
3. Conductors: Copper concentric lay Class B round stranded in accordance with ASTM B3, ASTM B8, and ASTM B496.
4. Conductor Screen: Extruded, semiconducting ethylene-propylene rubber in accordance with NEMA WC 71 and AEIC CS 8.
5. Insulation: 133 percent insulation level, ethylene-propylene rubber (EPR) containing no polyethylene, in accordance with NEMA WC 71, and AEIC CS 8.
6. Insulation Screen: Thermosetting, semiconducting ethylene-propylene rubber (EPR), extruded directly over insulation in accordance with NEMA WC 74 and AEIC CS 8.
7. Metallic Shield: Uncoated, 5-mil, copper shielding tape, helically applied with 12-1/2 percent minimum overlap.
8. Jacket: Extruded chlorinated polyethylene (CPE) compound applied in accordance with NEMA WC 71 or NEMA WC 74.
9. Operating Temperature: 105 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.
10. Manufacturers:
    a. Okonite Co.
    b. Pirelli Wire and Cable.
    c. General Cable.
    d. Southwire Co.

B. C-L-X Direct Bury Armored Insulated Cable:

1. Extrusion: Single-pass, triple-tandem, of conductor screen, insulation, and insulation screen.
2. Continuously corrugated welded aluminum sheath.
3. Type 15 kV, shielded, UL 1072, Type MV 105.
4. Conductors: Copper, compact, concentric lay Class B round stranded in accordance with ASTM B496.
5. Strand Fill: Waterproof strand compound enclosing conductors.
6. Conductor Screen: Extruded, semiconducting thermosetting compound in accordance with NEMA WC 71 and AEIC CS 8.
7. Insulation: 133 percent insulation level, thermosetting, tree-resistant, cross-link polyethylene (TR-XLP), in accordance with NEMA WC 71 and AEIC CS 8.
8. Insulation Screen: Thermosetting, semiconducting cross-link polyethylene, extruded directly over insulation.
9. Metallic Shield: Coated, 5-mil, copper shielding tape, helically applied with 12-1/2 percent minimum overlap.
10. Jacket: Extruded chlorinated polyethylene (CPE) compound applied in accordance with NEMA WC 71 or NEMA WC 74 and AEIC CS 8.
11. Operating Temperature: 105 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.
12. Manufacturers:
    a. Okonite Co.
    b. Pirelli Wire and Cable.
    c. General Cable.
    d. Southwire Co.

2.03 600-VOLT RATED CABLE

A. General:

1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer’s name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

6. Jacket shall be marked with the following information:
   a. Size.
   b. Grade of insulation.
   c. Voltage.
   d. Manufacturer name.
   e. UL label.

B. Type 1, Multiconductor Control Cable:

1. Conductors:
   a. 14 AWG, seven-strand copper.
   b. Insulation: 15-mil PVC with 4-mil nylon.
   c. UL 1581 listed as Type THHN/THWN rated VW-1.
   d. Conductor group bound with spiral wrap of barrier tape.
   e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
2. Cable: Passes the ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Southwire.

C. Type 2, Multiconductor Power Cable:

1. General:
   a. Meet or exceed UL 1581 for cable tray use.
   b. Meet or exceed UL 1277 for direct burial and sunlight-resistance.

c. Overall Jacket: PVC.

2. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: Chemically cross-linked ethylene-propylene or cross-linked polyethylene.
   c. UL rated VW-1 or listed Type XHHW-2.
   d. Color Code:
      1) Conductors, size 8 AWG and smaller, colored conductors, ICEA S-58-679, Method 1, Table 1.
      2) Conductors, size 6 AWG and larger, ICEA S-73-532, Method 4.
3. Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
4. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. of Current Carrying Conductors	Max. Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45
10	10	2 3 4	0.54 0.58 0.63	60
8	10	3 4	0.66 0.75	60
6	8	3 4	0.74 0.88	60
4	6	3 4	0.88 1.04	60 80
2	6	3 4	1.01 1.16	80
1	6	3 4	1.10 1.25	80
1/0	6	3 4	1.22 1.35	80

Conductor Size	Minimum Ground Wire Size	No. of Current Carrying Conductors	Max. Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
2/0	4	3 4	1.32 1.53	80
3/0	4	3 4	1.40 1.60	80
4/0	4	3 4	1.56 1.78	80 110

5. Manufacturers:
   a. Okonite Co.
   b. Southwire.

D. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nominal nylon.
   e. Color Code: Pair conductors, black and red.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

E. Type 4, 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal.

2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
3. Dimension: 0.32-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand, tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nylon.
   e. Color Code: Triad conductors black, red, and blue.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

F. Type 5, 18 AWG, Multitwisted Shielded Pairs, with a Common Overall Shield, Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 57 requirements.

1. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
   b. Tinned copper drain wires.
   c. Pair drain wire size AWG 20, group drain wire size AWG 18.
   d. Insulation: 15-mil PVC.
   e. Jacket: 4-mil nylon.
   f. Color Code: Pair conductors, black and red with red conductor numerically printed for group identification.
   g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.50	45
8	0.68	60
12	0.82	60

Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

4. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

G. Type 6, 18 AWG, Multitwisted Pairs with Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 57.

1. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
   b. Tinned copper drain wire size AWG 18.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nylon.
   e. Color Code: Pair conductors, black and red with red conductor numerically printed for group identification.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

Cable Sizes: Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.48	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.10	80
36	1.21	80

Cable Sizes: Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
50	1.50	80

1. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

2.04 300-VOLT RATED CABLE

A. General:

1. Type PLTC, meeting requirements of UL 13 and NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 105 degrees C.
5. Passes Vertical Tray Flame Test.
6. Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 24, Twisted Pair Fire Alarm Cable, Shielded: Power limited fire protective signaling circuit cable meeting requirements of NFPA 70, Article 760.

1. Cable: Pass NFPA 262, 70,000 Btu flame test and listed by California State Fire Marshall.
2. Outer Jacket: Red in color, identified along its entire length as fire protective signaling circuit cable.
3. Conductors:
   a. Solid, tinned, shielded, with stranded tinned copper drain wire.
   b. Insulation: 15-mil PVC.
4. Cable Sizes:

Wire Size	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Inches)
12	0.36	0.042
14	0.32	0.042

Wire Size	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Inches)
16	0.26	0.037
18	0.23	0.037

5. Manufacturers:
   a. West Penn Wire.
   b. Coleman Cable, Inc.

2.05 SPECIAL CABLES

A. Type 30, Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:

1. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568-C Category 6 requirements.
2. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.
3. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
4. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
5. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
6. Manufacturer and Product: Belden; 7852A.

2.06 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.07 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.

2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
   a. 30-mil, elastomer.
   b. Manufacturers and Products:
      1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
      2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.

B. Identification Devices:

1. Sleeve:
   a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturers and Products:
      1) Raychem; Type D-SCE or ZH-SCE.
      2) Brady, Type 3PS.
2. Heat Bond Marker:
   a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
   b. Self-laminating protective shield over text.
   c. Machine printed black text.
   d. Manufacturer and Product: 3M Co.; Type SCS-HB.
3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
4. Tie-On Cable Marker Tags:
   a. Chemical-resistant white tag.
   b. Size: 1/2 inch by 2 inches.
   c. Manufacturer and Product: Raychem; Type CM-SCE.
5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulug.
      3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Seamless.

c. Manufacturers and Products:
1) Thomas & Betts; Sta-Kon.
2) Burndy; Insulink.
3) ILSCO; ILSCONS.

3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
a. UL 486C.
b. Plated steel, square wire springs.
c. Manufacturers and Products:
1) Thomas & Betts.
2) Ideal; Twister.

2. Self-Insulated, Set Screw Wire Connector:
a. Two piece compression type with set screw in brass barrel.
b. Insulated by insulator cap screwed over brass barrel.
c. Manufacturers:
1) 3M Co.
2) Thomas & Betts.
3) Marrette.

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Uninsulated Crimp Connectors and Terminators:
a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
b. Manufacturers and Products:
1) Thomas & Betts; Color-Keyed.
2) Burndy; Hydent.
3) ILSCO.
4. Uninsulated, Bolted, Two-Way Connectors and Terminators:
a. Manufacturers and Products:
1) Thomas & Betts; Locktite.
2) Burndy; Quiklug.
3) ILSCO.

E. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation:

1. Thermally stabilized cross-linked polyolefin.

2. Single wall for insulation and strain relief.
3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
4. Manufacturers and Products:
    a. Thomas & Betts; SHRINK-KON.
    b. Raychem; RNF-100 and ES-2000.

2.08 ACCESSORIES FOR CONDUCTORS ABOVE 600 VOLTS

A. Molded Splice Kits:

1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
2. Capable of making splices with a current rating equal to, or greater than cable ampacity, conforming to IEEE 404.
3. With compression connector, EPDM molded semiconductive insert, peroxide-cured EPDM insulation, and EPDM molded semiconductive outer shield.
4. Premolded splice shall be rejacketed with a heat shrinkable adhesive-lined sleeve to provide a waterproof seal.
5. Manufacturers:
    a. Elastimold.
    b. Cooper Industries.

B. Heat Shrinkable Splice Kits:

1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
2. Capable of making splices with a current rating equal to, or greater than, cable ampacity, conforming to IEEE 404.
3. Class 15 kV, with compression connector, splice insulating and conducting sleeves, stress-relief materials, shielding braid and mesh, and abrasion-resistant heat shrinkable adhesive-lined rejacketing sleeve to provide a waterproof seal.
4. Manufacturers:
    a. Raychem.
    b. 3M Co.

C. Termination Kits:

1. Capable of terminating up to 15 kV, single-conductor, polymeric-insulated shielded cables plus a shield ground clamp.
2. Capable of producing a termination with a current rating equal to, or greater than, cable ampacity meeting Class 1 requirements of IEEE 48.

3. Capable of accommodating cable shielding or construction without need for special adapters or accessories.
4. Manufacturers:
   a. Raychem.
   b. 3M Co.

D. Bus Connection Insulation:

1. Heat shrinkable tubing, tape, and sheets of flexible cross-linked polymeric material formulated for high dielectric strength.
2. Tape and sheet products to have coating to prevent adhesion to metal surfaces.
3. Manufacturer: Raychem.

E. Elbow Connector Systems:

1. Molded, peroxide-cured, EPDM-insulated, 95 kV BIL, 200 amperes, 10,000A rms load-break elbows having copper current-carrying parts in accordance with IEEE 386.
2. Protective Caps: 95 kV BIL, 200 amperes, with molded EPDM insulated body.
3. Insulated Standoff Bushings: 95 kV BIL, 200 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.
4. Bushing Inserts: 95 kV BIL, 200 amperes, load-break with EPDM rubber body and all-copper, current-carrying parts.
5. Junctions: 95 kV two-way, three-way, four-way, 200 amperes, load-break, having EPDM rubber body mounted on adjustable bracket.
6. Mounting Plates: Two-, three-, and four-way, ASTM A167 stainless steel, complete with universal mounting brackets, grounding lugs and two parking stands.
7. Manufacturers:
   a. Cooper Industries.
   b. Elastimold.

F. Cable Lugs:

1. In accordance with NEMA CC1.
2. Rated 15 kV of same material as conductor metal.
3. Manufacturers and Products, Uninsulated Compression Connectors and Terminators:
   a. Burndy; Hydent.
   b. Thomas & Betts; Color-Keyed.

c. ILSCO.

4. Manufacturers and Products, Uninsulated, Bolted, Two-Way Connectors and Terminators:
   a. Thomas & Betts; Locktite.
   b. ILSCO.

2.09 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Approved for intended use by cable manufacturer.

D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

E. Manufacturers:

1. Ideal Co.
2. Polywater, Inc.
3. Cable Grip Co.

2.10 WARNING TAPE

A. As specified in Section 26 05 33, Raceway and Boxes for Electrical Systems.

2.11 SOURCE QUALITY CONTROL

A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

B. Conductors Above 600 Volts: Test in accordance with NEMA WC 71 and AEIC CS 8 corona level test for TR-XLP insulated cable.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation shall be in accordance with manufacturer’s recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18inches on center.

H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

I. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering area 1-1/2 inches to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductor insulation.
3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts, Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red

System	Conductor	Color
208Y/120 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
480Y/277 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Brown Orange Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

B. Conductors Above 600 Volts:

1. Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering area 1-1/2 inches to 2 inches wide.
2. Colors:
   a. Grounded Neutral: White.
   b. Phase A: Brown.
   c. Phase B: Orange.
   d. Phase C: Yellow.

3.03 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. All wires that are electrically the same (connected to common termination points) and do not pass through a contact or other switching device shall have the same wire identification. The wire labeling code for each end of the same wire shall be identical.

1. The wire identification code for internal panel wiring shall be the number/letter as designated on the Contract elementary and/or approved shop drawings.
2. Wire labeling for field wiring shall contain the panel/equipment name as a prefix and the termination point name. (I.E. PLC50-A103 or P10-124).

The hierarchy of label names is 1) PLC panel name, 2) MCC equipment name, and 3) Equipment name. Therefore, wires from PLC50 to the MCC50 P10 cubicle will be labeled PLC50-XXX. Wires from MCC50 P10 to field pressure switch PSH10 will be labeled P10-XXX.

3. Wire labels shall be exactly per interconnection submittal -- abbreviations determined in the field are not allowed. Abbreviations may be used in the wire label as submitted and approved in the interconnection drawings submittal.
4. Wire labels for lighting and receptacle circuits shall consist of the panel board and circuit number and a unique node number. (I.E. LP#3-A, LP#3-B, LP#3-N)
5. Wire labels may be omitted on “neutral jumpers” less than 8” in length.

C. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
2. Cables and Conductors 2 AWG and Larger:
   a. Identify with marker plates or tie-on cable marker tags.
   b. Attach with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.

5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.
10. Compression Lugs:
    a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    b. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Insulate uninsulated connections.
2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
3. Outdoors, Dry Locations: Use flame retardant, cold- and weather-resistant tape or single wall heat shrink.
4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.

F. Cap spare conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer’s instructions.

3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
4. Where connections of cables installed under this section are to be made under Section 40 90 00, Instrumentation and Control for Process Systems, leave pigtails of adequate length for bundled connections.
5. Cable Protection:
    a. Under Infinite Access Floors: May install without bundling.
    b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under floor or grouped into bundles at least 1/2 inch in diameter.
    c. Maintain integrity of shielding of instrumentation cables.
    d. Ensure grounds do not occur because of damage to jacket over shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.05 CONDUCTORS ABOVE 600 VOLTS

A. Do not splice unless specifically indicated or approved by Engineer.

B. Make joints and terminations with splice and termination kits, in accordance with kit manufacturer’s instructions.

C. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.

D. Single Conductor Cable Terminations: Provide heat shrinkable stress control and outer nontracking insulation tubings, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing, plus a ground braid and clamp.

E. Install terminals or connectors acceptable for type of conductor material used.

F. Provide outdoor rain skirts for riser pole and outdoor switchgear terminations.

G. Provide shield termination and grounding for terminations.

H. Provide necessary mounting hardware, covers, and connectors.

I. Where elbow connectors are specified, install in accordance with manufacturer’s instructions.

J. Connections and Terminations:

1. Install uninsulated crimp connectors and terminators for power circuit conductors 4 AWG and larger.
2. Install uninsulated, bolted, two-way connectors for motor circuit conductors No. 12 and larger.
3. Insulate bus connections with heat shrinking tubing, tape, and sheets.
4. Make bus connections removable and reusable in accordance with manufacturer's instructions.

K. Give 2 working days' notice to Engineer prior to making splices or terminations.

3.06 CONDUCTOR ARC AND FIREPROOFING

A. Install arc and fireproofing tape on 600-volt single conductors and cables, except those rated Type TC at splices in manholes, handholes, vaults, cable trays, and other indicated locations.

B. Install arc and fireproofing tape on 5+ kV cables at splices in manholes, handholes, vaults, cable trays, and other indicated locations.

C. Wrap conductors of same circuit entering from separate conduit together as single cable.

D. Follow tape manufacturer's installation instructions.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Rod electrodes.
2. Active electrodes.
3. Wire.
4. Grounding well components.
5. Mechanical connectors.
6. Exothermic connections.

B. Related Section: Section 26 41 00, Facility Lightning Protection: Grounding of lightning protection system.

1.02 REFERENCES

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

1. Institute of Electrical and Electronics Engineers:
   a. IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems.
   b. IEEE 1100, Recommended Practice for Powering and Grounding Electronic Equipment.
2. International Electrical Testing Association: NETA ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
3. National Fire Protection Association:
   a. NFPA 70, National Electrical Code.
   b. NFPA 99, Standard for Health Care Facilities.

1.03 SYSTEM DESCRIPTION

A. Each building, service entrance, and electrical distribution location shall have a suitable grounding system meeting requirements herein.

B. Grounding systems use the following elements as grounding electrodes:

1. Metal underground water pipe.

2. Metal building frame.
3. Concrete-encased electrode.
4. Rod electrode.
5. Plate electrode.

1.04 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5ohms maximum.

1.05 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed later): Requirements for submittals.

B. Product Data: Submit data on grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground.

D. Manufacturer's Installation Instructions: Submit for active electrodes.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.06 CLOSEOUT SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed later): Requirements for submittals.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.07 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

B. Perform Work in accordance with State of California Public Work's standard.

C. Maintain one copy of each document on site.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00, Product Requirements (to be completed later): Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.10 COORDINATION

A. Section 01 30 00, Administrative Requirements (to be completed later): Requirements for coordination.

B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.01 ROD ELECTRODES

A. Manufacturers:

1. Erico, Inc..
2. O-Z Gedney Co..
3. Thomas & Betts, Electrical l.

B. Product Description:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.
3. Length: 10 feet.

2.02 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: 4 AWG.

C. Grounding Electrode Conductor: Copper conductor bare.

D. Bonding Conductor: Copper conductor bare.

2.03 CONNECTIONS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Utilize low-smoke, low-emission process.
3. Manufacturers:
   a. Erico Products, Inc.
   b. Thermoweld.

B. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
5. Manufacturers:
   a. Burndy Corp.; Hyground Irreversible Compression.
   b. Thomas and Betts Co.
   c. ILSCO.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

D. Manufacturers:

1. Copperweld, Inc.
2. ILSCO Corporation.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical.

E. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers and Products:

1. Christy Co.
2. Lightning and Grounding Systems, Inc.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding shall be in compliance with NFPA 70 and IEEE C2.

B. Ground electrical service neutral at service entrance equipment with grounding electrode conductor to grounding electrode system.

C. Ground each separately derived system neutral with common grounding electrode conductor to grounding electrode system.

D. Bond together all grounding electrodes that are present at each building or structure served to form one common grounding electrode system.

E. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

F. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

G. Shielded Instrumentation Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

I. Metallic Equipment Enclosures: Use furnished ground lug; if none furnished, tap equipment housing and install solderless terminal connected to box with machine screw. For circuits greater than 20 amps use minimum 5/16-inch diameter bolt.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Use furnished ground lug in motor connection box; if none furnished, provide compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Above: Use furnished ground lug in motor connection box; if none furnished, tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

C. Space multiple ground rods by one rod length.

D. Install to 8 feet below local frost depth.

3.05 GROUNDING WELLS

A. Install for ground rods located inside buildings, asphalt and paved areas, and install riser ring and cover flush with surface.

B. Place 6 inches of crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:

1. Abovegrade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
2. Belowgrade Connections: Install exothermic weld or compression type connectors.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify CH2M HILL prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer’s recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer’s recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.

3. Install using connector manufacturer's compression tool having proper sized dies and operate per manufacturer's instructions.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Bond metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each manhole and handhole larger than 24-inch by 24-inch inside dimensions.

B. Ground Rod Floor Protrusion: 4 inches to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all noncurrent-carrying metal parts, and any metallic raceway grounding bushings to ground rod with 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

B. Where shown on Drawings.

C. Bolt connections to equipment ground bus.

3.11 PREPARATION

A. Remove paint, rust, surface contaminants at connection points.

3.12 INSTALLATION

A. Install in accordance with IEEE 142, 1100, and NEC Article 250.

B. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.

C. Install grounding and bonding conductors concealed from view.

D. Install grounding well pipe with cover at each rod location. Install well pipe top flush with finished grade.

E. Install bare copper wire in foundation footing as indicated on Drawings.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:

1. Section 26 05 26, Grounding and Bonding for Electrical Systems.
2. Section 26 27 26, Wiring Devices.

1.02 REFERENCES

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

1. American National Standards Institute:
   a. C80.1, Rigid Steel Conduit, Zinc Coated.
   b. C80.3, Specification for Electrical Metallic Tubing, Zinc Coated.
   c. C80.5, Aluminum Rigid Conduit - (ARC).
2. National Electrical Manufacturers Association:
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. FB 1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
   c. OS 1, Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   d. OS 2, Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
   e. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   f. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
   g. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.03 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground Provide conduit per size and fill per conduit schedules. Conduit type shall be per this specification or as otherwise called out on Drawing Details or schedules.

1.04 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.05 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed): Submittal procedures.

B. Product Data: Submit for the following:

1. Flexible metal conduit.
2. Liquidtight flexible metal conduit.
3. Nonmetallic conduit.
4. Flexible nonmetallic conduit.
5. Nonmetallic tubing.
6. Raceway fittings.
7. Conduit bodies.
8. Surface raceway.
9. Wireway.
10. Pull and junction boxes.
11. Handholes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.06 CLOSEOUT SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Closeout procedures.

B. Project Record Documents:

1. Record actual routing of conduits larger than 3/4 inch.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00, Product Requirements (to be completed): Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.08 COORDINATION

A. Section 01 30 00, Administrative Requirements (to be completed): Coordination and project conditions.

B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.01 CONDUIT, RACEWAYS AND WIREWAYS

A. General: Conduit, raceways, and wireways, wiring methods, materials, installation shall meet all requirements of the NEC, be UL labeled for the application, and meet the minimum following specifications.

B. All wiring shall be installed in conduits, raceways, or wireways when interconnecting equipment and devices.

C. Area Classifications:

1. Area classifications shall be per the following table unless otherwise noted.

Area Description	Classification
Enclosed within buildings (nonprocess areas)	NEMA 1
Enclosed within buildings (process areas)	NEMA 4
Underground vaults	NEMA 4
Hazardous locations	NEMA 7
All other locations outdoor and within shade structures	NEMA 3R

D. Conduits may connect into junction boxes or wireways as shown in the drawings or as requested by Contractor and approved by Engineer. Junction boxes (circle with J on Drawings) can be as simple as a condulet or JIC box, or larger box as determined by Contractor and needed for the installation. Drawing may depict junction box requirements. Wireways or junction boxes shall be rated for area (as noted on Drawings), or furnish minimum NEMA 4 if not noted.

E. The Contractor shall use conduit material types (SPEC per conduit schedule) as defined below or as otherwise shown in the Contract Drawings or as specifically called out in the conduit schedule.

1. Nonexposed underground portions of conduit run shall be per the following table for all signals and voltages unless otherwise shown on Drawings or conduit schedule.

Location	Material
Underground within Topock Compressor Station perimeter fence plus 20 feet beyond.	PVC-Coated Steel (GRS-PVC)
Beyond Topock Compressor Station perimeter fence plus 20 feet.	PVC-40 or HDPE

2. Exposed conduit material (not underground and beyond transition) shall be per the following table unless specifically noted otherwise in the plan Drawings. The conduit schedule denotes the conduit type for nonexposed (underground, in-concrete, etc.) and does not apply or coordinate with this table. Exposed condulets, elbows, fittings, device boxes, and hardware shall be of the same material and finish as the adjacent conduit.

Location	Material
NEMA 1 or 12	Galvanized rigid steel (GRS)
NEMA 3R	Galvanized rigid steel (GRS)
NEMA 4	PVC-Coated Steel (GRS-PVC)
NEMA4X	PVC-Coated Steel (GRS-PVC)
Class 1 Division 1 or 2 hazardous	GRS

3. Conduit transitions shall be GRS-PVC for 6 inches on either side of the transition point (minimum) or as shown on Drawing Details. Conduit transition is defined as conduit sections through concrete or earth in the area from below to abovegrade or through walls or vaults.

F. The minimum size conduit shall be 3/4-inch unless indicated otherwise on Drawings or for special connections to equipment.

G. Conduit stubs for future use shall be capped with coupling and plug. Identify each end with conduit labels.

H. Existing conduits to be abandoned that protrude above grade shall be cut flush and filled with grout.

I. Conduit Tags:

1. All conduits listed in the “Conduit and Wire Routing Schedule” shall have conduit tags at both ends of each conduit run with tag number from schedule identified. This shall include ends within underground pull boxes.
2. All underground conduits shall have conduit tags at both ends of each conduit run. This shall include ends within underground pull boxes.
3. Tags on each conduit shall denote destination of conduit (acronym) and a unique number. Use tags such as 01 and RTU, 02 and MCC, 03 and LP, 05 and P1, 06 and PIT-61, etc. Tag destination acronym shall reverse at the other end of conduit but the number shall stay the same. Two tags may be used if placed back-to-back.
4. All conduits shall have temporary tags during construction. Temporary tags may be made from duct tape with hand written ink marking or suitable equivalent. Temporary tags shall be removed by Contractor at time of installation of permanent tags.
5. Tag material shall be rigid laminated red plastic with white lettering. The size of the tag shall be 1/4-inch thick by 3/4-inch round or 3/4-inch by 1-inch rectangle minimum.
6. Letter height shall be 1/4-inch minimum. Engrave the tags with the conduit number or acronym. Labeling shall be neatly installed for visibility and shall be clearly legible. Securely fasten tags in place using 20 ga stainless steel tie wire through a pilot hole on the tag.
7. Conduit tags shall be custom manufactured per specification.

J. Support and Framing Channel:

1. Cross section of a single channel shall be 1-5/8 inches by 1-5/8 inches and cross-section of a double channel shall be 1-5/8 inches by 3-1/4 inches. The channel wall thickness shall be 12-gauge as applicable.
2. One-hole clamps shall be intended for pipe mounting on support channels and equipped with clamp-backs. The clamps shall be Efcor, Thomas and Betts, Appleton, or equal.
3. Spacers, provided to support underground conduits in concrete encasements, shall be plastic. The spacers shall be Carlon, Johns-Manville, Underground Products, or equal.
4. Anchors shall be expansion type for securing equipment to concrete foundations, floors, and walls. Anchors shall have length identification mark on the exposed end of the bolt. Provide Hilti Kwik Bolt 3, or equal.
5. Stanchions shall be as shown on Drawings. If a detail is not provided, then the stanchions shall be shop fabricated and welded 4-inch c-channel, 12-inch by 12-inch by 1/4-inch steel base plate, coated with a rust inhibiting primer and top coat of gray polyurethane gloss paint. Attach equipment to the stanchion direct or on a 1/4-inch aluminum sheet sized for the equipment supported.
6. Conduit hangers shall be trapeze construction, with double channel, 3/8-inch rods and nuts. Suspend from suitable structural support.
7. Support material and finish shall be per the following table unless otherwise noted on Drawings. Brackets, fittings, and hardware shall be of the same material and finish.

Location	Material
NEMA 1 or 12	Galvanized steel
NEMA 3R	Galvanized steel
NEMA 4	Stainless Steel Type 316
NEMA4X	PVC bonded, 40 mil, factory applied
Hazardous	Stainless Steel Type 316

8. Channels shall be used for mounting equipment to walls and for supporting conduit runs. Double channel type shall be used for fabricating equipment mounting racks as required and as detailed on Drawings. All field cut surfaces of the channels shall be covered with matching zinc paint or PVC to match adjacent surface.

2.02 METAL CONDUIT (GRS)

A. Manufacturers:

1. Carlon Electrical Products.
2. Allied Tube & Conduit.
3. Wheatland Tube Co.
4. Western Tube & Conduit Corp.
5. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Galvanized Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.03 PVC COATED METAL CONDUIT (GRS-PVC)

A. Manufacturers:

1. Thomas & Betts Ocal, Inc.
2. Robroy Industries.
3. Perma-cote Industries.
4. KorKap.
5. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Product Description: NEMA RN 1; rigid steel conduit with external PVC coating, 40-mil thick.

C. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.04 FLEXIBLE METAL CONDUIT

A. Manufacturers:

1. Carlon Electrical Products.
2. American Brass Company.
3. Electri-Flex Company.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Product Description: Interlocked steel construction.

C. Fittings: NEMA FB 1.

2.05 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (FLEX)

A. Manufacturers:

1. Anamet Electrical.
2. American Brass Company.
3. Electri-Flex Company.
4. American Flexible Conduit Company.
5. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Product Description: Interlocked steel construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.06 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Carlon Electrical Products.
2. Allied Tube & Conduit.
3. Wheatland Tube Co.
4. Western Tube & Conduit Corp.
5. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel or malleable iron set screw type.

2.07 NONMETALLIC CONDUIT (PVC-40, PVC-80)

A. Manufacturers:

1. Carlon Electrical Products.
2. Cantex.
3. Robroy Industries.
4. Scepter.
5. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Product Description: NEMA TC 2; Schedule 40 or 80 PVC.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.08 HIGH DENSITY POLYETHYLENE CONDUIT (HDPE)

A. Manufacturers:

1. Carlon Electrical Products.
2. Dura-line.
3. Blue Diamond.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Product Description: Smooth interior and exterior wall; extrude coilable tubing for use as a single or multiple raceway. UL listed for use as underground electrical raceway.

C. Manufactured in accordance with ASTM D3035, NEMA TC-7, UL 651B, from a suitable thermoplastic polymer conforming to the minimum standard of PE334470E/C as defined in ASTM D3350.

D. Fittings and Conduit Bodies: Designed for use with smoothwall (ASTM 3035), pressure tight to internal pressures above 200 psi when restrained or buried.

E. Install and complete joining of HDPE in accordance with manufacturer's guidelines.

2.09 FLEXIBLE METAL CLAD CONDUIT (MC)

A. Flexible metal conduit (Type MC) shall include stranded or solid copper THHN/THWN conductors with aluminum interlocking steel strip armor cover.

B. UL 1, UL 1479, File Reference E11831, CSA File Number 15035, CSA C22.2 No. 56 (trade size 3/8 only).

C. NEC 250.118(5), 300.22(C), 348, 430.223, 501.10(B)(2), 645.5.

D. Cable tray installations per NEC.

E. UL Classified 1, 2 and 3-hour Through-Penetration Fire Systems UL File R14141.

F. Fittings shall be listed for the use with flexible metallic conduit and conform to UL514B.

1. Steel box connectors are design coordinated with type MC cable.

2. No locknut required.
3. Positive grip clamp assures grounding continuity and holding power.
4. Tilt-in and tighten installation technique.
5. Wire protection provided by built-in insulated throat bushing.
6. UL Standard 514B, UL Listed File No. E–164166.
7. CSA Certified File No. LR–84516 for AFC–50, 75, and 5075 only.

2.10 WIREWAY

A. Manufacturers:

1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Walker Systems Inc.
5. The Wiremold Co.
6. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Product Description: General purpose type wireway.

C. Knockouts: None.

D. Size: length as indicated on Drawings.

E. Cover: Hinged cover with full gaskets.

F. Connector: Slip-in or Flanged.

G. Fittings: Lay-in type with removable side.

H. Finish: Rust inhibiting primer coating with gray enamel finish.

2.11 OUTLET BOXES

A. Manufacturers:

1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Appleton Electric Company.
5. Crouse-Hinds Company.
6. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic Outlet Boxes: NEMA OS 2.

D. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Furnish gasketed cover by box manufacturer.

E. Wall Plates for Finished Areas: As specified in Section 26 27 26, Wiring Devices.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.12 PULL AND JUNCTION BOXES

A. Manufacturers:

1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Appleton Electric Company.
4. Hoffman Engineering Company.
5. Crouse-Hinds Company.
6. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Surface Mounted Cast Metal Box: NEMA 250, Type 4X; flat-flanged, surface mounted junction box:

1. Material: Stainless steel.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

2.13 UNDERGROUND BOXES

A. Underground pull boxes shall be prefabricated concrete with “Christy Box” size and type or equivalent or dimensioned on Drawings. Provide larger boxes as determined in field to allow for adequate pull area at Contractor discretion. Extension sections shall be provided as necessary to reach the depth of

underground conduits with maximum depth of 48 inches. All boxes shall have galvanized steel holddown bolts and hardware. Boxes located in paved areas or other areas, which vehicles may travel shall be H/20 loading rated and have traffic covers. Steel covers or lids shall be galvanized and grounded with bonding jumper to the local grounding circuit per NEC. Pull box covers shall be labeled electrical, signal, utility, and telephone, whichever applies. Pull boxes shall be Christy Concrete Products, Brooks, or equal.

2.14 UNDERGROUND VAULTS

A. Box: Underground vaults shall be prefabricated reinforced concrete (4,000 PSI), H/20 load rating, with the size (minimum) as shown on Drawings.

1. Provide larger pull boxes when necessary to allow for adequate pull area or to accommodate the number of conduits entering box.
2. Extension sections shall be provided as necessary to reach the depth of underground conduits.
3. Provide sloped bottom with 4-inch drain hole in bottom center of vault.

B. Lid: Provide hinged, torsion spring assist, traffic rated H/20, lid cover assemblies. Provide single leaf for 2 by 3 feet pull boxes. Provide double leaf for vaults with openings larger than 2 by 3 feet.

C. Ground Bus: Provide a 1/4-inch by 12-inch copper ground bus in each vault. Provide eight 3/8-inch diameter holes for multiple No. 4/0 terminal compression or crimp connectors. Connect ground conductors from duct banks to the ground bus. Connect ground terminals to ground bus using bronze or stainless steel hardware.

D. Sectionalizing Equipment: Provide sectionalizing equipment including rack, buss, hardware, etc. for installation into ground vaults as shown on Drawings.

E. Cable Supports: Provide heavy-duty, nonmetallic cable racks for support of wire and cable in vaults. Racks shall be UL listed glass-reinforced nylon consisting of slotted wall brackets supporting cable support arms. Arms shall be designed to support a 400-pound load, minimum. Arms shall be adjustable by moving up and down the bracket. Each support bracket shall extend all the way from the bottom of the handhole to the top of the handhole. Provide 1/2-inch stainless steel bolts, washers, and anchors to secure racks to handhole wall. Cable racks shall be Underground Devices Incorporated Type RA arms with CR36 support brackets; Uni-strut Power-Rack F20N-STA33 Stanchions with F20N-ARM14 Arms; or equal. Provide racks to support conductors on 18-inch centers.

F. Underground vaults shall be Christy Concrete Products T series, Brooks, or equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Section 01 30 00, Administrative Requirements (to be completed): Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.02 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems.

B. Fasten raceway and box supports to structure and finishes with stainless steel hardware.

C. Identify raceway and boxes in accordance with this section.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

E. Route all above grade conduits parallel or perpendicular to structure lines and/or piping. Conduits installed above grade shall be braced in place with stanchions. Expansion joints shall be installed every 100 feet. Bends shall be concentric.

F. All interduct segments shall be “proofed” by passing a rigid mandrel through the interduct or conduit. The Contractor shall record the distance of any obstructions prior to wire or fiber optic installation. These records shall be submitted prior to cable installation. No compensation for cable damage will be considered or approved unless the segment was proofed prior to installation. If an obstruction is detected and unable to be cleared, the Contractor shall perform a subsequent retest under observation of the Engineer. The Contractor shall allow up to three of these observed retests under this Contract. During the mandrel operations, a table of distances from pull box to pull box shall be noted to allow for cable installation planning.

G. Mandrels: The following section includes both an overview of, and a procedure for using, PG&E-approved, flexible-steel mandrels to prove conduit systems.

1. Using Mandrels to Prove Conduit Systems:
   a. Applicants must ensure that the conduit systems required for PG&E cables and/or conductors are installed in a trench that meets all of PG&E's requirements and specifications for the particular job or project. The conduit systems must meet PG&E's requirements for each specific installation as well.
   b. Note: The term "conduit system" includes conduits, conduit bends, conduit fittings, and all related components (e.g., bell ends and cable protectors) that are needed to install PG&E cables and conductors.
   c. Applicants must ensure that conduit systems are not covered or hidden from view before the facilities are inspected visually by a PG&E field inspector. The inspector must determine if the conduit system and its installation comply with all of PG&E's specifications (e.g., type, size, schedule, radius of bends) and installation requirements before the customer backfills the trench.
   d. After the conduit system passes PG&E's visual inspection, including visual verification of the conduit system's materials and the radius of the bends, the applicant must backfill the trench and compact the soil. Then, the applicant must provide PG&E with proof that the conduit system is in compliance by successfully inserting and pulling an approved, flexible-steel mandrel through the entire conduit system.
   e. The PG&E inspector will remain onsite to ensure that the appropriately sized and approved, flexible-steel mandrel is inserted and pulled through the length of the conduit system without encountering blockages or obstructions.
   f. The applicant must provide the mandrel and appropriate pulling tape, as well as follow the procedures in Subsection B, below, for using the mandrel.
2. Procedure for Using Mandrels: Applicants must follow the procedural steps below when using a mandrel to prove a conduit system.
   a. Step 1:
      1) Select the mandrel that is sized properly for the type of conduit that will be proven see Table 4.1, "Mandrel Dimensions, Part Numbers, and Order Codes," for mandrel specifications.

2) Note: For high-density polyethylene (HDPE) continuous conduit only (i.e., 3-inch, 4-inch, 5-inch, and 6-inch sizes), use the next smaller-size mandrel shown in Table 4.1.

b. Step 2: To pull the mandrel through the conduit, securely tie one end of the 2,500-pound pulling tape to the pulling eye of the mandrel. (The pulling tape was installed in the conduit previously.)

c. Step 3:
   1) Securely tie a second section of 2,500-pound pulling tape to the pulling eye located on the other end of the mandrel. This section of tape must be long enough to replace the pre-installed pulling tape completely.
   2) Step 3. ensures that a run of pulling tape remains in the conduit after the mandrelling process is completed. Also, if the mandrel becomes blocked or stuck in the conduit, the second run of pulling tape allows the mandrel to be pulled back out of conduit and provides a means of measuring the distance to the point of blockage.

d. Step 4: After both pulling tapes are attached securely to the mandrel, insert the mandrel into one end of the conduit. Slowly start to pull the pulling tape at the opposite end of the conduit. This removes any slack in the pulling tape.

e. Step 5:
   1) Slowly pull the mandrel through the conduit. The rate of the pull should not exceed 100 feet per minute. Both the person pulling the tape and the PG&E inspector must check the pulling tape for signs of stress (i.e., molten plastic) as the tape comes out of the conduit.
   2) Note: The PG&E inspector may not approve a section of the conduit if any portion of the pulling tape shows damage in the form of molten plastic. If the inspector decides to reject the conduit section, he or she will secure the melted section of pulling tape as evidence.
   3) If the mandrel passes through the conduit without encountering any blockage or obstructions, the PG&E inspector will approve the conduit section for use.

3. Mandrel Design:
   a. The length must be adequate for the mandrel to pass through a 24-inch radius bend (all sizes).
   b. The disks must be fabricated from 1/2-inch, flat, steel plate (average weight: 490 pounds per cubic foot) with a 7/16-inch hole for the 3/8-inch cable.

c. The spacers must be fabricated from 1/2-inch iron pipe size (IPS) pipe with a minimum inside diameter of 0.6 inch.
d. Cable Size: 3/8 inch, 6 by 19 mild, plow-steel hoisting rope.
e. The outside diameter of the eye must not exceed Dimension A.
f. The size must be stamped permanently into one end of the plates.

Table 4.1
Mandrel Dimensions, Part Numbers, and Order Codes[1]

Size	PG&E	Manufacturer	Dimensions in Inches				Spacer
(In Inches)	Code	Part Numbers[3]	Max. Disk Diameter	Min. Disk Diameter	Mandrel Length	Total Length[2]	Length
2	202567	08400-200	1.69	1.69	6.5	15	0.25
3	202570	08400-300	2.65	1.65	10.5	23	0.75
4	202571	08400-400	3.57	2.57	10.5	23	0.75
5	200911	08400-500	4.56	3.56	10.5	23	0.75
6	202572	08400-600	5.51	4.51	10.5	23	0.75

[1] For HDPE continuous conduit only (sizes 3", 4", 5" and 6"), use the next smaller size mandrel.

[2] Dimensions are approximate.

[3] PG&E's approved mandrel manufacturers, DCD Design and Manufacturing.

3.03 INSTALLATION, RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in this section; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in this section.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit in and under slab from point-to-point.

K. Maximum Size Conduit in Slab Above Grade: 3/4 inch. Do not cross conduits in slab.

L. Maintain clearance between raceway and piping for maintenance purposes.

M. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

N. Cut conduit square using saw or pipe cutter; de-burr cut ends.

O. Bring conduit to shoulder of fittings; fasten securely.

P. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

Q. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

R. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricator installed factory elbows for bends in metal conduit larger than 2 inch size.

S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

X. Close ends and unused openings in wireway.

3.04 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting specified in section for outlet device.

B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26, Wiring Devices.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

I. Install stamped steel bridges to fasten flush mounting outlet box between studs.

J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

K. Install adjustable steel channel fasteners for hung ceiling outlet box.

L. Do not fasten boxes to ceiling support wires or other piping systems.

M. Support boxes independently of conduit.

N. Install gang box where more than one device is mounted together. Do not use sectional box.

O. Install gang box with plaster ring for single device outlets.

3.05 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.

C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.06 ADJUSTING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.07 CLEANING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 08 00
COMMISSIONING OF ELECTRICALSYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   b. D923, Standard Practice for Sampling Electrical Insulating Liquids.
   c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   f. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
   j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
   b. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5kV through 500kV.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.
e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.
g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
h. C2, National Electrical Safety Code.
i. C37.20.1, Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
j. C37.20.2, Standard for Metal-Clad Switchgear.
k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
l. C37.23, Standard for Metal-Enclosed Bus.
m. C62.33, Standard Test Specifications for Varistor Surge-Protective Devices.

3. Insulated Cable Engineers Association (ICEA):
   a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
   b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
   c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
4. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
5. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70B, Recommended Practice for Electrical Equipment Maintenance.
   c. 70E, Standard for Electrical Safety in the Workplace.
   d. 101, Life Safety Code.
7. National Institute for Certification in Engineering Technologies (NICET).
8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
   a. Schedule for performing inspection and tests.
   b. List of references to be used for each test.
   c. Sample copy of equipment and materials inspection form(s).
   d. Sample copy of individual device test form.
   e. Sample copy of individual system test form.
2. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:
   a. Staged sequence of initial energization of electrical equipment.
   b. Lock-Out-Tag-Out plan for each stage of the progressive energization.
   c. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
4. Operation and Maintenance Data:
   a. In accordance with Section 01 78 23, Operation and Maintenance Data (to be completed).
   b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.
5. Programmable Settings: At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on compact disc of as-left setpoints, programs, and device configuration files for:
   a. Protective relays.
   b. Intelligent overload relays.
   c. Variable frequency drives.
   d. Power metering devices.
   e. Uninterruptible power supplies.
   f. Electrical communications modules.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.

3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment listed herein has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment shall be:

1. Scheduled with Engineer and Owner prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify Owner at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Perform tests in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup (to be completed).

B. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Set, test, and calibrate protective relays, circuit breakers, fuses, power monitoring meters, and other applicable devices in accordance with values established by short circuit, coordination, and studies as provided by Engineer during construction.

E. Adjust mechanisms and moving parts of equipment for free mechanical movement.

F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents and approved Submittals.

H. Realign equipment not properly aligned and correct unlevelness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform Engineer of working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:

1. Electrical items that fail tests.

2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

O. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer door and panel sections having dented surfaces.
5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch up scratches and mars.
   b. If required because of extensive damage, as determined by Engineer refinish entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

3.02 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to Project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.
   a. Submit Voltage Field Test Report within 5 days of test.
4. Unbalance Corrections:
   a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
   b. Obtain written certification from responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.03 SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

A. Visual and Mechanical Inspection:

1. Insulator damage and contaminated surfaces.
2. Proper barrier and shutter installation and operation.
3. Proper operation of indicating devices.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system by:
   a. Closure attempt of device when door is in OPEN position.
   b. Opening attempt of door when device is in CLOSED position.
8. Check key interlocking systems for:
   a. Key captivity when device is in ON or CLOSED position.
   b. Key removal when device is in ON or CLOSED position.
   c. Closure attempt of device when key has been removed.
   d. Correct number of keys in relationship to number of lock cylinders.
   e. Existence of Other Keys Capable of Operating Lock Cylinders: Destroy duplicate sets of keys.
9. Check nameplates for proper identification of equipment per Drawings.
10. Verify fuse and circuit breaker ratings, sizes, and types conform to those specified.
11. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.
    a. Ohmic value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
12. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.

13. Verify performance of each control device and feature.
14. Control Wiring:
    a. Compare wiring to local and remote control and protective devices with elementary diagrams.
    b. Proper conductor lacing and bundling.
    c. Proper conductor identification.
    d. Proper conductor lugs and connections.
15. Exercise active components.
16. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    b. Each phase of each bus section.
    c. Phase-to-phase and phase-to-ground for 1 minute.
    d. With switches and breakers open.
    e. Control wiring except that connected to solid state components.
    f. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Overpotential Tests:
    a. Applied ac voltage and test procedure in accordance with IEEE and NETA ATS, Table 100.2.
    b. Each phase of each bus section.
    c. Phase-to-phase and phase-to-ground for 1 minute.
    d. Test results evaluated on a pass/fail basis.
3. Current Injection Tests:
    a. For entire current circuit in each section.
    b. Secondary injection for current flow of 1 ampere.
    c. Test current at each device.
4. Control Wiring:
    a. Apply secondary voltage to control power and potential circuits.
    b. Check voltage levels at each point on terminal boards and each device terminal.
5. Operational Test:
    a. Initiate control devices.
    b. Check proper operation of control system in each section.

3.04 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Each phase of each bus section.
   c. Phase-to-phase and phase-to-ground for 1 minute.
   d. With switches and breakers open.
   e. Control wiring except that connected to solid state components.
   f. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Ground continuity test ground bus to system ground.

3.05 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.

8. Cleanliness and improper blockage of ventilation passages.
9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.06 LIQUID FILLED TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Effective core and equipment grounding.
7. Removal of shipping brackets, fixtures, or bracing.
8. Tank leaks and proper liquid level.
9. Integrity and contamination of bus insulation system.
10. Verify tap-changer is set at correct ratio for rated voltage under normal operating conditions.
11. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.
3. Sample insulating oil in accordance with ASTM D923 and have laboratory test for:
   a. Dielectric breakdown voltage in accordance with ASTM D877 or ASTM D1816.
   b. Acid neutralization number in accordance with ASTM D974.
   c. Interfacial tension in accordance with ASTM D971.
   d. Color in accordance with ASTM D1500.
   e. Visual condition in accordance with ASTM D1524.
   f. Specific gravity in accordance with ASTM D1298.
   g. Water content, in parts per million, in accordance with ASTM D1533.
   h. Dielectric fluid test results in accordance with NETA ATS, Table 100.4.
   i. Power factor at 25 degrees C and at 100 degrees, in accordance with ASTM D924.
   j. Maximum power factor, corrected to 20 degrees C, in accordance with manufacturer’s specifications.

3.07 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable for:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.

c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
d. Color coding conformance with specification.
e. Proper circuit identification.

2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors:

1. Insulation Resistance Tests:
   a. Utilize 1,000V dc megohmmeter for 600-volt insulated conductors and 500V dc megohmmeter for 300-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

C. Low-voltage cable tests may be performed by installer in lieu of independent testing firm.

3.08 MEDIUM-VOLTAGE CABLES, 15 KV MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed cable for:
   a. Physical damage plus jacket and insulation condition.

b. Proper connections in accordance with single-line diagram or approved Submittals.
c. Proper shield grounding.
d. Proper cable support.
e. Proper cable termination.
f. Cable bends not in conformance with manufacturer's minimum allowable bending radius.
g. Proper arc and fireproofing in common cable areas.
h. Proper circuit and phase identification.

2. Mechanical Connections:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturers.
3. Conductors Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 5,000-volt megohmmeter for 15 kV conductors.
   b. Test each cable individually with remaining cables and shields grounded.
   c. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   d. Evaluate ohmic values by comparison with conductors of same length and type.
   e. Investigate values less than 50 megohms.
2. Shield Continuity Tests:
   a. By ohmmeter method on each section of conductor.
   b. Investigate values in excess of 10 ohms per 1,000 feet of conductors.
3. Acceptance Tests:
   a. In accordance with IEEE 400, ICEA S-93-639, NEMA WC 74, ICEA S-94-649, and ICEA S-97-682 for insulated conductors.
   b. Each conductor section tested with:
      1) Splices and terminations inplace but disconnected from equipment.
      2) Remaining conductors and shields grounded in accordance with IEEE 400.
   c. Apply maximum test voltage per NETA ATS, Table 100.6, based on method (DC, AC, PD or VLF) used.
   d. Measure only leakage current associated with conductor.

e. Utilize guard ring or field reduction sphere to suppress corona at disconnected terminations.
f. Maximum test voltage shall not exceed limits for terminators specified in IEEE 48, IEEE 386, or manufacturer's specifications.
g. Apply test voltage in a minimum of five equal increments until maximum acceptable test voltage is reached.
   1) Increments not to exceed ac voltage rating of conductor.
   2) Record dc leakage current at each step after a constant stabilization time consistent with system charging current.
h. Raise conductor to specified maximum test voltage and hold for 15 minutes or as specified by conductor manufacturer. Record leakage current at 30 seconds and 1 minute, and at 1-minute intervals, thereafter.
i. Immediately following test, ground conductor for adequate time period to drain insulation stored charge.
j. Test results evaluated on a pass/fail basis.

4. New Conductors Spliced to Existing Conductors:
   a. Prior to performing splices, high potential dc test new conductor sections.
   b. After splicing new conductors to existing conductors, disconnect existing conductors and perform the following tests:
      1) Shield continuity test.
      2) Insulation resistance test.
      3) High potential test with test voltage not to exceed 60 percent of applied acceptance dc test voltage.

3.09 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify door interlocking system operation.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.10 MEDIUM-VOLTAGE PAD MOUNT OR TRANSFORMER MOUNT VFI SWITCHES

A. Visual and Mechanical Inspection:

1. Proper operation of operating mechanism.
2. Bus and cable connection tightness.
3. Proper phase barrier material and installation.
4. Proper operation of indicating devices.
5. Perform mechanical operational test to verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate values exceeding 500 microhms or deviation of 50 percent or more from adjacent poles or similar switches.
3. Overpotential Tests:
   a. Applied ac voltage in accordance with NETA ATS, Table 100.19.
   b. Phase-to-phase and phase-to-ground for 1 minute.
   c. Test results evaluated on pass/fail basis.

3.11 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000V dc megohmmeter for 480-volt and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer’s published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.

g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.12 MEDIUM-VOLTAGE PAD MOUNT OR TRANSFORMER MOUNT VFI CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:

1. Check for proper element alignment.
2. Bolt torque level in accordance with NETA ATS, Table 100.12.
3. Perform mechanical operational tests on breaker and its operating mechanism in accordance with manufacturer's instructions, plus check:
   a. Pull rod adjustment.
   b. Trip latch clearance.
   c. Overtravel stops.
   d. Wipe and gap setting.
4. Perform breaker travel and velocity analysis in accordance with manufacturer's instructions; values shall be in accordance with manufacturer's acceptable limits.
5. Check contact erosion indicators in accordance with manufacturer's instructions.
6. With breaker in TEST position:
   a. Trip and close breaker with control switch.
   b. Trip breaker by manually operating each protective relay.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 2,500V dc megohmmeter for 15-kV circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Between the line and load stab of closed contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Overpotential Tests:
   a. Maximum applied ac voltage in accordance with NETA ATS, Table 100.19.

b. Each pole-to-ground with other poles grounded and contacts closed for 1 minute.
c. Test results evaluated on pass/fail basis.

4. Minimum pickup voltage tests on trip and close coils.
5. Control Wiring Tests:
   a. Insulation resistance test at 1,000V dc on control wiring, except that connected to solid state components.
   b. Insulation resistance to be 1 megohm minimum.
6. Vacuum bottle overpotential integrity test across each vacuum bottle with breaker in OPEN position, in accordance with manufacturer's instructions.
7. Power Factor Test (Each Phase):
   a. With breaker in both OPEN and CLOSED position.
   b. Compare power factor and arc chute watt loss with adjacent poles or manufacturer's published data.
8. Power Factor Test (Each Bushing):
   a. Utilize conductive straps and hot collar procedures if bushings are not equipped with power factor tap.
   b. Power factor and capacitance test results within nameplate rating of bushings.

3.13 PROTECTIVE RELAYS

A. Visual and Mechanical Inspection:

1. Visually check each relay for:
   a. Tight cover gasket and proper seal.
   b. Unbroken cover glass.
   c. Condition of spiral spring and contacts.
   d. Disc clearance.
   e. Condition of case shorting contacts if present.
2. Mechanically check each relay for:
   a. Freedom of movement.
   b. Proper travel and alignment.
3. Verify each relay:
   a. Complies with Contract Documents, approved Submittal, and application.
   b. Is set in accordance with recommended settings from Engineer.

B. Electrical Tests:

1. Insulation resistance test on each circuit to frame, except for solid state devices.

2. Test on nominal recommended setting for:
   a. Pickup parameters on each operating element.
   b. Timing at three points on time-current curve.
   c. Pickup target and seal-in units.
   d. Special tests as required to check operation of restraint, directional, and other elements in accordance with manufacturer's instruction manual.
3. Phase angle and magnitude contribution tests on differential and directional relays after energization to vectorially verify proper polarity and connections.
4. Current Injection Tests:
   a. For entire current circuit in each section.
   b. Secondary injection for current flow of 1 ampere.
   c. Test current at each device.

3.14 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually check current, potential, and control transformers for:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections.
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:
   a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
   b. Polarity test.
2. Potential Transformer Tests:
   a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 100.9, for 1 minute on:
      1) Winding-to-winding.
      2) Winding-to-ground.

b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.

3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

3.15 METERING AND INSTRUMENTATION

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.16 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control center, panelboard, and switchboard assemblies for proper connection and tightness.
2. Ground bus connections in electrical equipment and assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system’s resistance.
   b. Main ground electrode system resistance to ground to be no greater than 5 ohms.
2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3. Neutral Bus Isolation:
   a. Test each neutral bus individually with neutral bonding jumper removed at service entrance or separately derived system.
   b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
   c. Investigate values less than 50 megohms.

3.17 GROUND FAULT SYSTEMS

A. Inspection and testing limited to:

1. Zero sequence grounding systems.
2. Residual ground fault systems.

B. Visual and Manual Inspection:

1. Neutral main bonding connection to ensure:
   a. Zero sequence sensing system is grounded ahead of neutral disconnect link.
   b. Ground strap sensing system is grounded through sensing device.
   c. Neutral ground conductor is solidly grounded.
2. Verify control power has adequate capacity for system.
3. Manually operate monitor panels for:
   a. Trip test.
   b. No trip test.
   c. Nonautomatic rest.
4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
5. Relay check for pickup and time under simulated ground fault conditions.
6. Verify nameplate identification by device operation.

C. Electrical Tests:

1. Test system neutral insulation resistance with neutral ground link removed; minimum 1 megohm.
2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.
3. Test relay timing by injecting 300 percent of pick-up current or as specified by manufacturer. Relay operating time in accordance with manufacturer’s time-current characteristic curves.
4. Test system operation at 55 percent rated control voltage, if applicable.

5. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.18 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 1 hp and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate motor and check for:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.
   d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
   e. Excessive vibration, in excess of values in NETA ATS, Table 100.10.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.1 for:
      1) Motors above 200 horsepower for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
      2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 seconds and 60 seconds.
   b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer’s instructions.
4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

3.19 LOW-VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system.
8. Check nameplates for proper identification of:
    a. Equipment title and tag number with latest one-line diagram.
    b. Pushbuttons.
    c. Control switches.
    d. Pilot lights.
    e. Control relays.
    f. Circuit breakers.
    g. Indicating meters.
9. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify current and potential transformer ratios conform to Contract Documents.
11. Check bus connections for high resistance by low-resistance ohmmeter and calibrated torque wrench applied to bolted joints.
12. Ohmic value to be zero.
    a. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
13. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.
14. Verify performance of each control device and feature furnished as part of motor control center.
15. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
16. Exercise active components.

17. Inspect contactors for:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of connections.
18. Compare overload heater rating with full-load current for proper size.
19. Compare fuse, motor protector, and circuit breakers with motor characteristics for proper size.
20. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
    c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
    d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
    e. Test values to comply with NETA ATS, Table 100.1.
2. Current Injection through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
    a. Trip time in accordance with manufacturer's published data.
    b. Investigate values in excess of 120 seconds.
3. Control Wiring Tests:
    a. Apply secondary voltage to control power and potential circuits.
    b. Check voltage levels at each point on terminal board and each device terminal.
    c. Insulation resistance test at 1,000 volts dc on control wiring, except that connected to solid state components;1 megohm minimum insulation resistance.
4. Operational test by initiating control devices to affect proper operation.

3.20 MEDIUM-VOLTAGE SURGE ARRESTORS AND SURGE CAPACITORS

A. Visual Inspection:

1. Ground connections to ground electrode.
2. Shortest practical jumper connections to line.

B. Electrical Tests:

1. Grounding electrode resistance test in accordance with IEEE 81, Section 8.2.1.5 using three-point fall-of-potential method.
2. Insulation power factor.
3. Insulation resistance.
4. RF noise test using Stoddartnoise test set with applied voltage of 1.18 times maximum continuous operating voltage.
5. Insulation power factor leakage current, watts loss, and insulation resistance test in accordance with manufacturer's test values. RIV value not to exceed 10 microvolts above background noise.
6. Leakage current and watts loss tests.

END OF SECTION

SECTION 26 09 13
POWER MEASUREMENT AND CONTROL

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. Institute for Electrical and Electronics Engineers, Inc. (IEEE):
   a. C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
   b. C37.90.1, Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
   c. C57.13, Standard Requirements for Instrument Transformers.
3. International Electrotechnical Commission (IEC):
   a. 60255-5, Electrical Relays—Part 5: Insulation Coordination for Measuring Relays and Protection Equipment—Requirements and Tests.
   b. 60255-22-4, Measuring Relays and Protection Equipment—Part 22-4: Electrical Disturbance Tests—Electrical Fast Transient/Burst Immunity Tests.
   c. 60688, Electrical Measuring Transducers for Converting a.c. Electrical Quantities to Analogue or Digital Signals.
   d. 60870-5-104, Telecontrol Equipment and Systems—Part 5-104: Transmission Protocols—Network Access for IEC 60870-5-101 Using Standard Transport Profiles.
   e. 61850, Communication Network and Systems in Substations.
4. Telecommunications Industry Association (TIA):
   a. 232-F, Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
   b. 485-A, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.
5. National Electrical Manufacturers Association (NEMA):
   a. C12.1, Electric Meters Code for Electricity Metering.
   b. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.02 DEFINITIONS

A. AFD: Adjustable Frequency Drive.

B. CT: Current Transformer.

C. DNP: Distributed Network Protocol.

D. LCD: Liquid Crystal Display.

E. LED: Light Emitting Diode.

F. MFR. Multi-Function Relay.

G. MPR: Motor Protection Relay.

H. PLC: Programmable Logic Controller.

I. RTD: Resistance Temperature Detectors.

J. UCA: Utility Communications Architecture.

K. VT: Voltage Transformer.

1.03 SUBMITTALS

A. Action Submittals:

1. Instruction manuals for each type of device.
2. Special features, licensed programming software.
3. Potential and current schematic diagrams.
4. Control and metering schematic diagrams.
5. Interconnection wiring diagrams.
6. Installation and mounting requirements.
7. Complete descriptive literature and renewal parts data.

B. Informational Submittals:

1. Programming software used to configure devices, along with settings files necessary to reload or revise settings as left by Contractor.
2. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data (to be completed).

PART 2 PRODUCTS

2.01 MULTI-FUNCTION RELAY (MFR)

A. MfR shall provide primary protection and management of distribution feeders. Protection shall include:

1. Complete time overcurrent (51P, 51N, 51G), including sensitive ground.
2. Complete instantaneous overcurrent (50P, 50N, 50G), including sensitive ground.
3. Directional overcurrent (67P, 67N, 67G, 67_2).
4. Bus and Line undervoltage and overvoltage (27/59).
5. Negative sequence voltage (47).
6. Undervoltage automatic restoration (27/79).
7. Bus under-frequency (81U) with voltage and current level monitoring.
8. Bus over-frequency (81O) with voltage and current level monitoring.
9. Under-frequency automatic restoration (81/79).
10. Neutral displacement overvoltage (59N) used to give line to ground fault coverage on high impedance grounded or ungrounded systems, which are isolated.

B. Provide drawout construction to facilitate testing, maintenance, and interchange flexibility.

C. Operate with either wye-connected (four-wire) or open-delta-connected (three-wire) potential transformers, and three-phase, four-wire connected current transformers.

D. Control shall include manual close control, cold load pickup control, programmable logic inputs, two breaker control relay outputs, internal failure relay output, programmable relay outputs, solid state trip output, analog transducer input, and analog transducer outputs.

E. Monitoring and metering functions shall include:

1. Current: Phase A RMS current, Phase B RMS current, Phase C RMS current.
2. Voltage: Phase A-N (A-B) voltage, Phase B-N (B-C) voltage, Phase C-N (C-A) voltage.
3. Frequency.
4. Symmetrical components.
5. Three-phase power factor.
6. Three-phase real power.
7. Three-phase reactive power.

8. Three-phase apparent power.
9. Watt-hours.
10. VAR-hours.
11. Demand Measurement: Rolling demand, time interval, programmed to5, 10, 15, 20, 30, or 60 minutes. A fault locator with a record of last 10 faults.
12. Event Recorder: Record last 512 events, time tagged.
13. Waveform Capture: Relay shall store up to 256 cycles of data, captured for analog current and voltage inputs as well as digital data for output relays and input contact states. Amount of data to capture and trigger point shall be user configurable.
14. Data logger.
15. Latest Trip Report: Containing date and time, cause, phase, ground, sensitive ground, and neutral currents, line-line and line-ground voltages, neutral voltage, frequency, and analog Input.
16. Operation counter and accumulated interrupted currents per phase.
17. Coil (trip/close) monitoring inputs for detection of failed circuit regardless of breaker state.

F. User interfaces shall include:

1. Large 40-character display, navigation keys, and keypad.
2. Indicator LEDs on front panel which provide a quick visual indication of status.
3. Front panel RS232 serial port that provides easy computer access.
4. Two rear RS485 ports, one of which can be configured as a RS422 port.
5. Relay programmed to communicate using DNP 3.0 Level 2 Protocol through one of its ports.
6. RJ45 Ethernet port to allow 10BaseT Ethernet connectivity to local or wide area networks.
7. Relay capable of being set by Windows-based, easy to use setup graphical terminal interface.

G. Manufacturers and Products:

1. General Electric; GE F60.
2. Schweitzer Engineering Laboratories; SEL-351.

2.02 POWER METER (PM)

A. General:

1. Solid state device with LED displays.
2. Direct voltage input up to 600V ac.

3. Current input via current transformer with 5-ampere secondary.
4. Programmable current and potential transformer ratios.
5. Programmable limits to activate up to four alarms.
6. Selectable Voltage Measurements: Line-to-line or line-to-neutral and wye or delta.
7. Ethernet capable.
8. Modbus TCP Protocol.

B. Simultaneous Display:

1. Volts, three-phase.
2. Amperes, three-phase.
3. Kilowatts.
4. Kilowatt hours.
5. Power factor.
6. Frequency.
7. kW Demand with programmable period intervals.
8. kVA.
9. kVAR.
10. kVARh.
11. Voltage Rating: 95V ac to 600V ac.
12. Manufacturer and Product: Electro Industries; Shark 200.

2.03 INSTRUMENT TRANSFORMERS

A. Current Transformer (CT), 600Volts and Below:

1. Type: Molded bar or donut.
2. Accuracy: 0.3 at burden imposed by meters and instruments.
3. Shorting type terminal boards for current transformer leads.

B. Potential Transformer (PT), 600Volts and Below:

1. Type: Molded.
2. Accuracy Classification: 0.3 at burden imposed by meters and instruments, including future.
3. Primary Fuses: Two, current-limiting.
4. Secondary Fuses: One, current-limiting.

C. Current Transformer (CT), Over 600 Volts:

1. Type:
   a. Insulated dry indoor.
   b. Window type for relaying and ground sensing.

c. Wound type for metering.
2. Transformer Accuracy: In accordance with IEEE C57.13.
3. Class C20 or greater for relaying.
4. Class 1.2 maximum for imposed burden for metering.
5. Rating: As indicated.
6. Mechanical Rating: Equal to interrupting rating of circuit breakers.
7. Thermal Rating: 100 times normal, 1 second.
8. Size to operate continuously at rated primary current without insulation damage.
9. Identify polarity with standard mark or symbol.
10. Secondary Wiring: Install in conduit, PVC tubing or wiring trough.
11. Isolate from adjacent components and circuits by removable insulating or metal barriers.
12. Window type CTs accessible for replacement without removing high voltage insulated connections.

D. Potential Transformer (PT), Over 600 Volts:

1. Type: Insulated dry, indoor.
2. Rating: Primary voltage to 120-volt, single-phase with 60 kV BIL rating.
3. Three transformers connected phase-to-ground.
4. Thermal Capacity: Minimum 55 degrees rise above 30 degrees C ambient.
5. Mechanical Rating: Equal to short-time current carrying capability of circuit breaker.
6. Accuracy classification in accordance with IEEE C57.13 for connected burden.
7. Primary Protection: Two, integral mounted current-limiting fuses.
8. Secondary Protection: Single, separately mounted current-limiting fuse.
9. Identify polarity with standard marking or symbols.
10. Mount on drawout carriage installed in metering module, complete with secondary wiring.
11. Primary and secondary terminals to be disconnected and primary fuses grounded when rollout carriage is in open position.

2.04 TEST SWITCH MODULE

A. Function: Multipole switch bank for instrument transformer testing.

1. Allows current injection for each phase.
2. CT inputs short when current switches are open.

3. Ability to visually isolate (open) trip relay output circuits.
4. Cover provided.

B. Manufacturers and Products:

1. ABB; Type FT-1 Flexitest.
2. GE; Multilin 515.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. As defined in Section 26 08 00, Commissioning of Electrical Systems.

3.02 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at distribution equipment factory, Site, and classroom designated by Owner, for the minimum person-days listed below, travel time excluded:

1. 2 person-days to enter, confirm, and assist in testing protective relay settings and communications configuration at the distribution equipment. Device settings to be based on values generated in the device coordination study.
2. 2 person-days for initial energization and start-up of distribution system equipment.
3. 2 person-days for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by the Engineer.

B. See Section 01 43 33, Manufacturers' Field Services (to be completed), and Section 01 91 14, Equipment Testing and Facility Startup (to be completed).

END OF SECTION

SECTION 26 12 02
OIL-FILLED PAD MOUNTED TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM): D3487, Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   b. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   c. C57.12.22, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2,500 kVA and Smaller.
   d. C57.12.26, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors.
   e. C57.12.28, Switchgear and Transformers—Pad-Mounted Equipment, Enclosure Integrity.
   f. C57.12.90, Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers.
   g. C57.106, Guide for Acceptance and Maintenance of Insulating Oil in Equipment.
   h. C62.11, Metal-Oxide Surge Arrestors for Alternating-Current Power Circuits (>1 kV).
3. National Electrical Manufacturers Association (NEMA):
   a. TR 1, Transformers, Regulators, Reactors.
   b. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Dimensional drawings.
3. Transformer nameplate data.
4. Schematic and connection diagrams.
5. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed later).

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed later).
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection [, Observation,] and Testing (to be completed later).
3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed later).
4. Factory test reports certified.

1.03 QUALITY ASSURANCE

A. Design, test, and assemble in accordance with applicable standards of NEMA TR 1, IEEE C57.12.00, IEEE C57.12.22, IEEE C57.12.26, and IEEE C57.12.90.

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage and deliver prior to 90 percent Project completion the following materials:

1. Quantity two spray cans of paint to match color and quality of equipment final shop finish.
2. Two pentahead sockets for 1/2-inch socket drive.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cooper Power Systems.

B. Square D Co.

C. General Electric.

D. Cutler Hammer.

2.02 GENERAL

A. Integral Unit: Compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartments, assembled on a common structural base.

B. Anchor Bolts: Type 316 stainless steel, sized by electrical contractor, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

C. Furnish step up and step down transformers as shown on Drawings.

2.03 TRANSFORMER

A. kVA ratings and quantities as shown on Drawings.

B. High Side (Primary) Voltage: 12.47 kV line-to-line, three-phase, as shown, three- and four-wire, 60-Hz.

C. Low Side (Secondary) Voltage: 480/277, and 480 volts, three-phase, as shown, three- and four-wire, 60 Hz.

D. BIL Rating:

1. 95 BIL for 15 kV insulation class transformers.
2. 30 BIL for secondary.

E. Temperature Rise: 55/65 degrees C above 30 degrees average ambient with maximum ambient not to exceed 50 degrees C.

F. Impedance:

1. 1.35 percent minimum for transformers rated 150 kVA and less.
2. 3.0 percent minimum for transformers rated 225, 300, and 500 kVA.
3. 5.75 percent for transformers rated 750 kVA and above.

G. Efficiency: Meet or exceed values in Table 4-1 of DOE-2010.

H. Dielectric Coolant: Fully biodegradable, nontoxic, and nonbio-accumulating fluid, qualifying as “less flammable” per NEC 450.23; Factory Mutual Approved or UL Classified, Envirotemp FR3 Fluid.

I. Primary Taps:

1. Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.
2. Deadfront mounted externally operated no-load tap changer.
3. Provisions for locking handle in any position.

J. Coil Conductors: Aluminum windings.

K. Sound Level: In accordance with manufacturer’s standards and NEMA.

2.04 ENCLOSURE

A. In accordance with IEEE C57.12.28 requirements.

B. Welded carbon steel transformer tank, with cooling panels when required, and lifting eyes. Nitrogen Blanket.

C. 12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners that are externally removable.

D. Color: Provide sand color finish as approved by Engineer.

2.05 TERMINAL COMPARTMENTS

A. General: IEEE C57.12.28, enclosed high and low voltage compartments side by side, separated by steel barrier, bolted to transformer tank.

1. Doors:
   a. Individual, full-height, air-filled.
   b. Low voltage door with three-point latching mechanism, vault type handle, and single padlocking provision.
   c. High voltage door fastenings inaccessible until low voltage door has been opened.
   d. Door Bolts: Pentahead type.
   e. Lift-off, stainless steel hinges and door stops.
   f. Removable front sill to facilitate rolling or skidding over conduit stubs.
   g. Recessed lock pocket, with steel door release bolt adjacent to secondary compartment door handle.

B. High Voltage Compartment:

1. Deadfront in accordance with IEEE C57.12.26 type construction.
2. VFI circuit breaker with motorized operator.
3. High voltage bushings.
4. Transformer grounding pad.
5. Surge arrestors with barriers.
6. Radial feed.

C. Low Voltage Compartment:

1. Livefront in accordance with IEEE C57.12.26 type construction.
2. Low voltage bushings.
3. Grounding pad.
4. Stainless steel equipment nameplate.
5. Liquid level gauge.
6. 1-inch upper filter press and filling plug.
7. Drain valve with sampling device.
8. Dial type thermometer.
9. Pressure relief valve.
10. Pressure-vacuum gauge.
11. Mounting provision for potential transformers.
12. Nameplate.

2.06 BUSHINGS

A. High Voltage:

1. Deadfront Termination:
   a. Universal bushing well rated at 15 kV in accordance with IEEE 386.
   b. Bushings externally clamped and front removable.
   c. Rated for 200 amperes continuous, 95 kV BIL.
   d. Standoff brackets located adjacent to bushings.

B. Low Voltage:

1. Molded epoxy bushing clamped to tank with multi-hole spade type terminals.
2. Rated 150 percent of continuous full-load current, 30 BIL, 600 volts.
3. Internally connected neutral extending to neutral bushing.

2.07 HIGH VOLTAGE PROTECTION

A. Vacuum Fault Interrupter with Automatic Motorized Switching:

1. The VFI unit is to be used for backup phase overcurrent protection and ground fault protection, transformer protection.
2. The vacuum fault interrupter shall act as a three-phase group operated circuit breaker. The trip mechanisms for each phase shall be mechanically linked and the electronic control shall be set so that an overcurrent condition on any one phase shall simultaneously trip all three phases. A single operating handle shall be provided for manual opening, reset, and closing. The operating handle(s) shall be mounted on the front plate of the tank in close relation to the VFI being controlled and shall have three distinct operating positions corresponding to the vacuum fault interrupter positions of closed, open, or tripped. A pointer attached to the handle shall be provided for ready identification of the handle's position. The handle shall be designed for operation with a lineman's hotstick and have a push to close/pull to open/pull to reset operation requiring no more than 75 pounds of force and 60 degrees of movement for complete operation. Except with the motor operator, when the vacuum fault interrupter is tripped by automatic action of the VFI control, the operating handle shall drop to an intermediate position between its closed and open positions, to provide indication that it is tripped. The operating handle assembly shall include provisions to padlock the handle in the open position.
3. The VFI shall be used to open the source to the transformer primary windings after a 0- to 10-second time delay if primary source voltage is lost.
4. The VFI shall be used to close the source to the primary windings after an adjustable time delay of 0 to 10 minutes after return of source voltage.

B. Electronic Trip Control:

1. Overcurrent sensing shall be accomplished with an electronic trip control that shall be Cooper Power Systems type Tri-Phase Control with Ground (TPG) control.
2. The control shall use internally mounted 1000:1 bushing current transformers (CTs) to sense line current and shall also provide the control operating power, eliminating the effects of system voltage conditions. The control shall be self-contained and includes the following:

a. Meet the specified time-current curve immediately upon energization.
b. No “warm-up”, initialization, or arming time delays adjustments shall be necessary.
c. No minimum load requirement or battery backup device shall be necessary to meet the specified time-current characteristics.
d. The control shall have a minimum operating temperature range of minus 30 degrees C to plus 65 degrees C with no more than a plus or minus 5 percent variation in time-current response characteristics from its response at plus 25 degrees C.

C. The standard control shall provide minimum phase overcurrent trip settings that are field selectable (in 10-amp increments) from 20 amps to 1,290 amps. Trip settings may be changed while the transformer is energized (so service is not interrupted). An instantaneous trip feature shall be provided as a standard feature of the control. Instantaneous trip shall be a field selectable multiple of 1X, 3X, 5X,...15X times the phase overcurrent trip settings or it may be selected to be disabled. The instantaneous trip feature shall provide a fixed 0.025-second response time characteristic.

D. A single time-current curve shall be provided that is common to all three phases. Time-current trip curves shall be changeable via plug-in TCC modules. The time-current curve provided shall be the Tri-Phase with Ground – EF on phase and ground, and shall emulate the time-current characteristics of its associated fuse type.

E. The control and its enclosure shall be mounted on the inside of the cabinet door of the VFI tap compartment. The control enclosures shall be mild steel and vented in design to prevent trapping of moisture within the control. The control cabinet shall provide sufficient space for accessory control board that shall be mounted within the same control cabinet assembly as the TPG control.

F. TPG Ground Trip Element: The minimum trip selection for each phase element and for ground element shall be independently settable. Minimum ground trip settings shall be selectable from 10 to 640 amps, in 10-amp increments. A separate instantaneous trip feature shall be provided for ground as a standard feature that shall provide a selection of 1X, 3X, 5X....15X the ground minimum trip setting for the instantaneous trip pickup or it may be disabled. The instantaneous trip feature shall provide a fixed 0.025-second response time characteristic.

1. The overcurrent trip response time for ground trip shall be governed by a separate time-current curve plug-in module.
2. The ground trip sensing portion of the control shall be capable of being de-activated via a ground trip block switch.

G. A SCADA/accessory board shall be provided that is mounted within the same control cabinet assembly. This accessory shall include its own battery backup utilizing long life lithium batteries as required to support proper activation of the inrush restraint feature upon power up from a de-energized state and for proper operation of the trip indication targets. This accessory shall provide:

1. A minimum trip multiplier feature that shall be activated by a separate toggle switch located within the control housing. This feature shall allow normal minimum trip levels for each phase and ground to be raised from 1.1X to 13.7X their normal setting while this feature is active. This multiplier shall be field selectable and shall be independently settable for each phase and for ground. A contact output shall be supplied for remote status indication.
2. An inrush restraint feature that shall allow the control to automatically raise the set minimum trip levels for phase and ground to a field selectable multiple of 1X to 32X, in increments of 1X, for a selectable time interval of 0.5 to 32 seconds, in increments of 0.5 second. The feature shall also have the field selectable provision to block ground trip during the interval that the inrush restraint is active.
3. Trip indication targets shall be provided on the circuit board with separate targets for each phase and ground. After a trip event, these targets shall give visual indication where the fault occurred. The phase target shall reset after restoration of line current in the affected phase. The ground target shall reset after restoration of current in any phase. Contacts for remote indication of a trip event shall be provided for each phase and ground.
4. A separate ground trip block toggle switch shall be provided within the control enclosure to allow easy activation of ground trip when a known phase unbalance condition will be created due to switching or maintenance operations that may cause an unwanted ground trip. A contact shall be provided for remote status indication of the switch.
5. A separate three-pole toggle switch shall be provided within the control enclosure that shall function as a CT shorting switch. This toggle switch shall allow the operator to easily de-energize the control for maintenance, or disable the control from sensing and tripping on overcurrents. A contact shall be provided for remote status indication of the switch.

H. Motor Operators:

1. A dc motor operator, with control shall be supplied for the VFI transformer. The motor operator shall utilize 24V dc motor actuators to open and close the VFI circuit breaker. The time required to open or close the VFI shall be approximately 8 seconds. The motor control shall be equipped with a 2.5 amp-hour sealed lead acid gel-cell battery to supply energy to activate the motor operator and control functions. Battery charge shall be maintained by a temperature/voltage regulated charger within the motor control that shall be capable of fully re-charging a low battery within 24 hours.
2. The motor control shall utilize a user supplied 120V ac two-wire grounded supply. The control shall also have provisions for accepting a second, alternate 120V ac supply from a portable generator and shall provide a transfer relay to transfer to the alternate supply if the primary 120V ac supply is lost. A potential transformer for power supply to the motor control shall be provided, with all necessary wiring factory installed.
3. The motor control shall include the following features:
    a. Open, Close, and Stop pushbuttons shall be provided for operation of the motor actuator.
    b. A Manual/Auto toggle switch shall be provided. In the Manual position, the switch shall allow operation of the motor actuator by the pushbuttons on the control panel only and shall not allow automatic or SCADA operation. In the Auto position, the switch shall only respond to the time delay relay control or SCADA operation of the motor actuator.
    c. Open and Closed indicating lights shall be provided to indicate status of the VFI. These status lights shall use auxiliary switch inputs from the source VFI to determine open or closed status.
    d. Opening and closing indicating lights shall be provided to verify that the motor actuator is in process of opening or closing a switch. A lamp test pushbutton shall be provided to confirm that indicating lights are functional.
    e. A Power On/Off toggle switch shall be provided that shall disconnect the dc voltage supply from the control and the motor actuator and shall function as a dc circuit breaker to interrupt the dc supply in the event of a short circuit or overload.
    f. An indicator shall be provided to verify that 120V ac power is present and that the battery charging circuit is providing a charging voltage to the battery. A battery test pushbutton shall be

supplied with test points to apply a voltmeter for testing the condition of the battery.

g. The control shall include a terminal strip for connection to SCADA or automatic control equipment. The terminal strip shall have connections for reading the Open/Closed status of the VFI, initiating an Open or Close operation via a momentary dry contact, and reading the Opening/Closing status of the motor actuator as it performs the required operation.

h. The VFI control shall be provided with two sets of stage “a” and “b” auxiliary switches for the purpose of remote indication of status. The auxiliary switches shall be linked to the movable contact rod of the VFI. These auxiliary switches shall be rated for 15 amps at 120V ac/1 amp at 125V dc and wired to an external terminal strip.

I. Oil-Immersed Bayonet Expulsion Fuses:

1. Accessibility: Bayonet expulsion fuse accessible through primary compartment.
2. Expulsion Fuse for Low Current Faults: Interrupting capacity of 1,800 amperes rms asymmetrical.
3. Bayonet fuse externally replaceable with hot stick.

2.08 SURGE ARRESTORS

A. Metal-Oxide, Varistor Type:

1. Insulated body, elbow type, 15 kV Rated, 12.7 kV MCOV in accordance with IEEE C62.11.
2. Installed in high voltage compartment.
3. Connected to transformer high voltage terminals.

2.09 GAUGES AND FITTINGS

A. Liquid Level gauge.

B. Thermometer, dial type.

C. Pressure/vacuum gauge, Schrader valve.

D. Pressure Relief Device, 50 scfm.

E. Drain valve with sampler in LV compartment.

2.10 TANK GROUNDING PADS

A. High and Low Voltage Compartments:

1. Connected together with copper ground bus.
2. Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.

2.11 TAP CHANGER WARNING SIGN

A. Red laminated plastic, engraved to white core.

B. Engrave to read: DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.

C. Mount above tap changer handle.

2.12 FACTORY TESTS

A. Production tests in accordance with IEEE C57.12.90 and IEEE C57.12.00, Section 8 and Table 16.

B. Dielectric test in accordance with IEEE C57.12.26. Fluid shall be tested in bulk prior to units being filled.

PART 3 EXECUTION

3.01 GENERAL

A. Secure to mounting pads with anchor bolts.

B. Install plumb and longitudinally in alignment with pad or adjacent building wall.

C. Ground neutrals and enclosures in accordance with applicable codes.

3.02 ADJUSTMENTS

A. Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

END OF SECTION

SECTION 26 13.16.02
PAD-MOUNTED SWITCHGEAR

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. B117, Standard Practice for Operating for Salt Spray (Fog) Apparatus.
   b. B187, Standard Specification for Copper Bar, Bus Bar, Rod, and Shapes.
   c. B236, Standard Specification for Aluminum Bars for Electrical Purposes (Bus Bars).
   d. D523, Standard Test Method for Specular Gloss.
   e. D543, Standard Practice for Evaluating for Resistance of Plastics to Chemical Reagents.
   f. D570, Standard Test Method for Water Absorption of Plastics.
   g. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   h. D714, Standard Test Method for Evaluating Degree of Blistering of Paints.
   i. D756, Standard Practice for Determination of Weight and Shape Changes of Plastics under Accelerated Service Conditions.
   j. D790, Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastic and Electrical Insulating Materials.
   k. D1654, Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
   l. D2247, Standard Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.
   m. D2794, Standard Test Method for Resistance or Organic Coatings to the Effects of Rapid Deformation.
   n. D3359, Standard Test Methods for Measuring Adhesion by Tape Test.
   o. D4060, Standard Test Method for Abrasion Resistance to Organic Coatings by the Taber Abraser.
   p. D4214, Test Method for Evaluating Degree of Chalking of Exterior Paint Films.

q. G154, Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600V.
   b. C37.20.3, Metal Enclosed Interrupter Switchgear.
   c. C37.46, Specifications for Power Fuses and Fused Disconnecting Switches.
   d. C37.57, Metal Enclosed Interrupter Switchgear Assemblies—Conformance Testing.
   e. C37.58, Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear—Conformance Test Procedures.
   f. C37.91, Guide for Protective Relay Applications to Power Transformers.
   g. C57.12.28, Switchgear and Transformers, Pad-Mounted Equipment, Enclosure Integrity.
   h. C62.11, Metal-Oxide Surge Arrestors for Alternating-Current Power Circuits (>1 KV).
3. National Electrical Manufacturers Association (NEMA):
   a. C2, National Electrical Safety Code.
   b. C29.9, Wet-Process Porcelain Insulators - Apparatus Post-Type.
   c. C29.10, Wet Process Porcelain Insulators - Indoor Apparatus Type.
   d. LA 1, Surge Arrestors.
   e. SG 2, High Voltage Fuses.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive product information.
2. Dimensional drawings.
3. Itemized bill of material.
4. Operational description.
5. Installation instructions.
6. Switchgear configurations.
7. Interrupter switch data.
8. Bus data.
9. Fuse data and time-current characteristics on transparencies.
10. Power operator with voltage sensors data and circuitry.
11. Conduit entrance locations.

12. Concrete pad details.
13. Base spacer details.
14. Anchoring details.
15. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing (to be completed).
3. Certified factory test reports.
4. Manufacturer's installation instructions.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following special tools and material:

1. One set of three grounding jumpers 3 feet in length, complete with canvas storage bag for each set.
2. Voltage tester with audio and visual signals, batteries, shotgun clamp-stick adapter, and storage case.
3. 8 feet long shotgun clamp stick with canvas storage bag.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. S&C Co. or equal.

B. Provide pad mounted switchgear that is the product of a single manufacturer. Assembled units with component parts of several manufacturers will not be acceptable with the exception that minor items as terminal blacks, test switch, wiring, etc., may be manufactured by others.

2.02 GENERAL

A. Equipment suitable for 12,500 volts, three-phase, four-wire, solid grounded-wye electrical system having an available short-circuit current at line terminals of 22,000 amperes rms symmetrical.

B. Pad mounted switchgear complete with self-supporting enclosure for elbow-connected encased components.

C. Switchgear shall be power operated with remote supervisory control.

D. Design, test, and assemble in accordance to IEEE C37.20.3, IEEE C37.57, and IEEE C57.12.28.

E. Operating Conditions:

1. Ambient Temperature: Maximum 45 degrees C.
2. Equipment shall be fully rated without derating for these operating conditions.

F. Anchor Bolts: Type 316 stainless steel, 5/8-inch diameter, length sized by manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.03 EQUIPMENT RATINGS

1. Integrated switchgear assembly ratings at 60-Hz.
2. Voltage: 14.4 kV nominal, 17.0 kV maximum.
3. Insulation Level: 95 kV BIL.
4. Bus Current: 200 amperes continuous, as shown on one-line diagram.
5. Fuses with Integral Load Interrupter:
   a. Current: 200E maximum amperes, 200 load dropping amperes.
   b. Two-Time Duty-Cycle Fault Closing: 13,000 amperes rms asymmetrical.
6. Short-Circuit Rating: 14,000 amperes rms symmetrical, 310 mVa three-phase symmetrical at rated nominal voltage.

B. Fault-closing ratings to equal, or exceed, the short-circuit ratings of the pad mounted switchgear with:

1. Momentary and two-time duty-cycle rating of switches.
2. Momentary rating of bus.
3. Interrupting ratings of fuses.

2.04 ENCLOSURE

A. Monocoque, freestanding, self-supporting construction with welded structural and butt joints having external seams ground flush and smooth.

B. Enclosure sides, doors, roof, bottom flange, base spacer, and steel barriers constructed with 11-gauge hot-rolled, pickled, and oiled sheet steel.

C. Tamper resistant with no externally accessible hardware in accordance with security requirements of IEEE C57.12.28.

D. Removable lifting tabs bolted to blind-tapped sockets with resilient anticorrosion material between tabs and enclosure.

E. Enclosure Base:

1. Consisting of continuous 90-degree steel flanges welded to enclosure and turned inward for bolting to concrete pad.
2. Resilient closed-cell PVC gasket applied between flange bottom and pad.
3. Coat enclosure flange with wax-based anticorrosion moisture barrier.

F. Enclosure Roof:

1. Overlapping edges creating mechanical maze and ventilating openings.
2. Insulating nondrip compound applied to underside.

G. Doors:

1. Constructed with edge flanges overlapping door openings to form mechanical maze.
2. Two extruded-aluminum hinges with Type 316 stainless steel pins, full length of door extruded-aluminum interlocking supports, and stainless steel mounting hardware for each door.
3. Access door to power fuses equipped with storage space for replacement fuse components.
4. Hidden galvanized steel door holders swinging outward when door is in opened position.

H. Door Latch:

1. Automatic positive action, three-point, spring-loaded latching mechanism for each door or set of doors.

2. Pentahead socket wrench to actuate mechanism for unlatching door and recharging spring for next closing operation in same motion.
3. Tamper-proof padlocking shackle coordinated with latches to prevent:
   a. Unlatching mechanism until padlock is removed.
   b. Inserting padlock until mechanism is completely latched closed.

I. Finish:

1. Multistage process applied to interior and exterior surfaces, joints, and blind areas prior to enclosure assembly.
   a. Pretreatment protective film.
   b. Baked epoxy finished coating.
   c. Baked acrylic enamel top coating in accordance with IEEE C57.12.28.
2. Color: Gray.
3. Tests:
   a. Salt-spray test in accordance with ASTM B117.
   b. Humidity test in accordance with ASTM D2247 and ASTM D714.
   c. Accelerated weather tests in accordance with ASTM G154, ASTM D4214, and ASTM D523.
   d. Adhesion tests in accordance with ASTM D3359, Method B and ASTM D2794.
   e. Corrosion tests in accordance with ASTM D1645.
   f. Abrasion tests in accordance with ASTM D4060.
   g. Oil resistance testing with no shift in color, streaking, blistering, or loss of hardness.

2.05 BARRIERS

A. In compliance with NEMA C2.

B. Full-length steel barriers separating side-by-side compartments.

C. BIL Rated Fiberglass-Reinforced Polyester Barriers:

1. Fixed interphase and end barriers for each interrupter switch and each set of fuses.
2. Front and rear compartments isolated by fixed barriers.
3. Hanging front barrier for each door opening.

2.06 COMPONENT ENCASEMENT

A. In compliance with NEMA C2.

B. Switch and fuse components, and interconnecting bus enclosed in inner air-insulated, grounded, steel compartment bulkheads and 22-gauge galvanized steel floor.

C. Resilient gasketing between compartment bulkheads and enclosure roof and sides.

D. Dense closed-cell gaskets between fuse-handling mechanisms and compartment bulkhead.

E. Full-length steel barriers separating adjoining termination compartments.

F. BIL rated fiberglass-reinforced polyester barriers to isolate interphase bus from components.

G. Wide-angle viewing window in bulkhead for visual verification of each interrupter switch position.

H. Viewing window in bulkhead adjacent to each fuse-handling mechanism for visual check of blown-fuse indicators.

I. Parking stands adjacent to each 600-ampere rated bushing and 200-ampere rated bushing well.

J. Cable guides at each fuse-handling mechanism.

2.07 GROUND-CONNECTION PADS

A. Provided in each compartment on inside at bottom door stile with momentary rating equal to, or exceeding, short-circuit ratings of switchgear.

B. Constructed of 5/8-inch-thick nickel-plated steel, with oxide inhibitor and sealant coating, welded to enclosure.

C. Ground studs of each fuse terminal plus one ground stud at ground connection pad in each switch terminals.

2.08 GROUND RINGS

A. Provide full width in each switch compartment and at each fuse-handling mechanism.

B. Constructed of 3/8-inch-thick copper bolted to the metal enclosure inside at bottom door stile.

C. Cable guides at each fuse-handling mechanism ground ring.

2.09 INSULATORS

A. Interrupter switch and fuse mounting insulators, insulated operating shafts, and push rods constructed of cycloaliphatic epoxy resin in accordance with NEMA C29.9 and NEMA C29.10.

2.10 HIGH VOLTAGE BUS

A. Copper bus bar and bus supports.

B. Square-edged, hard-drawn copper bar in accordance with ASTM B187.

C. Bus rated 600-ampere with provisions for one cable terminations per phase.

2.11 CIRCUIT BREAKER

A. Vacuum Fault Interrupter with Automatic Motorized Switching:

1. The vacuum fault interrupter shall act as a three-phase group operated circuit breaker. The trip mechanisms for each phase shall be mechanically linked and the electronic control shall be set so that an overcurrent condition on any one phase shall simultaneously trip all three phases. A single operating handle shall be provided for manual opening, reset, and closing. The operating handle(s) shall be mounted on the front plate of the tank in close relation to the VFI being controlled and shall have three distinct operating positions corresponding to the vacuum fault interrupter positions of closed, open, or tripped. A pointer attached to the handle shall be provided for ready identification of the handle’s position. The handle shall be designed for operation with a lineman’s hotstick and have a push to close/pull to open/pull to reset operation requiring no more than 75 pounds of force and 60 degrees of movement for complete operation. Except with the motor operator, when the vacuum fault interrupter is tripped by automatic action of the VFI control, the operating handle shall drop to an intermediate position between its closed and open positions, to provide indication that it is tripped. The operating handle assembly shall include provisions to padlock the handle in the open position.
2. The VFI shall be used to open the source to the transformer primary windings after a 0- to 10-second time delay if primary source voltage is lost.

3. The VFI shall be used to close the source to the primary windings after an adjustable time delay of 0 to 10 minutes after return of source voltage.

B. Electronic Trip Control:

1. Overcurrent sensing shall be accomplished with an electronic trip control that shall be Cooper Power Systems type Tri-Phase Control with Ground (TPG) control.
2. The control shall use internally mounted 1000:1 bushing current transformers (CTs) to sense line current and shall also provide the control operating power, eliminating the effects of system voltage conditions. The control shall be self-contained and includes the following:
   a. Meet the specified time-current curve immediately upon energization.
   b. No “warm-up,” initialization, or arming time delays adjustments shall be necessary.
   c. No minimum load requirement or battery back-up device shall be necessary to meet the specified time-current characteristics.
   d. The control shall have a minimum operating temperature range of minus 30 degrees C to plus 65 degrees C with no more than a plus or minus 5 percent variation in time-current response characteristics from its response at plus 25 degrees C.

C. The standard control shall provide minimum phase overcurrent trip settings that are field selectable (in 10-amp increments) from 20 amps to 1,290 amps. Trip settings may be changed while the transformer is energized (so service is not interrupted). An instantaneous trip feature shall be provided as a standard feature of the control. Instantaneous trip shall be a field selectable multiple of 1X, 3X, 5X,...15X times the phase overcurrent trip settings or it may be selected to be disabled. The instantaneous trip feature shall provide a fixed 0.025-second response time characteristic.

D. A single time-current curve shall be provided that is common to all three phases. Time-current trip curves shall be changeable via plug-in TCC modules. The time-current curve provided shall be the Tri-Phase with Ground – EF on phase and ground, and shall emulate the time-current characteristics of its associated fuse type.

E. The control and its enclosure shall be mounted on the inside of the cabinet door of the VFI tap compartment. The control enclosures shall be mild steel and vented in design to prevent trapping of moisture within the control. The

control cabinet shall provide sufficient space for accessory control board that shall be mounted within the same control cabinet assembly as the TPG control.

F. TPG Ground Trip Element: The minimum trip selection for each phase element and for ground element shall be independently settable. Minimum ground trip settings shall be selectable from 10 to 640 amps, in 10-amp increments. A separate instantaneous trip feature shall be provided for ground as a standard feature that shall provide a selection of 1X, 3X, 5X....15X the ground minimum trip setting for the instantaneous trip pickup or it may be disabled. The instantaneous trip feature shall provide a fixed 0.025-second response time characteristic.

1. The overcurrent trip response time for ground trip shall be governed by a separate time-current curve plug-in module.
2. The ground trip sensing portion of the control shall be capable of being de-activated via a ground trip block switch.

G. A SCADA/accessory board shall be provided that is mounted within the same control cabinet assembly. This accessory shall include its own battery backup utilizing long life lithium batteries as required to support proper activation of the inrush restraint feature upon power up from a de-energized state and for proper operation of the trip indication targets. This accessory shall provide:

1. A minimum trip multiplier feature that shall be activated by a separate toggle switch located within the control housing. This feature shall allow normal minimum trip levels for each phase and ground to be raised from 1.1X to 13.7X their normal setting while this feature is active. This multiplier shall be field selectable and shall be independently settable for each phase and for ground. A contact output shall be supplied for remote status indication.
2. An inrush restraint feature that shall allow the control to automatically raise the set minimum trip levels for phase and ground to a field selectable multiple of 1X to 32X, in increments of 1X, for a selectable time interval of 0.5 to 32 seconds, in increments of 0.5 second. The feature shall also have the field selectable provision to block ground trip during the interval that the inrush restraint is active.
3. Trip indication targets shall be provided on the circuit board with separate targets for each phase and ground. After a trip event, these targets shall give visual indication where the fault occurred. The phase target shall reset after restoration of line current in the affected phase. The ground target shall reset after restoration of current in any phase.

Contacts for remote indication of a trip event shall be provided for each phase and ground.

4. A separate ground trip block toggle switch shall be provided within the control enclosure to allow easy activation of ground trip when a known phase unbalance condition will be created due to switching or maintenance operations that may cause an unwanted ground trip. A contact shall be provided for remote status indication of the switch.
5. A separate three-pole toggle switch shall be provided within the control enclosure that shall function as a CT shorting switch. This toggle switch shall allow the operator to easily de-energize the control for maintenance, or disable the control from sensing and tripping on overcurrents. A contact shall be provided for remote status indication of the switch.

H. Motor Operators:

1. A dc motor operator, with control shall be supplied for the VFI transformer. The motor operator shall utilize 24V dc motor actuators to open and close the VFI circuit breaker. The time required to open or close the VFI shall be approximately 8 seconds. The motor control shall be equipped with a 2.5 amp-hour sealed lead acid gel-cell battery to supply energy to activate the motor operator and control functions. Battery charge shall be maintained by a temperature/voltage regulated charger within the motor control that shall be capable of fully re-charging a low battery within 24 hours.
2. The motor control shall utilize a user supplied 120V ac two-wire grounded supply. The control shall also have provisions for accepting a second, alternate 120V ac supply from a portable generator and shall provide a transfer relay to transfer to the alternate supply if the primary 120V ac supply is lost. A potential transformer for power supply to the motor control shall be provided, with all necessary wiring factory installed.
3. The motor control shall include the following features:
    a. Open, Close, and Stop pushbuttons shall be provided for operation of the motor actuator.
    b. A Manual/Auto toggle switch shall be provided. In the Manual position, the switch shall allow operation of the motor actuator by the pushbuttons on the control panel only and shall not allow automatic or SCADA operation. In the Auto position, the switch shall only respond to the time delay relay control or SCADA operation of the motor actuator.

c. Open and Closed indicating lights shall be provided to indicate status of the VFI. These status lights shall use auxiliary switch inputs from the source VFI to determine open or closed status.
d. Opening and closing indicating lights shall be provided to verify that the motor actuator is in process of opening or closing a switch. A lamp test pushbutton shall be provided to confirm that indicating lights are functional.
e. A Power On/Off toggle switch shall be provided that shall disconnect the dc voltage supply from the control and the motor actuator and shall function as a dc circuit breaker to interrupt the dc supply in the event of a short circuit or overload.
f. An indicator shall be provided to verify that 120V ac power is present and that the battery charging circuit is providing a charging voltage to the battery. A battery test pushbutton shall be supplied with test points to apply a voltmeter for testing the condition of the battery.
g. The control shall include a terminal strip for connection to SCADA or automatic control equipment. The terminal strip shall have connections for reading the Open/Closed status of the VFI, initiating an Open or Close operation via a momentary dry contact, and reading the Opening/Closing status of the motor actuator as it performs the required operation.
h. The VFI control shall be provided with two sets of stage “a” and “b” auxiliary switches for the purpose of remote indication of status. The auxiliary switches shall be linked to the movable contact rod of the VFI. These auxiliary switches shall be rated for 15 amps at 120V ac/1 amp at 125V dc and wired to an external terminal strip.

I. Voltage Sensors:

1. Constant current output device producing output voltage directly proportional to line-to-ground voltage for three-phase signal sensing voltage, control power, and motor charging and tripping power.
2. Three sensors for each source, replacing the lower apparatus insulators of the interrupter switch, and having BIL and dielectric characteristics equivalent to replaced insulators.
3. Relay accuracy ambient temperature range of minus 40 degrees F to plus 160 degrees F.
4. Voltage sensor’s secondary conductors shielded from medium voltage and directly connected to variable burden resistors for field adjustment of voltage sensor outputs.

2.12 CONTROL WIRING

A. NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts for control, instrumentation, and power circuits.

B. Individual seven-strand, copper conductors, twisted and covered with a 100 percent aluminum, polyester shield with tinned copper drain wire and overall outer jacket, rated 600 volts, 90 degrees C minimum for transducer output and analog circuits.

C. Conductor Lugs: Preinsulated, self-locking, spade type with reinforced sleeves.

D. Wire Markers: Each wire individually identified with permanent markers at each end.

E. Internal circuit wiring crossing shipping splits to have plug connectors.

F. Splices: Not permitted.

2.13 SURGE PROTECTION

A. Sets of three metal-oxide, in accordance with IEEE C62.11 and NEMA LA 1.

B. Base mounted at switch terminals and bus terminals in Compartments 1 and 2.

C. Connect to line side of switch terminals and ground to switchgear ground bus.

D. Class: Intermediate.

E. Rating: 9 kV for 12 kV.

2.14 BASE SPACERS

A. Steel noncompartmented type bolted to enclosure flange and anchor to on-grade concrete pad.

B. Spacer height of 6 inches.

C. Complete with resilient closed-cell gasket between bottom flange and concrete pad.

D. Finish identical to that specified for enclosure finish.

2.15 LABELING

A. Nonmetallic, self-sticking with integral lettering and symbols.

B. Warning Labels:

1. Attach to exterior surface of each external door labels reading CAUTION—HIGH VOLTAGE-KEEP OUT.
2. Attach to internal surface of each external door and on all barriers used to prevent access to live parts, labels reading DANGER—HIGH VOLTAGE—KEEP OUT—QUALIFIED PERSONS ONLY.
3. Provide inside each interrupter switch access door, labels reading SWITCH BLADES MAY BE ENERGIZED IN ANY POSITION.
4. Provide inside each fuse access door, labels reading FUSES MAY BE ENERGIZED IN ANY POSITION.

C. Rating Labels: Attach inside each door, or set of double doors, labels indicating:

1. Voltage rating.
2. Main bus continuous rating.
3. Short-circuit ratings in amperes rms symmetrical and mVa three-phase symmetrical at rated nominal voltage.
4. Fuse type.
5. Fuse rating, including duty-cycle fault-closing capability.
6. Interrupter switch ratings, including duty-cycle fault-closing and short time momentary, amperes rms asymmetrical and 1 second, amperes rms symmetrical.

D. Connection Labels: Attach inside each door, or set of double doors, and inside each switch-operating hub access cover, labels showing three-line connection diagram for interrupter switches, fuses with integral load interrupter, and bus along with manufacturer’s model number.

E. Phase identification numbers 1, 2, and 3 above each phase connection at each fuse unit and interrupter switch.

2.16 NAMEPLATES

A. Deep etched aluminum on outside of each door, or set of double doors, indicating manufacturer’s name, catalog number, model number, date of manufacture, and serial number.

B. Riveted to door surface.

2.17 ACCESSORIES

A. One set of three grounding jumpers, 3 feet in length, complete with storage bag for each set.

B. One voltage tester with audio and visual signals, batteries, shotgun clamp-stick adapter, and storage case.

C. 8 feet, 5-1/2 inches long, shotgun clamp-stick with canvas storage bag.

2.18 SOURCE QUALITY CONTROL

A. Switchgear assembly shall be production tested in accordance with IEEE C37.20.3.

B. Fuses shall be production tested in accordance with IEEE C37.46.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Secure equipment to concrete pad with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Tighten current-carrying bolted bus connections and enclosure framing and panel bolts to manufacturer's recommendations.

D. Coordinate terminal connections with installation of secondary feeders.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative for the following services at Site, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance, final adjustment, and initial energization of equipment.
2. 1 person-day for testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for post-startup training.

B. Furnish training of Owner personnel at such times as requested by Owner.

END OF SECTION

SECTION 26 14 13
SWITCHBOARDS

PART 1 GENERAL

1.01 REFERENCES

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

1. National Electrical Manufacturers Association (NEMA):
   a. PB 2, Deadfront Distribution Switchboards.
   b. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
3. Underwriters Laboratories (UL):
   a. 489, Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   b. 891, Standard for Safety for Switchboards.
   c. 1561, Standard for Safety for Dry-Type General Purpose and Power Transformers.

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive product information.
2. Itemized Bill of Material.
3. Dimensional drawings.
4. Operational description.
5. One-line, three-line, and control schematic drawings.
6. Connection and interconnection drawings.
7. Circuit Breakers: Copies of time-current characteristics.
8. Bus data.
9. Incoming line section equipment data.
10. Transformer section equipment data.
11. Conduit entrance locations.
12. Anchoring instructions and details.
13. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
2. Manufacturer's installation instructions.
3. Factory Test Report.
4. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing (to be completed).
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).
6. Manufacturer's Certification of Proper Installation in as specified in Section 01 43 33, Manufacturers' Field Services (to be completed).

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

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

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

1. Fuses: One complete set of spare fuses of each current rating, both power and control.
2. Lights: One complete set of spare indicating lights.
3. Paint: One pint, to match enclosure exterior finish in color and quality.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. General Electric.

2. Westinghouse.
3. Siemens.
4. Square D.

2.02 GENERAL REQUIREMENTS

A. Equipment suitable for 480Y/277- or 208Y/120-volt, three-phase, four-wire solid grounded-wye as shown on Drawings, with electrical system having available short-circuit current at line terminals of 42,000 amperes rms symmetrical as shown on Drawings.

B. Comply with NEMA PB 2 and UL 891.

C. Switchboard and its major components to be manufactured and assembled by single manufacturer in order to achieve standardization for appearance, operation and maintenance, spare parts replacement, and manufacturer's services.

D. Lifting lugs on equipment and devices weighing over 100 pounds.

E. Operating Conditions:

1. Ambient Temperature: Maximum 45 degrees C.
2. Equipment shall be fully rated without derating for the above operating conditions.

2.03 STATIONARY STRUCTURE

A. Type: NEMA PB 2 construction, dead front, completely metal enclosed, self-supporting.

B. Sections bolted together to form one rigid assembly capable of being moved into position and bolted directly to floor without use of floor sills.

2.04 ENCLOSURE

A. Equipment Finish: Baked enamel applied over rust-inhibiting phosphated base coating.

1. Color:
   a. Exterior: Gray finish.
   b. Interior: Gray.
   c. Unpainted Parts: Plated for corrosion resistance.
   d. Indoor Enclosure: NEMA 250, Type 1:

2. Rear, full-height, bolt-on panels for each enclosure section.
3. Cable Termination Access: Padlock provision.
4. Front Access:
   a. Service line and load terminations, internal devices, device and bolted bus connections, and protective device removal, serviceable from front only.
   b. Sections aligned across back to permit placement flush against wall.
   c. Working Space: As required by NFPA 70.
5. Front and Rear Access:
   a. With service line and load terminations, internal devices, and device and bolted bus connections serviceable from rear and protective devices serviceable from front.
   b. Align sections across back and front with NFPA 70 required working space in front, back, and sides.
6. Transition sections as required or shown.
7. Side and Top Covers: Removable, captive, screw-on plates with formed edges on each side.
8. Front Cover: Hinged door with formed edges.

B. Aisle-less Outdoor Enclosure:

1. NEMA 250, Type 3R enclosing NEMA 250, Type 1, enclosed switchboard where located outdoors.
2. Hinged, full-height doors with three-point latch operated by vault-type handle with multiple padlocking provisions for each front switchboard section.
3. Minimum 10-inch front access space between exterior door and front of interior switchboard doors.
4. Gasketed doors, end panels, and sloped roof.
5. Ventilating louvers with filters in front door and rear panels.
6. Space Heaters: Thermostatically controlled 250-watt, 120-volt, in each switchboard vertical section. Furnish transformer with primary fuses to power heaters.
7. Adjustable thermostat for temperature range of 50 degrees F to 70 degrees F.

2.05 BUSWORK

A. Material: Phase noninsulated copper throughout entire length of sufficient cross section to limit temperature rise at rated current to 55 degrees C.

B. Bus Arrangement: A-B-C, left-to-right, top-to-bottom, and front-to-rear, as viewed from front.

C. Brace for short-circuit currents as shown amperes rms symmetrical on Drawings. Minimum 42 kaic.

D. Neutral Bus: Continuous current rating 50 percent.

E. Ground Bus:

1. Copper.
2. Rating: As shown, 300 amperes, minimum.
3. Bolted to each vertical section.
4. Bus Connections and Joints: Bolted with Belleville washers.

F. Extend each bus entire length of switchboard.

2.06 PROTECTIVE DEVICES

A. Molded-Case Circuit Breakers:

1. Main, Tie, and Branch Feeder Protective Devices: Group mounted, suitable for use with 75 degree C wire at full 75 degree C ampacity when mounted in switchboard.
2. Breakers 225-Ampere Frame and Above: Solid-state trip unit.
3. Interrupting Rating: As shown on Drawings without series derating. Minimum 42 kaic.
4. Breakers 2,000-Ampere through 3,000-Ampere Frame: UL 489 listed and labeled 100 percent application in accordance with NFPA 70.

B. Trip Units – Molded Case Circuit Breakers Below 400 Amperes:

1. The trip unit shall be Eaton type Digitrip 310 or approved equal.
2. Each molded case circuit breaker microprocessor-based tripping system (MPT) shall consist of three current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.
3. An adjustable trip setting dial mounted on the front of the trip unit, or interchangeable ratings plugs shall establish the continuous trip ratings

of each circuit breaker. Rating plugs shall be fixed or adjustable as otherwise indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

4. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
   a. Adjustable long-time setting (set by adjusting the trip setting dial or rating plug).
   b. Adjustable short-time setting and delay with selective curve shaping.
   c. Adjustable instantaneous setting.
   d. Adjustable ground fault setting and delay.
5. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
6. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override.
7. Furnish internal ground fault protection with adjustable settings. Provide neutral ground fault sensor for four-wire loads.
8. Breakers shall have built-in test points for testing the long-time delay, instantaneous, and ground fault functions of the breaker by means of a test set.

C. Trip Units – Molded Case Circuit Breakers – 400 to 1200 Amperes:

1. The trip unit shall be Eaton type Digitrip OPTIM 550 – Programmable or approved equal.
2. Each circuit breaker microprocessor-based tripping system (MPT) shall consist of three current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached. The trip unit shall be Eaton Type OPTIM or approved equal.
3. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed-type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

4. System coordination shall be provided by the following microprocessor-based programmable time/current curve shaping adjustments:
   a. Programmable long-time pickup settings in 1-percent increments, with plus or minus 5 percent band tolerance.
   b. Programmable long-time delay with selectable I^2t or I^4t curve shaping.
   c. Programmable short-time settings (dependent on long-time setting) in 1-percent increments, with plus or minus 5 percent band tolerance.
   d. Programmable short-time delay with selectable flat or I^2t curve shaping.
   e. Programmable instantaneous pickup settings in 1-percent increments.
   f. Programmable ground fault pickup settings trip or alarm in 1-percent increments.
   g. Programmable ground fault delay with selectable flat or I^2t curve shaping.
5. The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
6. When the instantaneous setting has been deselected, a selectable discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.
7. Internal ground fault protection or alarm settings if specified shall not exceed 1,200 amperes. Provide neutral ground fault sensor for four-wire loads.
8. The trip unit shall have an information system that utilizes battery backed-up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. The LEDs shall be complemented by trip event information stored in non-volatile memory after a trip event. A trip reset button shall be provided to turn off the LED indication and reset the memory after an automatic trip. A test pushbutton shall energize an LED to indicate battery status.
9. A red LED shall be provided on the face of the trip unit and preset to flash on and off when an adjustable high-load level is exceeded. A time-delay shall be provided to avoid nuisance alarms. The microprocessor-based trip units shall be capable of monitoring the following data:
   a. Instantaneous value of phase, neutral and ground current.
   b. Minimum and maximum current values.
   c. Average demand current.

d. System diagnostic information such as alarms and cause of trip.
e. Approximate level of fault current that initiated an automatic trip operation.

10. The trip unit shall contain test capability. Testing shall be carried out by using a handheld programmer, a breaker interface module or a remote computer to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in either the “Trip” or “No Trip” test mode. Provide an auxiliary power module to allow the breaker trip unit to be tested with a 120-volt external power source.
11. A handheld programming unit shall be provided to set/change the network communication breaker address for each device, set the system baud rate, distribution frequency, display breaker information, and display monitored values. In addition, provide password protection for programming time/current setpoints and to perform functional testing of phase and ground trip characteristics. The programmer shall be self-powered by an internal battery. Provide as a minimum one handheld programming unit per assembly.
12. The monitored data shall be displayed by a handheld programmer, a breaker interface module, or a remote computer.
13. Circuit breakers shall be provided with a 24V dc power supply mounted within the assembly. In addition, provide a minimum of one auxiliary switch and one bell alarm, each with Form C contacts in each breaker. Provide additional auxiliary switches, bell alarms, shunt trips, and undervoltage releases where indicated on Drawings.

2.07 CONTROL WIRING

A. Control, Instrumentation, and Power/Current Circuits: NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts.

B. Transducer Output/Analog Circuits: Shielded cable rated 600 volts, 90 degrees C minimum.

C. Conductor Lugs: Preinsulated, self-locking, spade-type, with reinforced sleeves.

D. Identification: Individually, with permanent wire markers at each end.

E. Enclose in top and vertical steel wiring troughs, and front-to-rear in nonmetallic wiring troughs.

F. Splices: Not permitted in switchboard wiring.

2.08 TERMINAL BLOCKS

A. Enclosed in steel wiring troughs.

B. Rated 600 volts, 30 amperes minimum, one-piece barrier type with strap screws.

C. Shorting type for current transformer leads.

D. Provide terminal blocks for:

1. Conductors connecting to circuits external to switchboard.
2. Internal circuits crossing shipping splits.
3. Equipment parts requiring replacement and maintenance.

E. Spare Terminals: Not less than 20 percent.

F. Group terminal blocks for external circuit wiring leads.

G. Maintain 6-inch minimum space between columns of terminal blocks.

H. Identification: Permanent, for each terminal and columns of terminal blocks.

I. Manufacturer: General Electric; Type EB-5.

2.09 INSTRUMENTATION AND METERING

A. As specified in Section 26 09 13, Power Measurement and Control.

2.10 POWER METER

A. As specified in Section 26 09 13, Power Measurement and Control.

2.11 KEY INTERLOCK

A. Mechanical lock cylinder within breaker compartments as shown on Drawings.

B. Keys to be captive when breakers are closed.

2.12 IDENTIFICATION

A. Nameplates:

1. Master:
   a. Deep-etched aluminum, with manufacturer's name and model number.
   b. Riveted to main vertical section.
2. Circuit Breaker Cubicle and Door-Mounted Device:
   a. Engraved plastic, UV stabilized and suitable for temperatures to 40 degrees C continuous.
   b. Color: Black with white.
   c. Characters: Block-type, 3/16-inch high.
   d. Size: Manufacturer's standard.
   e. Inscription: As shown on one-line diagram.
   f. Blank plates for future spaces.
   g. Attachment Screws: Self-tapping stainless steel.

B. Section Identification:

1. Engraved metallic, riveted to each vertical section.
2. Serial number, bus rating, and section reference number.
3. Size: Manufacturer's standard.

C. Switchboard Sign:

1. Two signs each on front and back of switchboard.
2. Engraved, acrylic.
3. Size: Manufacturer's standard.
4. Color: Red with white.
5. Characters: Gothic-type, 1-inch high.
6. Inscription: DANGER/HIGH VOLTAGE/KEEP OUT.
7. Attachment: Four rivets each sign.

2.13 FACTORY TESTING

A. Performance tests in accordance with UL 891 and production tests in accordance with NEMA PB-2.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Secure to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

END OF SECTION

SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
   c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C50.41, Polyphase Induction Motors for Power Generating Stations.
   c. MG 1, Motors and Generators.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories (UL):
   a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
   b. 674, Standard for Safety for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
   c. 2111, Standard for Safety for Overheating Protection for Motors.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. DIP: Dust-ignition-proof enclosure.

C. EXP: Explosion-proof enclosure.

D. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

E. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

F. ODP: Open drip-proof enclosure.

G. TEFC: Totally enclosed, fan-cooled enclosure.

H. TENV: Totally enclosed, nonventilated enclosure.

I. WPI: Open weather protected enclosure, Type I.

J. WPII: Open weather protected enclosure, Type II.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Nameplate data in accordance with NEMA MG 1.
3. Additional Rating Information:
    a. Service factor.
    b. Locked rotor current.
    c. No load current.
    d. Safe stall time for motors 100 hp and larger.
    e. Multispeed load classification (for example, variable torque).
    f. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.
    g. Guaranteed minimum full load efficiency and power factor.
4. Enclosure type and mounting (such as, horizontal, vertical).
5. Dimensions and total weight.

6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
7. Bearing type.
8. Bearing lubrication.
9. Bearing life.
10. Space heater voltage and watts.
11. Description, ratings, and wiring diagram of motor thermal protection.
12. Motor sound power level in accordance with NEMA MG 1.
13. Maximum brake horsepower required by the equipment driven by the motor.
14. Description and rating of submersible motor moisture sensing system.
15. Seismic anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing (to be completed).

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing (to be completed).
2. Factory test reports.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing (to be completed).
4. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. General Electric.
2. Reliance Electric.
3. MagneTek.
4. Siemens Energy and Automation, Inc., Motors and Drives Division.
5. Baldor.
6. U.S. Electrical Motors.
7. TECO-Westinghouse Motor Co.
8. Toshiba International Corp., Industrial Division.
9. WEG Electric Motors Corp.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. For motors used in hazardous (classified) locations, Class I, Division 1, Groups B, C, and D, and Class II, Division 1, Groups E, F, and G provide motors that conform to UL 674 and have an applied UL listing mark.

E. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

F. Lifting lugs on motors weighing 100 pounds or more.

G. Operating Conditions:

1. Maximum ambient temperature not greater than 50 degrees C.
2. Motors shall be suitable for operating conditions without reduction being required in nameplate rated horsepower or exceeding rated temperature rise.
3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specification.

B. Constant Speed Applications: Brake horsepower of driven equipment at any possible operating condition not to exceed motor nameplate horsepower rating, excluding service factor.

C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any operating condition not to exceed motor nameplate horsepower rating, excluding service factor.

2.04 SERVICE FACTOR

A. Inverter-duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.

B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specification:

Voltage Rating		
Size	**Voltage**	**Phase**
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3
450 hp and larger	4,000	3

C. Suitable for full voltage starting.

D. 100 hp and larger also suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:
   a. Tested in accordance with NEMA MG 1, Paragraph 12.59.
   b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-12, Full-load Efficiencies for NEMA Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound), or as indicated in motor-driven equipment specification.
2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code F or lower, if motor horsepower not covered by NEMA MG 1 tables.

B. Safe Stall Time: 12 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.

C. Three-phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specification, Class F with Class B rise at nameplate horsepower and designated operating conditions, except EXP motors which must be Class B with Class B rise.

2.09 ENCLOSURES

A. Enclosures to conform to NEMA MG 1.

B. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.

C. Explosion-Proof (EXP):

1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class I, Division 1, Group D hazardous locations.
2. Drain holes with drain and breather fittings.
3. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
4. Terminate thermostat leads in terminal box separate from main terminal box.

D. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Article Special Motors.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

Terminal Box Usable Values		
Voltage	**Horsepower**	**Percentage**
Below 600	15 through 125	500
Below 600	150 through 300	275
Below 600	350 through 600	225
Above 600	All sizes	200

E. Terminal for connection of equipment grounding wire in each terminal box.

F. Coordinate motor terminal box conduit entries versus size and quantity of conduits shown on Drawings.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
2. 1 hp through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.

B. Vertical Motors:

1. Thrust Bearings:
   a. Antifriction bearing.
   b. Manufacturer’s standard lubrication 100 hp and smaller.
   c. Oil lubricated 125 hp and larger.
   d. Minimum 50,000 hours L-10 bearing life.
2. Guide Bearings:
   a. Manufacturer’s standard bearing type.
   b. Manufacturer’s standard lubrication 200 hp and smaller.

c. Oil lubricated 250 hp and larger.
d. Minimum 100,000 hours L-10 bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.
2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:

1. Oil reservoirs with sight level gauge.
2. Oil fill and drain openings with opening plugs.
3. Provisions for necessary oil circulation and cooling.

E. Inverter Duty Rated Motors, Bearing Isolation: Motors larger than 50 hp shall have electrically isolated bearings to prevent stray current damage.

2.12 NOISE

A. Measured in accordance with NEMA MG 1.

B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1, Part 7.

2.14 EQUIPMENT FINISH

A. External Finish: Prime and finish coat manufacturer’s standard. Field painting in accordance with Section 09 90 00, Painting and Coating.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for guarded machine in NEMA MG 1, and attached with stainless steel screws.

B. Winding Thermal Protection:

1. Thermostats:
   a. Motors for constant speed application 10 hp larger.
   b. Bi-metal disk or rod type thermostats embedded in stator windings.
   c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Provide manual reset at motor controller.)
   d. Leads extending to separate terminal box for motors 100 hp and larger.

C. Space Heaters:

1. Provide winding space heaters with leads wired out to motor terminal box.
2. Provide extra hole or hub on motor terminal box as required.
3. Unless shown otherwise, heater shall be suitable for 120V ac supply, with wattage suitable for motor frame size.]

D. Nameplates:

1. Raised or stamped letters on stainless steel or aluminum.
2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

E. Anchor Bolts: Provide meeting manufacturer’s recommendations and of sufficient size and number for specified seismic condition.

2.16 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Chemical Industry, Severe-Duty (CISD-TEFC):

1. In accordance with IEEE 841.
2. TEFC in accordance with NEMA MG 1.
3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.

4. Motor Frame, End Shields, Terminal Box, and Fan Cover: Cast iron.
5. Ventilating Fan: Corrosion-resistant, nonsparking, external.
6. Drain and Breather Fittings: Stainless steel.
7. Nameplate: Stainless steel.
8. Gaskets between terminal box halves and terminal box and motor frame.
9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
10. Double shielded bearings.
11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
12. External Finish: Double-coated epoxy enamel.
13. Coated rotor and stator air gap surfaces.
14. Insulation System, Windings, and Connections:
    a. Class F insulation, Class B rise or better at 1.0 service factor.
    b. Multiple dips and bakes of nonhygroscopic polyester varnish.
15. Service Factor:
    a. At 40 Degrees C Ambient: 1.15.
    b. At 65 Degrees C Ambient: 1.00.
16. Safe Stall Time Without Injurious Heating: 20 seconds minimum.

C. Severe-duty Explosion-proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

D. Severe-duty, Dust-ignition-proof: Meet requirements for DIP enclosures and CISD-TEFC motors.

E. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in motor-driven equipment specification.

F. Inverter Duty Motor:

1. Motor supplied power by adjustable voltage and adjustable frequency drives shall be inverter duty rated.
2. Suitable for operation over entire speed range indicated.
3. Provide forced ventilation where speed ratio is greater than published range for motor provided.
4. When installed in Division 1 hazardous (classified) location shall be identified as acceptable for variable speed when used in Division 1 location.

G. Submersible Pump Motor:

1. Manufacturers:
    a. Reliance Electric.
    b. ITT Flygt Corp.

2. At 100 Percent Load:

Submersible Pump Motors		
Horsepower	**Guaranteed Minimum Efficiency**	**Guaranteed Minimum Power Factor**
5 through 10	80	82
10.1 through 50	85	82
50.1 through 100	87	82
Over 100	89	82

3. Insulation System: Manufacturer's standard Class B or Class F.
4. Motor capable of running dry continuously.
5. Enclosure:
   a. Hermetically sealed, watertight, for continuous submergence up to 65-foot depth.
   b. Listed to meet UL 674 and NFPA 70 requirements for Class I, Division 1, Group D hazardous atmosphere.
   c. Seals: Tandem mechanical.
6. Bearing and Lubrication:
   a. Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.
   b. Minimum 15,000 hours L-10 bearing life.
7. Inrush kVA/horsepower no greater than NEMA MG 1 and NFPA 70, Code F.
8. Winding Thermal Protection:
   a. Thermal sensor and switch assembly, one each phase, embedded in stator windings and wired in series.
   b. Switches normally closed, open upon excessive winding temperature, and automatically reclose when temperature has cooled to safe operating level.
   c. Switch contacts rated at 5 amps, 120V ac.
9. Motor Seal Failure Moisture Detection:
   a. Probes or sensors to detect moisture beyond seals.
   b. Probe or sensor monitoring module for mounting in motor controller, suitable for operation from 120V ac supply.
   c. Monitoring module with control power transformer, probe test switch and test light, and two independent 120V ac contacts, one opening and one closing when flux of moisture is detected.

10. Bearing Overtemperature Protection for Motors Larger than 100 hp:
    a. Sensor on lower bearing housing monitoring bearing temperature.
    b. Any monitoring relay necessary to provide 120V ac contact opening on bearing overtemperature.
11. Winding thermal protection, moisture detection, and bearing overtemperature specified above may be monitored by single device providing two independent 120V ac contacts, one closing and one opening on malfunction.
12. Connecting Cables:
    a. One cable containing power, control, and grounding conductors or two separate cables, one containing power and grounding conductors, and the other containing control and grounding conductors.
    b. Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.
    c. Length: 30 feet minimum.
    d. UL 83 listed and sized in accordance with NFPA 70.

H. Inclined Motors:

1. Motors suitable for operation only in horizontal position not acceptable.
2. Bearings designed for thrust imposed by driven equipment and by motor rotor when motor is in inclined position.
3. Lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.

2.17 FACTORY TESTING

A. Tests:

1. In accordance with IEEE 112 for polyphase motors.
2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
    a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59. and Paragraph 12.60.
    b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
    c. On motors of 100 hp and smaller, furnish certified copy of motor efficiency test report on an identical motor.

B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.
2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1.
3. Efficiency and power factor by Test Method F, IEEE 112, Forms F-1, F-2, and F-3.
4. Temperature Test: IEEE 112, Form A-2.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed), for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 100 hp.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Two-winding transformers.

B. Related Requirements:

1. Section 03 30 00, Cast-In-Place Concrete: Housekeeping pads.
2. Section 26 05 26, Grounding and Bonding for Electrical Systems.
3. Section 26 05 33, Raceway and Boxes for Electrical Systems.

1.02 REFERENCE STANDARDS

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

1. National Electrical Manufacturers Association:
   a. NEMA ST 1, Specialty Transformers (Except General Purpose Type).
   b. NEMA ST 20, Dry Type Transformers for General Applications.
2. International Electrical Testing Association: NETA ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.03 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed): Submittal procedures.

B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

C. Test and Evaluation Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

D. Source Quality Control Submittals: Indicate results of factory tests and inspections.

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

1.04 CLOSEOUT SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Closeout procedures.

B. Record Documentation: Record actual locations of transformers.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 3 years' experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00, Product Requirements (to be completed): Product storage and handling requirements.

B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 TWO-WINDING TRANSFORMERS

A. Manufacturer List:

1. Cutler-Hammer.
2. General Electrical.
3. Jefferson.
4. ACME.
5. Square D.
6. Or equivalent.

B. Substitution Limitations:

1. Section 01 60 00, Product Requirements (to be completed): Requirements for substitutions for other manufacturers and products.

C. Description: NEMA ST 20, factory-assembled, air-cooled, dry type transformers, ratings as indicated on Drawings.

D. Operation:

1. Primary Voltage: As shown on Drawings.
2. Secondary Voltage: As shown on Drawings.
3. Insulation system and average winding temperature rise for rated kVA as follows:
   a. 1-15 kVA: Class 185 with 115 degrees C rise.
   b. 16-500 kVA: Class 220 with 115 degrees C rise.
4. Case Temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.
5. Winding Taps:
   a. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
   b. Transformers 15 kVA and Larger: NEMA ST 20.
   c. Sound Levels: NEMA ST 20.
6. Mounting:
   a. 1-15 kVA: Suitable for wall mounting.
   b. 16-75 kVA: Suitable for floor mounting, in accordance with Manufacturer instructions.
   c. Larger than 75 kVA: Suitable for floor mounting.

E. Materials:

1. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.
2. Coil Conductors: Continuous copper windings with terminations brazed or welded.
3. Enclosure: Type 1 or Type 3R based on Drawings. Furnish lifting eyes or brackets.

F. Fabrication:

1. Isolate core and coil from enclosure using vibration-absorbing mounts.
2. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.02 SHIELDED TRANSFORMERS

A. Manufacturer List:

1. Cutler-Hammer.

2. General Electrical.
3. Jefferson.
4. ACME.
5. Square D.
6. Or equivalent.

B. Substitution Limitations:

1. Section 01 60 00, Product Requirements (to be completed): Requirements for substitutions for other manufacturers and products.

C. Description: NEMA ST 20, factory-assembled, air-cooled, dry type shielded isolation transformers, ratings as indicated on Drawings.

2.03 SOURCE QUALITY CONTROL

A. Section 01 40 00, Quality Requirements (to be completed): Testing, inspection and analysis requirements.

B. Production test each unit according to NEMA ST20.

PART 3 EXECUTION

3.01 EXAMINATION

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for installation examination.

B. Verify mounting supports are properly sized and located including concealed bracing in walls.

3.02 PREPARATION

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for installation preparation.

B. Provide concrete pads under provisions of Section 03 30 00, Cast-in-Place Concrete.

3.03 DEMOLITION

A. Disconnect and remove abandoned transformers.

B. Maintain access and adequate ventilation to existing transformers and other installations remaining active and requiring access and ventilation. Modify installation or provide access panel or ventilation grilles.

3.04 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, in accordance with Section 26 05 33, Raceway and Boxes for Electrical Systems, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Transformer Support:

1. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer.
2. Mount floor-mounted transformers on vibration isolating pads suitable for isolating transformer noise from building structure.
3. Mount trapeze-mounted transformers as indicated on Drawings.

D. Provide seismic restraints.

E. Install grounding and bonding in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems.

3.05 FIELD QUALITY CONTROL

A. Section 01 40 00, Quality Requirements (to be completed): Requirements for inspecting and testing.

B. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for testing, adjusting, and balancing.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.06 ADJUSTING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Testing, adjusting, and balancing.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

3.07 CLEANING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for cleaning.

B. Clean existing transformers to remain or to be reinstalled.

END OF SECTION

SECTION 26 23 00
LOW-VOLTAGE SWITCHGEAR

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI): C37.50, Switchgear—Low-Voltage AC Power Circuit Breakers Used in Enclosures—Test Procedures.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
   b. C37.16, Standard for Preferred Ratings, Related Requirements, and Application Recommendation for Low-Voltage AC (635V and below) and DC (3200V and below) Power Circuit Breakers.
   c. C37.20.1, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
   d. C37.20.3, Standard for Metal Enclosed Interrupter Switchgear.
   e. C37.100, Standard Definitions for Power Switchgear.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL):
   a. 489, Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   b. 1558, Standard for Safety for Metal-Enclosed, Low-Voltage Power Circuit Breaker Switchgear.

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive product information.
2. Itemized Bill of Material.
3. Dimensional drawings.
4. Operational description.
5. Anchoring instructions and details.
6. One-line, three-line, and control schematic drawings.
7. Connection and interconnection drawings.

8. Circuit Breakers: Copies of time-current characteristics.
9. Ground Fault Protection: Time-current characteristics.
10. Bus data.
11. Incoming line section equipment data.
12. Transformer section equipment data.
13. Conduit entrance locations.
14. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing (to be completed).

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing (to be completed).
2. Manufacturer's installation instructions.
3. Factory Test Report.
4. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing (to be completed).
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

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

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

1. Power and Control Fuses: One complete set.
2. Indicating Lights: One complete set.
3. Paint: One pint, to match enclosure exterior finish in color and quality.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. General Electric.
2. Westinghouse.
3. Siemens.
4. Square D.

2.02 GENERAL REQUIREMENTS

A. Service: 480Y/277 volts, three-phase, four-wire, solid grounded wye, having an available short circuit current at line terminals as shown.

B. Designed and assembled in accordance with IEEE C37.20.3, IEEE C37.100, ANSI C37.50, and UL 1558.

C. Switchgear and its major components shall be end products of one manufacturer in order to achieve standardization for appearance, operation and maintenance, spare parts replacement, and manufacturer's services.

D. Operating Conditions:

1. Ambient Temperature: Maximum 50 degrees C.
2. Equipment shall be fully rated without derating for operating conditions.

E. Lifting lugs on equipment and devices weighing over 100 pounds.

F. Anchor Bolts: Type 316 stainless steel, 5/8-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

2.03 STATIONARY STRUCTURE

A. Type: ANSI C37.50 switchgear construction, consisting of breaker sections, transition sections, and auxiliary sections assembled to form a rigid, self-supporting, metal enclosed front access only structure.

B. Material: 12-gauge minimum cold-rolled steel, formed with reinforced steel members.

C. Grounded metal barriers between each breaker, main bus, branch cabling, and instrumentation/control.

D. Modular-designed steel frame with removable plates and individual, bolted, steel-framed vertical sections.

E. Individual, hinged doors over each breaker, metering, and auxiliary compartments.

F. Cable Installation and Termination Compartments:

1. Front accessible hinged doors, capable of being bolted closed.
2. Cable bending space in accordance with NFPA 70.
3. Cable supports in each vertical section.

G. Breaker Compartments:

1. Individual, grounded compartments, with:
   a. Sheet steel, top, bottom, sides, and compartment door with padlocking features.
   b. Flame-retardant, arc track-resistant nonmetallic rear barrier.
   c. Drawout rails, stationary breaker contacts, interlocks, and necessary control and indicating devices.
   d. Shutters over stationary contacts when breaker is in TEST or DISCONNECT position.
   e. Padlocking provision on rackout rails for locking breaker in TEST or DISCONNECT position.
2. Drawout Mechanism:
   a. Shall retain removable element in connected position.
   b. Mechanical interlocks to ensure breaker is open before moved from a position, or when between positions.
   c. Four Distinct Breaker Positions: CONNECTED, TEST, DISCONNECTED, and WITHDRAW.
   d. Indicators to display breaker position.
   e. Capable of being operated without opening breaker door.
3. Breaker frame grounded to steel frame throughout travel of drawout mechanism.
4. Each compartment designed for specific breaker frame size.
5. Future breaker compartments fully equipped with electrical connections, bolted metal barrier across compartment face, and compartment door.

H. Slide-Out Instrument Tray:

1. Mount above associated breaker.
2. Accessible from front of switchgear.
3. For control circuitry, power monitor, and associated devices.

2.04 ENCLOSURE

A. Finish: Baked enamel applied over rust-inhibiting phosphated base coating.

1. Color:
   a. Exterior: Provide gray finish.
   b. Interior: White.
   c. Unpainted Parts: Plated for corrosion resistance.

B. Aisle-less Outdoor Enclosure:

1. NEMA 250, Type 3R, enclosing NEMA 250, Type 1 enclosed switchgear.
2. Hinged, full-height doors with three-point latch operated by vault type handle with multiple padlocking provisions for each front switchgear section.
3. Minimum 10-inch front access space between exterior door and front of interior switchgear doors.
4. Gasketed doors, end panels, and sloped roof having 4-inch minimum overhang on all sides.
5. Support assembly on two 6-inch-high I-beams running parallel to switchgear length.
6. Steel bottom enclosure and support assembly undercoated with coal tar emulsion.
7. Ventilating louvers with filters in front door and rear panels.
8. Space Heaters: Thermostatically controlled 250-watt, 120-volt, in each switchgear vertical section.
9. Adjustable thermostat for temperature range of 50 degrees F to 70 degrees F.

2.05 BUSWORK

A. Material: Phase noninsulated copper of sufficient cross section to limit temperature rise at rated current to 55 degrees C.

B. Bus Arrangement: A-B-C, left-to-right, top-to-bottom, and front-to-rear, as viewed from front.

C. Brace for short circuit currents as shown.

D. Main Horizontal Bus: Nontapered, continuous current rating as shown.

E. Neutral Bus: Continuous current rating as shown.

F. Ground Bus:

1. Material: Copper.
2. Rating: As shown.
3. Bolted to each vertical section.
4. Ground lug for 4/0 copper conductors on each end of bus.
5. Bus Connections and Joints: Bolted with Belleville washers.

2.06 PROTECTIVE DEVICES

A. Power Air Circuit Breakers:

1. Main and feeder breakers in accordance with IEEE C37.13 and IEEE C37.16.
2. Arrangement: Fully rated main and branch feeder circuit breakers.
3. Three-pole electrically and mechanically trip-free with:
   a. Self-aligning primary and secondary contacts.
   b. Integral, solid state, over-current trip programmer.
   c. Arc quenchers.
   d. Closing Mechanism: Manual and electric as shown.
   e. Stored energy mechanism with maximum five-cycle closing.
   f. Solid state trip device.
4. Individually mounted, drawout breaker listed for 100 percent continuous ampere rating.
5. Interrupting Rating: 100,000 amperes rms symmetrical at 480 volts.

B. Mechanical Operation:

1. Front mounted, spring charging handle.
2. Mechanical closing escutcheon mounted pushbutton.
3. Mechanical trip, escutcheon mounted, trip pushbutton handle.

C. Electrical Operation:

1. Motor or solenoid automatic charging, plus manual charging.
2. Electrically closing, escutcheon mounted pushbutton with mechanical closing upon loss of control power.
3. Electrical trip, escutcheon mounted, trip pushbutton.
4. Control Power Voltage: 120V ac.

D. Color-Coded Visual Indicators: Contacts OPEN and CLOSED, plus mechanism CHARGED and DISCHARGED.

E. Accessories:

1. Slow breaker closing handle for contact adjustments.
2. Breaker lifting hoist and travel rail on top of switchgear.
3. Auxiliary a/b contacts on main and feeder breakers.

F. Solid State Trip Units: Flux-shift trip and current sensors.

1. Protective Programmers:
   a. Self-powered, automatic rms sensing micro-electronic processor.
   b. No external relays or accessories.
   c. Printed circuit cards with gold-plated contacts.
   d. Programmable Controls:
      1) Fixed-point, with repetitive accuracy and precise unit settings.
      2) Trip adjustments made by nonremovable, discrete step switching.
   e. Field-Installable Rating Plugs:
      1) Long-time pickup LED indicator and test receptacle.
      2) Matching load and cable requirements.
      3) Interlocked with tripping mechanism.
      4) Breaker to remain trip-free with plug removed.
      5) Keyed rating plugs to prevent incorrect application.
   f. Long-time pickup light.
   g. Selective coordination time/current curve shaping adjustable functions:
      1) Current setting.
      2) Long-time pickup.
      3) Long-time delay.
      4) Instantaneous pickup with short-time delay.
      5) Short-time pickup.
      6) Short-time delay with I2T function, and IN-OUT switch.
      7) Ground fault pickup.
      8) Ground fault delay with I2T function.
   h. Fault Trip Indicators: Mechanical push-to-reset.
2. Phase Current Sensors:
   a. Fixed, mounted on breaker frame.
   b. Molded epoxy construction.
   c. One toroidal type for each phase.

2.07 CONTROL WIRING

A. NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts for control, instrumentation, and power/current circuits.

B. Shielded cable rated 600 volts for transducer output and analog circuits.

C. Enclosed in top and vertical steel wiring troughs, and front-to-rear in nonmetallic wiring troughs.

D. Conductor Lugs: Preinsulated, self-locking, spade type, with reinforced sleeves.

E. Identification: Individually, with permanent wire markers at each end.

F. Splices: Not permitted in switchgear wiring.

2.08 TERMINAL BLOCKS

A. Enclosed in steel wiring troughs.

B. Rated 600 volts, 30 amperes minimum, one-piece barrier type with strap screws.

C. Shorting type for current transformer leads.

D. Provide terminal blocks for:

1. Conductors connecting to circuits external to switchgear.
2. Auxiliary contacts from circuit breaker position.
3. Internal circuits crossing shipping splits.
4. Equipment parts requiring replacement and maintenance.

E. Spare Terminals: Not less than 20 percent.

F. Group terminal blocks for external circuit wiring leads.

G. Maintain 6-inch minimum space between columns of terminal blocks.

H. Identification: Permanent, for each terminal and columns of terminals blocks.

2.09 TEST FACILITIES

A. Breakers with integral external test points for portable test kit.

B. Handheld test kit for functional testing of trip circuitry of each breaker.

2.10 INSTRUMENTATION AND METERING

A. As specified in Section 26 09 13, Power Measurement and Control.

2.11 EQUIPMENT IDENTIFICATION

A. Master Nameplate:

1. Deep-etched aluminum with manufacturer's name and model number.
2. Riveted to main vertical section.

B. Section Identification:

1. Engraved metallic, riveted to each vertical section.
2. Serial number, bus rating, and section reference number.
3. Size: Manufacturer's standard.

C. Nameplate:

1. Engraved, acrylic for each circuit breaker cubicle and door-mounted device.
2. Black with white block type characters.
3. Character Height: 3/16-inch.
4. Size: Manufacturer's standard.
5. Inscriptions: As shown on one-line diagram.
6. Blank plates for future spaces.
7. Attachment Screws: Self-tapping stainless steel.

D. Cubicle Labels:

1. Nonmetallic, applied inside each cubicle compartment.
2. Device serial number, rating, and description.
3. Size: As required.

E. Switchgear Signs:

1. Two signs each on front and back of switchgear.
2. Size: Manufacturer's standard.
3. Engraved, acrylic.
4. Color: Red with white.
5. Inscription: DANGER/HIGH VOLTAGE/KEEP OUT.

6. Characters: Gothic type, 1 inch high.
7. Attachment: Four rivets each sign.

2.12 KEY INTERLOCKS

A. Mechanical lock cylinder, located in main and generator breaker compartments as shown on Drawings.

B. Keys to be captive when breakers are closed.

2.13 FACTORY TESTING

A. In accordance with IEEE C37.20.1.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Secure equipment to mounting pads with anchor bolts.

C. Install equipment plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Distribution and branch circuit panelboards.
2. Electronic grade branch circuit panelboards.
3. Load centers.

B. Related Requirements: Section 26 05 26, Grounding and Bonding for Electrical Systems.

1.02 REFERENCE STANDARDS

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

1. Institute of Electrical and Electronics Engineers: IEEE C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. National Electrical Manufacturers Association:
   a. FU 1, Low Voltage Cartridge Fuses.
   b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
   c. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   d. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   e. PB 1, Panelboards.
   f. PB 1.1, General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
3. International Electrical Testing Association: NETA ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
4. National Fire Protection Association: NFPA 70, National Electrical Code.
5. Underwriters Laboratories Inc.:
   a. 50, Cabinets and Boxes
   b. 67, Safety for Panelboards.

c. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
d. 1283, Electromagnetic Interference Filters.
e. 1449, Transient Voltage Surge Suppressors.
f. 1699, Arc-Fault Circuit Interrupters.

1.03 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed): Requirements for submittals.

B. Product Data: Submit catalog data showing specified features of standard products.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

D. Source Quality control submittals: Indicate results of shop and factory tests and inspections.

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

1.04 CLOSEOUT SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for submittals.

B. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

C. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for maintenance products.

B. Extra Stock Materials: Furnish two of each panelboard key. Panelboards keyed alike.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 DISTRIBUTION PANELBOARDS

A. Manufacturer List:

1. Cutler-Hammer.
2. General Electric.
3. Schneider Electric.
4. Siemens.

B. Substitution Limitations: Section 01 60 00, Product Requirements (to be completed): Requirements for substitutions for other manufacturers and products.

C. Description: NEMA PB 1, circuit breaker type panelboard.

D. Operation:

1. Service Conditions:
   a. Temperature: 0 to 130 degrees F.
   b. Altitude: 475 feet above sea level.
2. Minimum integrated short circuit rating: 22,000 amperes rms symmetrical for 240 or 208 volt panelboards; 65,000 amperes rms symmetrical for 480 volt panelboards, or as indicated on Drawings.

E. Materials:

1. Panelboard Bus: Copper, current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.
2. Molded Case Circuit Breakers: UL 489, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
3. Circuit Breaker Accessories: Trip units, padlock hasps, and auxiliary switches as indicated on Drawings.

4. Surge Suppressers: Integrated into panelboard per specifications herein.
5. Enclosure: NEMA PB 1, Type or 201or 3R20 inches deep,6 inches wide, cabinet box.
6. Cabinet Front: Surface type, fastened hinged door with flush lock.

F. Finishes: Manufacturer's standard gray for indoor or custom sand or beige color for outdoor equipment baked spray enamel as shown on Drawings.

2.02 SURGE SUPPRESSION

A. Description:

1. Integral Surge Suppresser: Component recognized in accordance with UL 1449 and UL 1283.
2. Panelboard: UL 67 listed and TVSS device UL 1449 Component Recognized. TVSS device meets UL 1449. Furnish panelboard markings with clamp voltage at TVSS terminals and clamp voltage at panelboard line terminals.

B. Performance:

1. Integral Surge Suppressers:
   a. Meet or exceed the following criteria:
      1) Maximum single impulse current rating not less than 120 kA for each phase.
      2) Pulse Lift Test: Capable of protecting against and surviving 5000 IEEE C62.41 Category C transients without failure or degradation.
      3) Clamping voltage not exceeding the following:

Voltage	L-N	N-G	L-G
208Y/120	500 V	500 V	500 V
480Y/277	1000 V	1000 V	1000 V

C. Fabrication:

1. Integral Surge Suppresser:
   a. Furnish copper bus bars for surge current path.
   b. Construct using surge current modules (MOV based). Each module fused with user replaceable 200,000 AIR rated fuses. Status of each module monitored on front cover of panelboard enclosure and on module.

c. Furnish with audible alarm activated when one of surge current modules has failed. Furnish alarm on/off to silence alarm and alarm push-to-test switch to test alarm. Locate switches and alarm on front cover of panelboard enclosure.
d. Furnish response time no greater than five nanoseconds for individual protection modes.
e. Designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.
f. Furnish visible indication of proper suppresser connection and operation. Lights indicate operable phase and module.
g. Furnish minimum EFI/RFI filtering of 34 dB at 100 kHz with insertion loss ratio of 50: 1 using Mil Std. 220A methodology.

2. Panelboards
a. Top or bottom feed as indicated on Drawings. Furnish circuit directory inside door.
b. Construct box of galvanized steel. Box size as indicated on Drawings.
c. Main bus constructed of copper and rated for load current.
d. Furnish interior with branch circuit breakers. Furnish one 60amp circuit breaker, with appropriate number of poles, as dedicated disconnect for SPD.
e. Furnish standard rated neutral assembly with copper neutral bus.
f. Furnish with insulated ground bus and safety ground bus.
g. Furnish wiring gutters in accordance with NEC.
h. Field connections to panelboard: main breaker type.
i. Construct with surface mounted trim and NEMA Type 1or 3R enclosure, as shown on Drawings.
j. Furnish with branch breaker positions and nominal current rating as indicated on Drawings.

2.03 SOURCE QUALITY CONTROL

A. Section 01 40 00, Quality Requirements (to be completed): Testing, inspection and analysis requirements.

B. Independently test integral surge suppressers with category C3 high exposure waveform (20 kV-1.2/50us, 10kA-8/20 us) per IEEE C62.41.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panelboards and load centers in accordance with NEMA PB 1.1.

B. Install panelboards and load centers plumb.

C. Height: 6 feet to top of panelboard and load center; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

D. Install filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard and load center. Revise directory to reflect circuiting changes to balance phase loads. Identify each circuit as to its clear, evident and specific purpose of use.

F. Install engraved plastic nameplates in accordance with Section 26 05 02, Basic Electrical Requirements.

G. Ground and bond panelboard enclosure according to Section 26 05 26, Grounding and Bonding for Electrical Systems. Connect equipment ground bars of panels in accordance with NFPA 70.

3.02 FIELD QUALITY CONTROL

A. Section 01 40 00, Quality Requirements (to be completed): Requirements for inspecting, testing.

B. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for testing, adjusting, and balancing.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

E. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

F. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

3.03 CLEANING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for cleaning.

END OF SECTION

SECTION 26 24 19
MOTOR-CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Motor control centers.

B. Related Requirements: Section 26 05 26, Grounding and Bonding for Electrical Systems.

1.02 REFERENCE STANDARDS

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

1. Institute of Electrical and Electronics Engineers: IEEE C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. National Electrical Manufacturers Association:
   a. FU 1, Low Voltage Cartridge Fuses.
   b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
   c. ICS 2.3, Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers.
   d. ICS 3, Industrial Control and Systems: Factory Built Assemblies.
   e. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   f. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   g. ICS 7, Industrial Control and Systems: Adjustable Speed Drives.
   h. ICS 7.1, Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.
3. International Electrical Testing Association: NETA ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
4. Underwriters Laboratories Inc.:
   a. 198E, Class R Fuses.
   b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

c. 508, Industrial Control Panels.
d. 845, Motor Control Centers.

1.03 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed): Submittal procedures.

B. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time and current curves of equipment and components.

D. Test and Evaluation Reports: Indicate field test and inspection procedures and test results.

E. Source Quality Control Submittals: Indicate results of shop and factory tests and inspections.

F. Field Quality Control Submittals: Indicated results of Contractor furnished tests and inspections.

1.04 CLOSEOUT SUBMITTALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Closeout procedures.

B. Operation and Maintenance Data: Submit replacement parts list for controllers.

C. Project Record Documents: Record actual locations, configurations, and ratings of motor control centers and major components.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 3 years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00, Product Requirements (to be completed): Product storage and handling requirements.

B. Deliver in 60-inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.

C. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with NEMA ICS 2.3. Lift only with lugs provided. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.07 AMBIENT CONDITIONS

A. Section 01 50 00, Temporary Facilities and Controls (to be completed): Ambient conditions control facilities for product storage and installation.

B. Conform to NEMA ICS 2 service conditions during and after installation of motor control centers.

1.08 EXISTING CONDITIONS

A. Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.01 MOTOR CONTROL CENTER

A. Manufacturer List:

1. Allen-Bradley.
2. Cutler-Hammer.
3. General Electric Company.
4. Square D.
5. Siemens Energy & Automation, Inc.

2.02 GENERAL

A. Like Items of Equipment: End product of one manufacturer.

B. Make adjustments necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.

C. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.

D. Control Transformer:

1. Two winding, 120-volt secondary, primary voltage to suit.
2. Two current-limiting fuses for primary circuit.
3. One fuse in secondary circuit.
4. Mount within starter unit.

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

F. Lifting lugs on equipment and devices weighing over 100 pounds.

G. Anchor Bolts: As specified in Section 05 50 00, Metal Fabrications, and as shown on the Schedule of Electrical and Mechanical Materials for Corrosion Control, located in the General Section of the Drawings.

H. Seismic Zone and Importance Factor shall be as specified in Section 01 61 00, Common Product Requirements (to be completed).

I. Operating Conditions:

1. Ambient Temperature: Maximum 45 degrees C.
2. Altitude: 30 feet above sea level.
3. Equipment to be fully rated.

J. Enclosures: In accordance with NEMA 250.

K. Equipment Finish:

1. Electrocoating process applied over rust-inhibiting phosphated base coating.
2. Exterior Color: Manufacturer’s standard.

2.03 MOTOR CONTROL CENTERS

A. General:

1. In accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 18, and UL 845.

2. Provided Service Entrance Rated where shown on Drawings.
3. Voltage Rating: 600 volts.
4. Short Circuit Rating: Amperes rms symmetrical at 480 volts for entire motor control center as a complete assembly, as shown on Drawings.
5. Main and branch circuit breakers, controllers, wire connections, and other devices to be front mounted and accessible, unless otherwise noted.
6. NEMA ICS 18, Part 3.
   a. Class IIS.
   b. Type B.

B. Enclosure:

1. Type: NEMA 250 Type 1, indoor.
2. Vertical Section Standard Indoor Dimensions for NEMA 1 Type:
   a. Nominal, 90 inches high, 20 inches wide, 21 inches deep.
   b. Alternative width dimensions of 24 inches, 30 inches, or larger are acceptable for oversize devices or panels as shown on Drawings.
   c. Do not exceed space shown without notifying Engineer.
3. Construction:
   a. Sheet steel reinforced with channel or angle irons.
   b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
   c. Removable top cover plates and bottom cover plates.
   d. Removable plates on end panels for future bus extension.
4. Section Mounting: Removable formed-steel channel sills and lifting angles to meet specified seismic requirements.
5. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.
6. Vertical Wiring Compartment:
   a. Full height, isolated from unit starters with separate hinged door and tie supports.
   b. No terminal blocks allowed in vertical wireway compartment.
7. Terminal board compartment at unit space indicated with 10 percent spare terminals.
8. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.
9. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
10. Door Interlocking: Mechanically interlock starter and feeder doors so doors cannot be opened with unit energized. Provide defeater

mechanism to allow intentional access and energizing at any time by qualified individual.

11. External disconnect handles with ON/OFF and trip positions showing, padlockable in OFF position with up to three-lock capability.
12. Cable Entrance: Main leads enter from top and bottom control and feeder circuits enter from top and bottom.

C. Bus:

1. Horizontal Power Bus:
   a. Three-phase copper, entire width of control center, rated as shown.
   b. Tin or silver-plated at joints.
   c. Construct to allow future extension of additional sections.
   d. Pressure type solderless lugs for each incoming line cable.
   e. Isolated from top horizontal wireway.
   f. Provide Belleville washers on bus connection bolts.
2. Vertical Power Bus:
   a. Three-phase copper, full height of section, rated 600 amperes.
   b. Tin-plated at joints.
   c. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.
   d. Insulated and isolated barrier, complete with shutters.
   e. Provide Belleville washers on bus connection bolts.
3. Neutral Bus: None.
4. Ground Bus:
   a. Copper, bare 600 amperes, entire width of control center and in each vertical wireway.
   b. Provide Belleville washers on bus connection bolts.
5. Bus Bracing: Amperes rms symmetrical as shown on Drawings.

D. Motor Controller Unit:

1. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Construction:
   a. Drawout combination type with stab connections for starters NEMA ICS, Size 5 and smaller.
   b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 6 and larger.
   c. Readily interchangeable with starters of similar size.

d. Pull-apart unit control wiring terminal boards capable of accepting up to 2#14 AWG wires minimum on all units.

3. Starters:
   a. NEMA ICS 18, standard rating, except none smaller than NEMA ICS, Size 1.
   b. Rating: Horsepower rated at 600-volt, UL labeled for 65,000 amperes at 480 volts short circuit capacity with overload protection.
   c. Three-phase, nonreversing, unless specified otherwise.
   d. Disconnect Type: Circuit breaker.
   e. Combination Full Voltage, Magnetic Starter:
      1) Control: As shown on Drawings.
   f. Combination Reduced Voltage, Solid State Starter:
      1) Control: As shown on Drawings.
      2) Bypass contactor.
      3) Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
      4) Kick start, with adjustable torque and time settings.
      5) Ramp start, selectable current or torque, and adjustable time.
      6) Smooth stop ramp, adjustable time.
      7) Phase loss unbalance and phase reversal protection.
      8) LED display or LCD of fault, N.O. contact to communicate fault condition.
   g. Combination Two-Speed Motor Magnetic Starter:
      1) Control: As shown on Drawings.
   h. Combination Adjustable Frequency Drive, Solid State Starter: Drives as specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
   i. Padlockable operating handle when de-energized with up to threelock capability.
   j. Unit door interlocked to prevent opening when disconnect is in closed position.
   k. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.
   l. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

4. Disconnecting Device:
   a. In each starter, control circuit disconnect to de-energize circuits in unit which are not de-energized by starter power disconnect device.
   b. Padlockable in OPEN position for up to three locks.
      1) Disconnecting Device: Pull-apart terminal blocks capable of de-energizing external source control circuits in unit.

2) Control Devices: As indicated and as specified in Section 26 05 04, Basic Electrical Materials and Methods.
3) Control Wiring:
   a) Copper, 14 AWG, minimum.
   b) Permanent sleeve type markers with wire numbers applied to each end of wires.
   c) Terminate wires using insulated locking fork or ring type crimp terminals.
   d) Terminate current transformer leads on shorting type terminal blocks.

E. Incoming Line Terminal:

1. Construction: As specified in Paragraph Motor Controller Unit.
2. Incoming Service Feeder: Cable.

F. Main Protective Device and Feeder Unit:

1. Construction: As specified in Paragraph Motor Controller Unit.
2. Incoming Service Feeder: Cable.
3. Phase Monitoring Relay:
   a. Three-phase monitoring relay to protect against low voltage, voltage unbalance, and phase reversal.
   b. Manufacturer and Product: Schneider Electric/Square D; Class 8430 Type MPS or Class 8430 Type MPD.
   c. SPD: As specified in Section 26 43 00, Surge Protective Device.

G. Transformers: As specified in Section 26 22 00, Low-Voltage Transformers.

H. Panelboards: As specified in Section 26 24 16, Panelboards.

I. Pushbuttons, Indicating Lights, Selector Switches, Elapsed Time Meters, Control Relays, Time-Delay Relays, and Reset Timers: As specified in Section 26 05 04, Basic Electrical Materials and Methods.

J. Nameplates:

1. Laminated plastic; white, engraved to black core.
2. Provide for each motor control center and each unit.
3. Engrave with inscription shown on single-line diagram.
4. Provide blank nameplates on spaces for future units.
5. Attach with stainless steel panhead screws on face of control center.

2.04 FULL-VOLTAGE NON-REVERSING CONTROLLERS

A. Manufacturer List:

1. Allen Bradley.
2. Cutler-Hammer.
3. General Electric.
4. Square D.
5. Siemens Energy & Automation, Inc.

B. Substitution Limitations: Section 01 60 00, Product Requirements (to be completed): Requirements for substitutions for other manufacturers and products.

C. Description: NEMA ICS 2, AC general-purpose Class A magnetic or solid-state controller for induction motors rated in horsepower as shown on Drawings.

D. Operation: Control Voltage: 120volts, 60 Hertz.

E. Materials:

1. Overload Relay: NEMA ICS 2; bimetal or melting alloy.
2. Product Options and Features:
   a. Auxiliary Contacts: NEMA ICS 2, normally open and normally closed contacts in addition to seal-in contact.
   b. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oil tight type.
   c. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
   d. Pushbuttons: Covered type.
   e. Indicating Lights: LED type.
   f. Selector Switches: Rotary type.
   g. Relays: NEMA ICS 5.
   h. Control Power Transformers: 120-volt secondary, 250VA minimum, in each motor controller or as scheduled. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

2.05 SOLID STATE REDUCED VOLTAGE MOTOR CONTROLLERS

A. Manufacturer List:

1. Allen-Bradley.
2. Cutler Hammer.

3. General Electric.
4. Square D.
5. Siemens Energy & Automation, Inc.

B. Substitution Limitations:

1. Section 01 60 00, Common Product Requirements (to be completed): Requirements for substitutions for other manufacturers and products.

C. Solid State Reduced Voltage Motor Controllers: UL 508; integrated, modular unit consisting of power SCRs, microprocessor controls, digital display, programming keypad, output auxiliary contacts, and external communications ports.

1. Rating: Severe duty nonreversible.
2. Power Structure: Modular design for easy replacement, with built in overload protection, integral heat sinks, and two SCRs for each phase.
3. Control Structure: Digital microprocessor to control and supervise operation of motor controller with self tuning power supply, logic control circuitry, SCR firing circuitry.
4. Overload Protection: Three-phase current sensing acting as motor thermal protective device, selectable trip class.

D. Operation:

1. Starting: Voltage ramping, current limiting with torque ramping, and torque control with voltage boost.
2. Stopping: Coast to stop.
3. Provide integral SCR bypass for full voltage operation without separate bypass contactor.

E. Digital Display: Manufacturer's standard front mounted, LED type, indicating status of motor, controller, and fault conditions.

1. Motor Indications: Three-phase current, three-phase voltage, power, power usage, power factor, thermal capacity, and elapsed time.
2. Controller Indications: Ready, starting, running, and stopping.
3. Fault Indications: Line fault, shorted SCR, power loss, over temperature, under load, overload, under voltage, over voltage, excessive starts, phase reversal, and jam.

F. Programming Keypad: Manufacturer's standard front mounted for setting and adjusting the following controller functions.

1. Full load amperes.
2. Starting current limits.
3. Acceleration ramp.
4. Initial torque.
5. Voltage boost.
6. Starting mode.
7. Starting time.
8. Stopping mode.
9. Thermal overload trip class.

G. Output Auxiliary Contacts: Provide contacts to signal the following operating conditions.

1. Normal.
2. Up to speed.
3. Bypass.
4. Alarm.

H. Controller Remote Communications:

1. Port: RS232 and Ethernet.
2. Protocol: Ethernet/IP.

2.06 CIRCUIT BREAKERS

A. See Section 26 05 04, Basic Electrical Materials and Methods.

2.07 SURGE PROTECTIVE DEVICES

A. Manufacturer List: Shall be same manufacturer as motor control center, integrally mounted in MCC. See Section 26 43 00, Surge Protective Device, for Specification.

2.08 SOURCE QUALITY CONTROL

A. Section 01 40 00, Quality Requirements (to be completed): Testing, inspection and analysis requirements.

B. Shop inspect and perform standard productions tests for each controller in accordance with manufacturer's standards.

C. Make completed motor control center available for inspection at manufacturer's factory prior to packaging for shipment. Notify Engineer at least seven days before inspection is allowed.

D. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Engineer at least 7 days before inspections and tests are scheduled.

PART 3 EXECUTION

3.01 EXAMINATION

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for installation examination.

B. Verify surfaces are suitable for motor control center installation.

3.02 INSTALLATION

A. Install in accordance with NEMA ICS 2.3 and NEMA 7.1.

B. Tighten accessible bus connections and mechanical fasteners after placing motor control center.

1. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
2. Install equipment plumb and in longitudinal alignment with pad or wall.
3. Coordinate terminal connections with installation of secondary feeders.
4. Grout mounting channels into floor or mounting pads.
5. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer’s recommendations.

C. Select and install heater elements in motor controllers to match installed motor characteristics.

D. Install engraved plastic nameplates in accordance with Section 26 05 02, Basic Electrical Requirements.

E. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage rating, and phase rating. Place label in clear plastic holder. Indicate method of identifying phase conductors.

F. Ground and bond motor control centers in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. Section 01 40 00, Quality Requirements (to be completed): Requirements for inspecting, testing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.16.

D. Inspect and test variable frequency controllers according to NEMA ICS 7.1.

3.04 CLEANING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Requirements for cleaning.

B. Clean existing motor control centers to remain or are to be reinstalled.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes wall switches; wall dimmers; receptacles; multioutlet assembly; and device plates and decorative box covers.

B. Related Sections:

1. Section 26 05 33, Raceway and Boxes for Electrical Systems: Outlet boxes for wiring devices.

1.02 REFERENCES

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

1. National Electrical Manufacturers Association:
   a. WD 1, General Requirements for Wiring Devices.
   b. WD 6, Wiring Devices-Dimensional Requirements.

1.03 SUBMITTALS

A. Section 01 33 00, Submittal Procedures (to be completed): Submittal procedures.

B. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

C. Samples: Submit two samples of each wiring device and wall plate illustrating materials, construction, color, and finish.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 3 years’ experience.

1.05 EXTRA MATERIALS

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Spare parts and maintenance products.

B. Furnish two of each style, size, and finish wall plate.

PART 2 PRODUCTS

2.01 WALL SWITCHES

A. Manufacturers:

1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Single Pole Switch:

1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

C. Double Pole Switch:

1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

D. Three-way Switch:

1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

E. Four-way Switch:

1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.

4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

F. Color: Brown.

1. Product Description: NEMA WD 1, Heavy-Duty, AC only general-use snap switch.

G. Body and Handle: Brown with toggle handle.

H. Ratings: Match branch circuit and load characteristics.

2.02 RECEPTACLES

A. Single Convenience Receptacle:

1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Duplex Convenience Receptacle:

1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

C. GFCI Receptacle:

1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

D. Color: Brown.

E. Product Description: NEMA WD 1, Heavy-duty general use receptacle.

F. Device Body: Brown plastic.

G. Configuration: NEMA WD 6, type as indicated on Drawings.

H. Convenience Receptacle: Type 5-20.

I. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.03 WALL PLATES

A. Manufacturers:

1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.
4. Substitutions: Section 01 60 00, Product Requirements (to be completed).

B. Decorative Cover Plate: Stainless steel.

C. Jumbo Cover Plate: Stainless steel.

D. Weatherproof Cover Plate: Stainless steel plate with hinged and gasketed device cover.

PART 3 EXECUTION

3.01 EXAMINATION

A. Section 01 30 00, Administrative Requirements (to be completed): Coordination and project conditions.

B. Verify outlet boxes are installed at proper height.

C. Verify wall openings are neatly cut and completely covered by wall plates.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.02 PREPARATION

A. Clean debris from outlet boxes.

3.03 EXISTING WORK

A. Disconnect and remove abandoned wiring devices.

B. Modify installation to maintain access to existing wiring devices to remain active.

C. Clean and repair existing wiring devices to remain or to be reinstalled.

3.04 INSTALLATION

A. Install devices plumb and level.

B. Install switches with OFF position down.

C. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Install receptacles with grounding pole on bottom.

F. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

G. Install wall plates on flush mounted switches, receptacles, and blank outlets.

H. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

I. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.

J. Use jumbo size plates for outlets installed in masonry walls.

K. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.05 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 26 05 33, Raceway and Boxes for Electrical Systems, to obtain mounting heights as specified and as indicated on Drawings.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle 18 inches above finished floor.

3.06 FIELD QUALITY CONTROL

A. Sections 01 40 00, Quality Requirements (to be completed), and 01 70 00, Execution and Closeout Requirements (to be completed): Field inspecting, testing, adjusting, and balancing.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify each receptacle device is energized.

E. Test each receptacle device for proper polarity.

F. Test each GFCI receptacle device for proper operation.

3.07 ADJUSTING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Testing, adjusting, and balancing.

B. Adjust devices and wall plates to be flush and level.

3.08 CLEANING

A. Section 01 70 00, Execution and Closeout Requirements (to be completed): Final cleaning.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 26 29 23
LOW-VOLTAGE ADJUSTABLE FREQUENCY DRIVE SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. Electronic Industries Alliance (EIA): 359-A-1, Special Colors.
2. Hydraulic Institute Standards (HIS).
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   c. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
4. National Electrical Manufacturer's Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. CP 1, Shunt Capacitors.
   c. MG 1, Motors and Generators.
   d. WC 57, Standard for Control, Thermocouple Extensions, and Instrumentation Cables.
5. National Fire Protection Association (NFPA): 79, Electrical Standard for Industrial Machinery.

1.02 DEFINITIONS

A. Terms that may be used in this section:

1. AFD: Adjustable frequency drive.
2. CMOS: Complementary metal oxide semiconductor.
3. CSI: Current source inverter.
4. EMU: Energy monitoring unit.
5. GTO: Gate turn-off thyristor.
6. MTBF: Mean time between failure.
7. PWM: Pulse width modulation.
8. ROM: Read only memory.
9. RTD: Resistance temperature detector.
10. Rated Load: Load specified for equipment.

11. Rated Speed: Nominal rated (100 percent) speed specified for equipment.
12. TDD: Total demand distortion.
13. THD: Total harmonic distortion.
14. TTL: Transistor transistor logic.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Composite drive/motor efficiency (CE) is defined as ratio of motor shaft kW to drive input kW. AFD system minimum requirements:
   a. At 60-Hz drive output and 100 percent load, CE equals 92 percent.
   b. At 50-Hz drive output and 60 percent load CE equals 89 percent.
   c. At 40-Hz drive output and 30 percent load CE equals 84 percent.
   d. At 30-Hz drive output and 12.5 percent load CE equals 77 percent.
2. Rated Continuous Operation Capacity: Not less than 1.15 times full load current rating of driven motor, as indicated on motor nameplate, and suitable for continuous operation at continuous overload which may be imposed on motor by driven pump operating over specified speed range.
3. Basis for Harmonic Computations: Using Simplified Plant One-Line Diagram for current and voltage distortion computations, furnish harmonic filters, line reactors, isolation transformers, or higher pulse converter arrangements required to meet current/voltage distortion and line notching limits.
4. Normal Source Current Harmonic Distortion: Compute normal source individual and total current harmonic distortion at location identified as PCC (point of common coupling) in accordance with IEEE 519.
5. Furnish isolating transformers or series reactors, harmonic filters, or other devices necessary for proper system operation. Furnish necessary devices and circuits to prevent operation of one drive from adversely affecting operation of other drives supplied from same transformer or same bus.
6. When isolation transformers are used, design to meet K-factor requirements of drive(s) connected.

B. Design Requirements:

1. Drive system consisting of adjustable frequency controller, drive motor, auxiliary items, and components necessary for complete operating system.

2. Other equipment is being powered from same bus as adjustable frequency drives. Ensure proper operation of drives and other loads under normal and emergency conditions.
3. Furnish AFDs rated on basis of actual motor full load nameplate current rating times the service factor.
4. Drive System: Convert incoming three-phase, 60-Hz ac power to variable voltage, adjustable frequency output for adjustable speed operation of a standard ac induction squirrel-cage motor, using pulse-width-modulation (PWM) technique to produce adjustable frequency output.
5. System rated for continuous industrial duty and suitable for use with NEMA MG 1, Design B motors.
6. Incoming Line Circuit Breaker: Provide positive means of disconnecting incoming power, and overcurrent protection for drive system.
7. Incoming Line Reactor: Design to minimize harmonic distortion on incoming power feeder.

1.04 SUBMITTALS

A. Action Submittals:

1. Overall drive system operating data, including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0, 40, 60, 80, 100, and 110 percent of rated speed.
2. Individual and total harmonic content (voltage and current) reflected in system normal source supply at driven equipment actual load at 70 percent and 100 percent of rated speed at locations specified in Simplified Plant One-Line Diagram and load conditions specified. Normal source system short-circuit available at drive shall be calculated from data furnished in Supplements to this section. Use TDD and THD factors as defined in IEEE 519 to designate total harmonic content.
3. AFD output pulse maximum peak voltage, pulse rise time, and pulse rate of rise including justification for proposed deviation from specified values. Include motor manufacturer’s certification motor insulation will withstand long-term over-voltages caused at motor terminals due to specified output pulse data or proposed deviation from this data.
4. Data on shelf life of “dc link” capacitor.
5. Complete system rating, including nameplate data, continuous operation load capability throughout speed range of 0 percent to 120 percent of rated speed.

6. Complete adjustable frequency controller rating coordinated with motor full load nameplate current rating; list controller special features being supplied.
7. Controller, reactor, harmonic filter, and isolating transformer (if applicable) dimensional drawings; information on size and location of space for incoming and outgoing conduit.
8. Maximum heat dissipation from enclosure.
9. Should separate enclosures and equipment be necessary for filter elements, provide complete dimensional information including location of space for incoming and outgoing conduit, weight, maximum heat loss, and minimum current carrying capacity and recommended wire size for required interconnecting circuits.
10. Layout of controller face showing pushbuttons, switches, instruments, and indicating lights.
11. Complete system operating description.
12. Complete system schematic (elementary) wiring diagrams.
13. Complete system interconnection diagrams between controller, drive motor, and related components or controls external to system, including wire numbers and terminal board point identification.
14. One-line diagram of system, including component ratings.
15. Description of diagnostic features being provided.
16. Descriptive literature for control devices such as relays and timers.
17. Itemized bill-of-materials listing system components.
18. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).

B. Informational Submittals:

1. Statement of Supplier qualifications.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer’s printed installation instructions.
5. Factory functional test reports.
6. Certified copy of test report for identical motor tested in accordance with NEMA MG 1-12.53a and IEEE 112, Test Method B, showing rated load, rated speed efficiency meeting or exceeding specified values; motors not as specified will be rejected.
7. Field test reports.
8. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing (to be completed).

9. Suggested spare parts list to maintain equipment in service for period of 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
10. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
11. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).
12. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).

1.05 QUALITY ASSURANCE

A. Supplier: Minimum 5 years' experience in furnishing similar size and type adjustable frequency, controlled speed, drive systems.

1.06 EXTRA MATERIALS

A. Furnish for Each Drive Unit: One complete power bridge and one spare printed circuit card for each modular, plug-in type card in controller.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Components and accessories specified in this section shall be products of:

1. Allen Bradley.
2. Fuji Electric.
3. General Electric.
4. ABB.
5. Eaton Cutler Hammer.
6. Toshiba.
7. Square D.

2.02 SERVICE CONDITIONS

A. Ambient Operating Temperature: 32 degrees F to 104 degrees F.

B. Storage Temperature: Minus 40 degrees F to 158 degrees F.

C. Humidity: 0 percent to 95 percent relative (non-condensing).

D. Altitude: 475 feet.

E. Frequency Stability: Plus or minus 0.1 percent of maximum frequency.

2.03 COMPONENTS

A. Drive Units:

1. Incorporate switching power supply operating from dc bus, to produce PWM output waveform simulating sine wave and providing power loss ride through of 2 milliseconds at full load, full speed.
2. Current-limiting semiconductor fuses for protection of internal power semiconductors.
3. Employ diode bridge rectifier providing constant displacement power factor of 0.95 minimum at all operating speeds and loads.
4. Use transistors for output section, providing a minimum 97 percent drive efficiency at full speed, full load.
5. Employ dc power discharge circuit so that after removal of input power dc link capacitor voltage level will decay below 50V dc within 1 minute after de-energizing following NEMA CP 1 and NFPA 79. Design dc link capacitor for a MTBF of 5 years.
6. Operate with open circuited output.
7. Input Voltage: 480V ac plus or minus 10 percent.
8. Output Voltage: 0 to 480 volts, three-phase, 0 to 60 Hz, minimum.
9. Maximum peak voltage of PWM AFD output pulse of 1,000 volts, with pulse rise time of not less than 2 microseconds, and maximum rate of rise of 500 volts per microsecond. Maximum frequency of PWM AFD output pulse (carrier) frequency of 3,000 Hz. Should magnitudes of these characteristics be more stressful to motor insulation than specified values, furnish insulation systems on motors suitable for proposed values.
10. Motor Audible Noise Level: When operating throughout speed range of PWM AFD, no more than 3 dBA above that designated in NEMA MG 1 for same motor operated at constant speed with a 60-Hz supply voltage.
11. Short-Time Overload Capacity: 125 percent of rated load in rms current for 1 minute following full load, full speed operation.
12. Equipment Short-Circuit Rating: Suitable for connection to system with maximum source three-phase, bolted fault, short-circuit available of 42,000 amps rms symmetrical at 480 volts.
13. Furnish drives with output current-limiting reactors mounted within equipment enclosure.
14. Diagnostics: Comprehensive for drive adjustment and troubleshooting:
    a. Memory battery backup; 100-hour minimum during power loss.

b. Status messages will not stop drive from running but will prevent it from starting.
c. Fault Condition Messages and History: First fault protection function to be activated, ability to store six successive fault occurrences in order. Minimum faults numerically:
    1) Overcurrent (time and instantaneous).
    2) Overvoltage.
    3) Undervoltage (dc and ac).
    4) Overtemperature (drive, motor windings, motor bearing, pump bearing).
    5) Serial communication fault.
    6) Short-circuit/ground fault (motor and drive).
    7) Motor stalled.
    8) Semiconductor fault.
    9) Microprocessor fault.
    10) Single-phase voltage condition.

15. Drive Protection:
    a. Fast-acting semiconductor fuses.
    b. Overcurrent, instantaneous overcurrent trip.
    c. Dc undervoltage protection, 70 percent dropout.
    d. Dc overvoltage protection, 130 percent pickup.
    e. Overtemperature, drive, inverter, converter, and dc link components.
    f. Overtemperature, motor, and pump.
    g. Single-phase protection.
    h. Reset overcurrent protection (manual or automatic reset).
    i. Active current limit/torque limit protection.
    j. Semiconductor fault protection.
    k. Short-circuit/ground fault protection.
    l. Serial communication fault protection.
    m. Microprocessor fault.
    n. Surge protection for transient overvoltage (6,000 volts, 80 joule surge, tested per IEEE C62.41).
    o. Visual display of specific fault conditions.
16. Operational Features:
    a. Use manufacturer’s standard unless otherwise indicated.
    b. Sustained power loss.
    c. Momentary power loss.
    d. Power interruption.
    e. Power loss ride through (0.1 second).
    f. Start on the fly.
    g. Electronic motor overload protection.

h. Stall protection.
i. Slip compensation.
j. Automatic restart after power return (ability to enable/disable function).
k. Critical frequency lockout (three selectable points minimum, by 1.5-Hz steps in 10-Hz bands, to prevent resonance of system).
l. Drive maintenance system software for complete programming and diagnostics.
m. Ground fault protection, drive, and motor.
n. Operate with no motor connected to output terminals.

B. Rectifier: Three-phase 6-pulse full wave diode bridge rectifier to provide constant dc voltage to drive's dc bus.

C. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.

D. Controller: Microprocessor-controller PWM inverter to convert to dc voltage to variable voltage, adjustable frequency, three-phase ac output. Output voltage shall vary proportionally with frequency to maintain constant ratio of volts to hertz up to 60-Hz; above 60-Hz, voltage shall remain constant with drive operating in constant horsepower output mode.

E. Enclosure:

1. NEMA 250, Type 1, gasketed, freestanding, enclosure for mounting against wall, completely front accessible, and hinged doors. Properly sized to dissipate heat generated by controller within limits of specified operating conditions (including ambient temperature and ambient airflow). Enclosure not to exceed dimensions shown on Drawings.
2. Cable termination compartment door interlocked main circuit breaker, defeatable (lockable in the open position), emergency stop pushbutton, alphanumeric keypad and display, and operator's controls.
3. Wire drive from below for power and control wiring.
4. Size forced-ventilation for periodic operation to cool each unit with maximum room ambient temperature of 95 degrees F. Furnish redundant fans such that if one fan fails remaining fans furnish adequate ventilation for drive when operating at maximum capacity. Furnish filters on ventilation intakes.
5. Wiring:
   a. Bundle stranded copper wiring neatly with nylon tie wraps or with continuous plastic spiral binding.

b. Label each terminal for permanent identification of leads.
c. Identify each wire at each end with imprinted mylar adhesive-back wire markers.
d. Incorporate in as-installed wiring diagrams for wire and terminal numbers shown.
e. Wiring across door hinge, use 19-strand, NEMA WC 57 Class C stranding looped for proper twist rather than bending at hinge.
f. Wire connections internal to panels by crimp-on terminal types.
g. For multiple enclosure systems, complete interconnection wiring with gasketed enclosure openings for wiring.
h. Multipoint plug receptacles for control wiring crossing equipment shipping splits.

6. Selector switches, indicating lights, potentiometers, instruments, protective devices, and major system components identified by means of mechanically attached, engraved, laminated nameplates.

F. Operator Interface:

1. Controls: Mount drive local control on front door of enclosure and include control switch and membrane type keypad for the following operator functions:
   a. Start (when in local mode).
   b. Stop (when in local mode).
   c. Speed increase (when in local mode).
   d. Speed decrease (when in local mode).
   e. Parameter mode selection (recall programmed parameters).
   f. LOCAL/OFF/REMOTE control selection (in remote, furnish for remote RUN command digital input and speed increase/decrease via remote 4 mA to 20 mA analog signal).
   g. Fault reset, manual for faults, except loss of ac voltage which is automatic upon return.
   h. RUN/preset speed.
   i. Parameter lock, password or key switch lockout of changes to parameters.
   j. Start disable, key switch or programmed code.
2. Control circuit disconnect shall de-energize circuits in units that are not de-energized by main power disconnect device as required by California Administrative Code.
3. 120 volts, single-phase, 60-Hz circuits for control power and operator controls from internal control power transformer. Furnish power for motor space heaters rated 120 volts.

4. Arrange component and circuit such that failure of a single component cannot cause cascading failure(s) of other component(s).
5. Alphanumeric Display: During normal operation and routine test, the following parameters shall be available:
    a. Motor current (percent of drive rated current).
    b. Output frequency (Hertz).
    c. Output voltage.
    d. Running time.
    e. Local/remote indicator.
    f. Status of digital inputs and outputs.
    g. Analog input and output values.
    h. Output motor current per leg.
    i. All test points.
6. Adjustable Parameters: Set drive operating parameters and indicate in numeric form. Potentiometers may not be used for parameter adjustment. Minimum setup parameters available:
    a. Frequency range, minimum, maximum.
    b. Adjustable acceleration/deceleration rate.
    c. Volts per Hertz (field weakening point).
    d. Active current limit/torque limit, 0 percent to 140 percent of drive rating.
    e. Adjustable voltage boost (IR compensation).
    f. Preset speed (adjustable, preset operating point).
    g. Provision for adjustment of minimum and maximum pump speed to be furnished as function of 4 mA to 20 mA remote speed signal.

G. Signal Interface:

1. Digital Input:
    a. Accept a remote RUN command contact closure input.
    b. High temperature contact closure input from field mounted motor temperature monitoring relay.
        1) Digital Output: Furnish three discrete output dry contact closures rated 5 amps at 120V ac.
    c. DRIVE RUNNING.
    d. DRIVE FAULT (with common contact closure for all fault conditions).
    e. DRIVE IN REMOTE MODE.

2. Analog Input: When LOCAL/OFF/REMOTE switch is in REMOTE, control drive speed from remote 4 mA to 20 mA dc signal.
   a. Make provisions for adjustment of minimum and maximum motor speed which shall result from this signal.
   b. Factory set this adjustment to comply with operating speed range designated in driven equipment specifications.
   c. Frequency resolution shall be 0.1 percent of base speed.
3. Analog Output: Furnish two 4 mA to 20 mA dc signals for actual frequency, actual load.
4. Ethernet Communication Interface: TCP/IP, compatible with MODBUS and Ethernet/IP Protocols.

H. Accessories:

1. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.
2. Lifting Lugs: Equipment weighing over 100 pounds.
3. Anchor Bolts: Type 316 stainless steel sized by equipment manufacturer and as specified in Section 05 50 00, Metal Fabrications.

2.04 FACTORY FINISHING

A. Enclosure:

1. Primer: One coat of rust-inhibiting coating.
2. Finish:
   a. Interior: One coat white enamel.
   b. Exterior: Manufacturer’s standard baked enamel finish.
3. Enclosure types shall be as required in Section 26 05 04, Basic Electrical Materials and Methods.

2.05 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all control panels furnished.

C. Record test data for report.

D. Functional Test: Perform manufacturer’s standard and the following tests:

1. Test diodes, transistors, and GTOs at a thermal level of 125 degrees C.

2. Test TTL and CMOS chips at 70 degrees C.
3. Test printed circuit boards while heat cycled to maximum temperature of 65 degrees C.
4. Test run power sections at maximum 40 degrees C for 12 hours and run with motors for 6 hours.
5. Test assembled drive at maximum 40 degrees C and full load, full speed for 4 hours.
6. Test power capacitors and active components.
7. Operate controller with motor throughout its specified range, and at rated power supply load for 1 hour.
8. Resonance: When harmonic filters are furnished to meet specified harmonic distortion requirements, perform analysis and furnish documentary evidence that filter elements do not resonate with remainder of system parameters at harmonic frequencies present.

E. Motor Test: See associated pump/process equipment specification for motor testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

3.02 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each controller.
2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.
3. Vibration Test:
   a. Complete assembly, consisting of motor, load, and flexible shafting, connected and in normal operation shall not develop amplitudes of vibration exceeding limits recommended by HIS.
   b. Where loads and drives are separated by intermediate flexible shafting, measure vibration both at top motor bearing and at two points on top pump bearing, 90 degrees apart.
4. Record test data for report.

B. Performance Test:

1. Conduct on each controller.

2. Perform under actual or approved simulated operating conditions.
3. Test for continuous 12-hour period without malfunction.
4. Demonstrate performance by operating continuous period while varying application load, as input conditions allow, to verify system performance.
5. With plant load connected to normal utility source, measure the following to show parameters within specified limits:
    a. Total and individual current harmonic distortion, up to and including 35th harmonic, at location identified as PCC in Simplified Plant One-Line Diagram, under following load conditions:
        1) AFDs running at full load and half load.
        2) Half of specified AFDs running at full load and half load.
    b. Power factor at input side of each drive. Documented verification that power factor is maintained at 95 percent as speed of drive goes down from 100 percent to 33 percent.
6. Record test data for report.

C. Test Equipment:

1. Use Dranetz, Model No. 626-PA, harmonic distortion monitor and Series 626 disturbance analyzer or equivalent instrument to document results.
2. Provide diagnostic plug-in test card complete with instructions, multi-position selector switch, and meters or built-in diagnostic control panel or ROM-based processor for monitoring ac, dc, and digital signals to assist in troubleshooting and startup of drive.

3.03 MANUFACTURERS' SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 4 hours for prestartup classroom or Site training.
4. 1 person-day for facility startup.
5. 4 hours for post-startup training of Owner's personnel.

B. See Section 01 43 33, Manufacturers' Field Services (to be completed), and Section 01 91 14, Equipment Testing and Facility Startup (to be completed).

END OF SECTION

SECTION 26 41 00
FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.01 REFERENCES

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

1. Lightning Protection Institute (LPI): 175, Standard of Practice.
2. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 780, Standard for the Installation of Lightning Protection Systems.
3. Underwriters Laboratories, Inc. (UL):
   a. 96, Standard for Lightning Protection Components.
   b. 96A, Standard for Installation Requirements for Lightning Protection Systems.

1.02 DESIGN REQUIREMENTS

A. Provide lightning protection system design for the following structures:

1. MW-20 Bench Control Building.
2. Transwestern Bench Operations Building.
3. Remedy Treatment Plant Building.

B. Design lightning protection system to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

1.03 SUBMITTALS

A. Action Submittals:

1. Drawings:
   a. Lightning protection system layout.
   b. Component locations.
   c. Detailed plans.
2. Down conductor.
3. Connecting conductor.
4. Bond strap.
5. Air terminals.
6. Fittings.

7. Connectors.
8. Ground rods.

B. Informational Submittals:

1. Field test report.
2. Ground Witness Certification-Form LPI-175A.
3. Post-Installation Certification-Form LPI-175B.
4. UL 96 Master Label “C” Certification.

1.04 QUALITY ASSURANCE

A. Designer: Lightning protection system design shall be prepared by an LPI-certified designer or recognized lightning protection manufacturer.

B. System components shall be the product of a manufacturer regularly engaged in the manufacturing of lightning protection components in accordance with UL 96.

C. Lightning protection system shall be installed under direct supervision of an LPI 175 Certified Master Installer.

D. Inspection of final installation and grounding connection shall be performed by an LPI-certified inspector.

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

F. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Thompson Lightning.
2. IPC Protection.

3. Erico Eritech Lightning Protection Systems.
4. VFC, Inc.

2.02 GENERAL

A. Complete system shall bear UL 96 Master Label C.

B. System Material: Copper or high copper content, heavy-duty bronze castings, unless otherwise specified.

C. Material shall comply in weight, size, and composition for the class of structure to be protected as established by NFPA 780.

2.03 COMPONENTS

A. Air Terminal:

1. Material: Solid copper rods with tapered or blunt points as required for application.
2. Diameter: 2 inch.
3. Length: Sufficient to extend minimum 10 inches above object being protected.
4. UL 96 Label B applied to each terminal.

B. Conductors:

1. Lightning System Conductors: Bare medium hard-drawn stranded copper, or stranded aluminum as required for the application**.**
2. Main Down Conductor: Smooth twist stranding Class I.
3. Connecting Conductor: Concentric stranding Class I.
4. Bonding Conductor: Flexible strap, minimum 3/4-inch wide by 1/8-inch thick.
5. Main down and connecting conductors shall bear the UL 96 Label A, applied every 10 feet.
6. Grounding Conductors: Stranded bare copper.

C. Cable Fastener And Accessories: Capable of withstanding minimum pull of 100 pounds.

D. Fittings:

1. Heavy-duty.
2. Bolts, Screws, and Related Hardware: Stainless steel.

E. Ground Rods:

1. Material: Copper-clad.
2. Diameter: 5/8 inch.
3. Length: 10 feet.

F. Grounding Connections:

1. Welds: Exothermic process.
2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
3. Hardware: Silicone bronze.

G. Cable Connections and Splicers:

1. Welds: Exothermic process.
2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
3. Through-Roof Connectors: Straight or right angle with bronze and lead seal flashing washer.

H. Conduit: Schedule 40 PVC, as specified in Section 26 05 33, Raceway and Boxes for Electrical Systems.

PART 3 EXECUTION

3.01 GENERAL

A. Workmanship to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

B. Aluminum materials shall be used where required to meet the galvanic corrosion requirements of UL 96A.

C. Provide pitchpockets or method compatible with roofing to waterproof roof penetrations.

D. Install system in inconspicuous manner so components blend with building aesthetics.

3.02 EXAMINATION

A. Verify conditions prior to installation. Actual conditions may require adjustments in air terminal and ground rod locations.

3.03 INSTALLATION

A. Air Terminals:

1. Supports: Brackets or braces.
2. Parapet Bracket Attachment: Lag or expansion bolts.
3. Secure base to roof surface with adhesive or pitch compatible with roofing bond.
4. Provide terminal flashing at roof penetrations.
5. Perimeter Terminals:
   a. Maximum Spacing: 20 feet.
   b. Maximum Distance From Outside Edge of Building: 2 feet.
6. Roof Ridge Terminals: Maximum spacing 20 feet.
7. Mid-Roof Terminals: Maximum spacing 50 feet.
8. Provide blunt point air terminals for applications exposed to personnel.

B. Conductors:

1. Conceal whenever practical.
2. Provide 1-inch PVC conduit in building walls or columns for main downleads and roof risers.
3. Support: Maximum spacing for exposed conductors.
   a. Vertical: 3 foot.
   b. Horizontal: 4 foot.
4. Maintain horizontal and vertical conductor courses free from dips or pockets.
5. Bends: Maximum 90 degrees, with minimum 8-inch radius.
6. Install air terminal conductors on the structural roof surface before roofing composition is applied.

C. Bonding:

1. Bond to Main Conductor System:
   a. Roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
   b. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
2. Bond each steel column or major framing members to grounding system.
3. Bond each main down conductor to grounding system.

D. Grounding System:

1. Grounding Conductor:
   a. Completely encircle building structure.
   b. Bury minimum 1 foot below finished grade.
   c. Minimum 2 feet from foundation walls.
2. Interconnect ground rods by direct-buried copper cables.
3. Maximum Resistance: 5 ohms when connected to ground rods.
4. Connections:
   a. Install ground cables continuous between connections.
   b. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
   c. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
   d. Use bolted offset parapet bases or through-roof concealed base assemblies for air terminal connections.
   e. Provide electric service arrestor ground wire to building water main.

3.04 FIELD QUALITY CONTROL

A. Field Testing:

1. Isolate lightning protection system from other ground conditions while performing tests.
2. Resistance: Test ground resistance of grounding system by the fall-of-potential method.
   a. Test Resistance to Ground: Maximum 5 ohms.
   b. Install additional ground rods as required to obtain maximum allowable resistance.
3. Test Report:
   a. Description of equipment tested.
   b. Description of test.
   c. Test results.
   d. Conclusions and recommendations.
   e. Appendix, including appropriate test forms.
   f. Identification of test equipment used.
   g. Signature of responsible test organization authority.

END OF SECTION

SECTION 26 42 00
CATHODIC PROTECTION SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI): 301, Specifications for Structural Concrete.
2. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   c. A518/A518M, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
   d. A615/A615M, Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   e. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   f. C150, Standard Specification for Portland Cement.
   g. C387, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   h. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
3. Canadian Standards Association (CSA).
4. Concrete Reinforcing Steel Institute (CRSI).
5. NACE International (NACE).
6. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. C80.1, Rigid Steel Conduit, Zinc Coated Specification for.
   c. C80.6, I Intermediate Metal Conduit (IMC)—Zinc Coated.
   d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   e. WC 70, Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   f. WC 71, Standard for Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy.
   g. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
8. Society for Protective Coatings (SSPC):
   a. SP 1, Solvent Cleaning.
   b. SP 6, Commercial Blast Cleaning.
9. Underwriters Laboratories Inc. (UL):
   a. 6, Standard for Safety Electrical Rigid Metal Conduit Steel.
   b. 360, Standard for Safety Liquid-Tight Flexible Steel Conduit.
   c. 514B, Standard for Safety Conduit, Tubing, and Cable Fittings.
   d. 1242, Standard for Safety Intermediate Metal Conduit.

1.02 DEFINITIONS

A. Active Column: Anode and coke breeze portion of a deep anode ground bed that discharges current.

B. Ferrous Metal Pipe: Pipe made of steel or iron and pipe containing steel or iron as a principle structural material, except reinforced concrete.

C. Inactive Column: Gravel fill and seal portions of a deep anode ground bed that does not discharge current.

D. Lead, Lead Wires, Joint Bonds, Cable: Insulated copper conductor; the same as wire.

E. Pipeline Appurtenances: Fittings, couplings, tees, elbows, valves, and other metallic components in a piping system.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Catalog cuts and other information for products to be used.
   b. Proposed electrical logging equipment list for review and approval prior to start of drilling operations for deep anode installation.
   c. Overall System Wiring Diagram: Identify location of connections, label markings, wire size, color, and products.

B. Informational Submittals:

1. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements (to be completed).

2. Quality Assurance:
   a. Qualifications of Cathodic Protection Specialist: Certified by NACE International.
   b. Installers and Driller's Experience Statement: Include name of individual(s) who will install the cathodic protection system ground beds and operate the drilling equipment.
3. Operation and Maintenance Data:
   a. As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).
   b. Include electrical schematic of rectifier, parts list with part replacement number, and troubleshooting procedures.
4. Field Test and Inspection Reports.
5. Driller's logs for deep anode installations.
6. Certified test report of wire-to-anode connections, including connection resistance values.

1.04 QUALITY ASSURANCE

A. Cathodic Protection Specialist:

1. NACE International certified.
2. Perform periodic field observation and testing services during installation of deep anode ground beds and installation of other cathodic protection system components associated with the Project.
3. Available onsite at beginning of the Work to verify proper installation of cathodic protection system components. Make additional Site visits at intervals required to:
   a. Verify proper installation of surface anode ground beds and distributed ground beds, rectifiers, and associated wiring.
   b. Determine compliance with these Specifications.
   c. Provide cathodic protection testing as specified herein.
   d. Resolve field problems.

B. Installer: Minimum 3 years' experience installing type of cathodic protection system specified.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Coil anode wires and secure, and package anode as required to prevent damage during shipment. Damaged anode or wire shall be cause for replacement of the complete anode.

1.06 EXTRA MATERIALS

A. Provide for Each Rectifier:

1. Three complete set of spare fuses.
2. Three each ac input lightning arrestors.
3. Three each dc output lightning arrestors.
4. Provide spare parts in sealed, waterproof bag.

1.07 SOIL RESISTIVITY SURVEY

A. Contractor shall perform a soil resistivity survey for the purpose of selecting and designing the cathodic protection system. Soil resistance shall be measured by the Wenner four pin method to a depth equal to the buried pipe or structure that is to be protected. Moisture content and salt content shall be measured also to provide an accurate representation of soil resistivity.

PART 2 PRODUCTS

2.01 IMPRESSED CURRENT ANODES

A. High-Silicon Cast Iron-Tubular:

1. Description: Tubular, center-tap connection, modified high-silicon cast iron meeting requirements of ASTM A518/A518M, Grade 3, with dimensions and chemical composition listed below.
2. Dimensions:
   a. Length: 60 inches minimum.
   b. Outside Diameter: 2.2 inches minimum.
   c. Wall Thickness: 0.25 inch minimum.
   d. Weight: 36 pounds minimum.
3. Composition:
   a. Silicon: 14.20 percent to 14.75 percent.
   b. Manganese: 1.50 maximum.
   c. Carbon: 0.70 percent to 1.10 percent.
   d. Chromium: 3.25 percent to 5.00 percent.
   e. Copper: 0.50 percent maximum.
   f. Molybdenum: 0.50 percent maximum.
   g. Iron: Remainder.
4. Anode-to-Wire Connection:
   a. Compression wedge, soldered connector (Anotec “Style 2,” or equal).
   b. Connection Resistance: 0.0015 ohm, maximum.

5. Manufacturer and Product: Anotec Industries Ltd., Langley, B.C., Canada; Centertec Series Anodes, Type 2260.

B. High-Silicon Cast Iron-Standard:

1. Description: High-silicon cast iron, meeting requirements of ASTM A518/A518M, Grade 3.
2. Dimensions:
   a. Length: 36 inches minimum.
   b. Outside Diameter: 1 inch minimum.
   c. Ends Enlarged to: 2 inches minimum.
   d. Weight: 7 pounds minimum.
3. Composition of High-Silicon Cast Iron:
   a. Silicon: 14.20 percent to 14.75 percent.
   b. Manganese: 1.50 percent maximum.
   c. Carbon: 0.70 percent to 1.10 percent.
   d. Chromium: 3.25 percent to 5.00 percent nominal.
   e. Copper: 0.50 percent maximum.
   f. Molybdenum: 0.50 percent maximum.
   g. Iron: Remainder.
4. Anode-to-Wire Connection:
   a. Manufacturer’s standard using lead potting compound and strain relief grommet, Anotec Style 2.
   b. Electrically insulate anode-to-wire connection with manufacturer’s standard splice insulation.
   c. Provide anodes with heat shrinkable, sealant filled end caps. End caps shall be factory installed.
5. Manufacturer and Product: Anotec Industries Ltd.; Type 4884L.

C. Graphite:

1. Description: Resin-impregnated graphite with standard lead wire connections and the following dimensions:
   a. Length: 30 inches minimum.
   b. Outside Diameter: 3 inches minimum.
   c. Weight: 12.5 pounds minimum.
2. Anode-to-Wire Connection:
   a. Manufacturer’s standard.
   b. Electrically insulate anode-to-wire connection with manufacturer’s standard splice insulation.
   c. Provide anodes with heat shrinkable, sealant filled end caps. End caps shall be factory installed.

D. Mixed Metal Oxide:

1. Description: Tubular mixed metal oxide anode suitable for this intended service.
2. Composition: Mixed metal oxide material thermally deposited on either titanium coated copper core or solid titanium substrate.
3. Current Rating: Anode shall provide a minimum service life of 30 years at a minimum current output of 3 0.2 ampere per anode in coke breeze (soil).
4. Anode-to-Wire Connection: Manufacturer’s standard hydraulic crimp.
5. Manufacturer and Product: Eltech Systems Incorporated, Chardon, OH; Lida Type HMWPE Tubular Anodes.

E. Prepackaged Anodes:

1. Type: High-silicon cast iron or graphite anodes.
2. Prepackaging Requirements: Furnish anodes with compacted coke breeze in a 2.2-inch diameter by 60-inch long galvanized steel container.
3. Container: 28 gauge with one longitudinal welded lock seam and 3/4-inch plywood end caps.
4. Furnish prepackaged anodes with two centralizers on anode quarter-points prior to packaging to prevent anode settlement during shipment.
5. Furnish complete with wire.

F. Wire-to-Anode Connection:

1. Factory installed using manufacturer’s standard and as specified herein.
2. Stronger than the wire.
3. Measure resistance of wire-to-anode connections with a Kelvin bridge circuit or equal.
4. Replace wire connections that have a resistance of 0.004 ohm or greater.
5. Submit test records that include the following information:
   a. Anode number.
   b. Anode wire length.
   c. Resistance value of connection.
   d. Test equipment.
   e. Test method.

G. Wire Labels: Label end of each anode wire with anode number and wire length, stamped onto brass tags. Number anodes sequentially from bottom to top.

2.02 ANODE CENTRALIZERS

A. Metal or plastic assemblies that can be securely attached to anodes to center them in the drilled hole. Centralizers shall not block hole or impair installation of anode, anode wire, or coke breeze.

2.03 COKE BREEZE

A. Calcined Petroleum Coke: Lubricated, low resistance, calcined petroleum coke, suitable for pumping, with the following composition:

1. Volatile Matter: 0.10 percent maximum.
2. Ash: 0.6 percent maximum.
3. Sulfur: 5.8 percent maximum.
4. Fixed Carbon: 99 percent minimum.
5. Particle Size: 100 percent passing 16-mesh and 98 percent retained by 200-mesh.
6. Bulk Density: 65 pounds per cubic foot, minimum.
7. Minimum Resistivity: 0.10 ohm-cm at 150 psi.
8. Manufacturers and Products:
    a. Asbury Carbon, Asbury, NJ; Asbury 251-P.
    b. Cathodic Engineering Co., Hattiesburg, MS; Loresco SC-3.
    c. Great Lakes Carbon, New York, NY; Carbo Coke 60.

B. Composition of Metallurgical Coke:

1. Volatile Matter: 6 percent maximum.
2. Ash: 18 percent maximum.
3. Sulfur: 1 percent maximum.
4. Fixed Carbon: 82 percent minimum.
5. Particle Size: 1/8 inch to 3/8 inch.
6. Bulk Density: 45 pounds per cubic foot.

2.04 DEEP ANODE CONSTRUCTION MATERIALS

A. Vent Pipe:

1. Active Column: 1 inch, ASTM D1785 Schedule 40 PVC pipe, with 1/8-inch holes drilled completely through both sides of pipe at 4-inch centers in active anode column area.
2. Inactive Column and Buried: Solid 1-inch, ASTM D1785 Schedule 40 PVC.

3. Surface Vent Pipe: ASTM A53/A53M standard steel pipe, 1-inch diameter with 180-degree fabricated gooseneck at the top. Hot-dip galvanize after fabrication.

B. Casing: ASTM A53/A53M, standard weight steel pipe.

C. Ground Bed Sealing Material: Cement grout, bentonite-gelatinous mud, puddled clay, or concrete in accordance with applicable state and local regulations.

D. Deep Anode Well Cap:

1. Two-piece, cast-iron well seal with a rubber packer to form a watertight seal.
2. Seals shall allow vent pipe penetrations with rubber packing providing a watertight seal of annular space.
3. Manufacturers:
   a. Campbell Manufacturing, Bechtelsville, PA.
   b. Berkeley Pump Co., Berkeley, CA.

E. Anode Terminal Box:

1. Terminal Box: NEMA 250, Type 4 or Type 4X coated 14-gauge steel with minimum inside dimensions of 16 inches by 12 inches by 6 inches deep. Furnish box with a one-piece oil-resistant gasket mounted inside door to form oiltight and dustfree seal.
2. Coatings for Steel Boxes: Baked enamel or heat-cured 100 percent solid thermosetting epoxy coating.
3. Terminals and Connectors: Furnish a separate panelboard, buss bar, and terminal strip or terminal block connectors, and necessary fasteners for connecting anode lead terminals to rectifier positive lead.
4. Shunts: Holloway Type RS, 0.01 ohm.
5. Manufacturers:
   a. Universal Rectifiers Inc., Rosenberg, TX.
   b. Stahlin Brothers, Inc., Belding, MI.
   c. Hoffman Engineering Co., Anoka, MN.

2.05 GUARDRAIL ASSEMBLY

A. Material: ASTM A53/A53M, Type E or Type S, Grade B, Schedule 40 steel pipe, with 4-inch-diameter corner posts and 2-inch-diameter guardrails.

B. Fabrication: Weld together and grind rough spots and sharp edges of steel post and rails; sandblast to Commercial Grade (SSPC-SP 6) and coat with one coat

of rust-inhibitive primer and two coats of alkyd enamel paint. Total coating system 6 mils dry film thickness, minimum.

2.06 HEADER WIRE JUNCTION BOX

A. Junction Box: NEMA 250, Type 4 or Type 4X coated 14-gauge steel with minimum inside dimensions of 16 inches by 12 inches by 6 inches deep. Furnish box with a one-piece oil-resistant gasket mounted inside door to form and oiltight and dustfree seal, stainless steel latches, and a hasp for padlocking. Box shall be suitable for mounting with a double hub on two 2-inch or larger rigid steel conduits.

B. Coatings for Steel Boxes: Baked enamel or heat-cured 100 percent solid thermosetting epoxy coating.

C. Terminals and Connectors: Furnish separate panelboard, buss bar, and terminal strip or terminal block connectors, and necessary fasteners for connecting anode lead terminals to rectifier positive lead and structure wires to rectifier negative lead.

D. Mounting: Furnish junction box on two 2-inch rigid steel conduits and mounting hardware necessary to provide a rigid support.

E. Terminal Box Manufacturers:

1. Universal Rectifiers Inc., Rosenberg, TX.
2. Stahlin Brothers, Inc., Belding, MI.
3. Hoffman Engineering Co., Anoka, MN.

2.07 RECTIFIER

A. General: Air-cooled, manually controlled. Design rectifier to operate continuously at an ambient temperature of 45 degrees C and capable of 110 percent of rated input without damage to the rectifier components.

B. Ac Input: 120/240 volts, single-phase, 60-Hz. Furnish suitably sized magnetic type circuit breaker mounted on rectifier panel.

C. Transformer:

1. Two-winding, insulating type, meeting requirements of NEMA, UL, and CSA.

2. Furnish with fine and coarse secondary taps with rectifier output controlled by a minimum of 20 evenly divided steps of adjustment. Arrange coarse and fine taps in consecutive order.
3. Insulation: Rated for a minimum temperature of 130 degrees C with actual hottest spot temperature at rated conditions not to exceed 100 degrees C.

D. Rectifying Elements: Full wave bridge, silicon selenium diode stack with efficiency filter, metal oxide thyristors, and current-limiting devices for overvoltage and overcurrent protection of stack.

E. Output Rating: 8 volts, 4 amperes, minimum.

F. Lightning Protection: Furnish for ac input and dc output.

G. Meters: Dc voltage and current meters, D'Arsonval jeweled movement type, accurate to within 2 percent of actual voltage and current output.

H. Shunt: Holloway type shunt mounted in series with the ammeter, with voltage and current clearly identified on shunt body.

I. Enclosure:

1. 11-gauge galvanized steel suitable for post mounting.
2. Furnish with hinged doors on front and both sides to allow access, stainless steel latches, and hasp for locking.
3. Seal enclosure to protect interior components from weather, vandalism, and nest building insects; furnish adequate ventilation.

J. Panelboard:

1. Nonmetallic, suitable for mounting meters, shunt, circuit breaker, fuses, and output terminals.
2. Locate panelboard at front of rectifier to allow access for testing and adjustment.
3. Clearly engrave or identify with a permanent marking system the polarity of output terminals, fine and course transformer tap settings, meters, and fuses.

K. Convenience Outlet: 120V ac ground fault interrupting (GFI) convenience outlet installed on rectifier panel.

L. Current Interrupter: Solid state timing device to interrupt secondary current. Interrupter shall be capable of continuous operation, and shall consist of

1-minute adjustable recycling timer or electronic timer, “Test-Normal” toggle switch, and relay or connector to interrupt main circuit.

M. Mounting Hardware: Tap studs, tap bars, nuts, washers, and other mounting hardware shall be suitably sized brass or tin-plated copper.

N. Nameplate: Engraved metal plate mounted on interior side of front door listing manufacturer name, model number, serial number, year manufactured, and ac and dc input and output electrical ratings.

O. Manufacturers and Products:

1. Universal Rectifiers Inc., Rosenberg, TX; Air Cooled Gas Station Series.
2. Corpro, Houston, TX Model SW Series.

2.08 OVERHEAD POWER SERVICE

A. Service Pole: Class 5, 30-foot, preservative treated wood pole, or as required to meet or exceed local electrical codes and utility requirements.

B. Weatherhead: 1-inch cast aluminum, Crouse-Hinds Type F; Thomas and Betts 1540AL Series.

C. Meter Base: 240-volt, single-phase, three-wire, 100-ampere, with 1-inch hubs in accordance with local power utility requirements. Type 3R construction, combination meter/main CB-load center—safety socket with factory installed test/bypass facilities. Provide provisions for padlock on load side hinged door to accommodate a 7/16-inch lock shank. Furnish with circuit breakers sized for 110 percent to 135 percent of ac current flow at maximum rectifier output.

D. Entrance Switch: Heavy-duty, fusible NEMA 250, Type 3R raintight, rated at 240 volts, 30 amperes, two-pole. Furnish with circuit breakers sized for 110 percent to 135 percent of ac current flow at maximum rectifier output. Provide provisions for padlock on load side hinged door to accommodate a 7/16-inch lock shank.

E. Ground Rod: Copper-clad steel, 5/8-inch diameter by 8-foot long.

F. Ground Wire and Clamp: 6 AWG solid copper ground wire with a high copper content alloy or bronze bolt-on ground rod clamp.

2.09 UNDERGROUND POWER SERVICE

A. Pedestal Rating: 100-ampere, single service pedestal enclosure with a combination meter base and two-pole circuit breaker sized for 110 percent to 135 percent of the ac current flow at maximum rectifier output. Type 3R construction, combination meter/main CB-load center—safety socket with factory installed test/bypass facilities. Provide provisions for padlock on load side hinged door to accommodate a 7/16-inch lock shank.

B. Pedestal Case: 12-gauge steel minimum. Provide provisions for padlock on circuit breaker cover door to accommodate a 7/16-inch lock shank.

C. Special Coating: Furnish pedestal case with a polyamide converted epoxy coating, applied in two coats to a dry film thickness of 8 mils minimum. Pedestals furnished with coating that does not meet or exceed this requirement shall be sanded to bare metal and coated with specified coating.

2.10 CONDUIT, FITTINGS, AND ACCESSORIES

A. Rigid and Flexible Conduit and Fittings: As specified in Section 26 05 33, Raceway and Boxes for Electrical Systems.

B. Rigid Metal Conduit and Fittings: Hot-dipped galvanized steel meeting requirements of NEMA C80.1 and UL 6 and UL 514B. Do not use setscrew type couplings, elbows, and nipples.

C. Intermediate Conduit and Fittings: Hot-dipped galvanized steel meeting requirements of NEMA C80.6 and UL 1242 and UL 514B. Do not use setscrew type couplings, elbows, and nipples unless approved by Owner.

D. Rigid PVC Conduit and Fittings: ASTM D1785, Schedule 40, UL listed for concrete-encasement, underground direct burial, concealed and direct sunlight exposure. Conduits, couplings, elbows, nipples, and other fittings shall meet requirements of NEMA TC 3, UL, NEC, and ASTM specified tests for intended use.

E. Flexible Metal Conduit: UL 360 listed, liquid-tight conduit consisting of galvanized steel flexible conduit covered with an extruded PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.

F. Locknuts, Two-Hole Straps, and Miscellaneous Hardware: Hot-dipped galvanized steel.

G. Conduit Bushings: Threaded plastic or plastic-coated galvanized steel fittings.

2.11 HANDHOLES AND PULL BOXES

A. Concrete boxes of reinforced cast concrete, 10 inches by 17 inches by 8 inches deep minimum inside dimensions. Furnish with hot-dipped galvanized steel cover fastened in place with stainless steel screws.

B. Manufacturers and Products:

1. Brooks Products, Inc.; Model 36-PB.
2. Oldecastle; Model Christy B1017.

2.12 CONCRETE

A. Furnish as specified in Section 03 30 00, Cast-in-Place Concrete.

2.13 CONCRETE

A. Reinforcing Steel: ASTM A615/A615M, Grade 60 deformed bars.

B. Welded Wire Fabric: ASTM A497/A497M.

C. Formwork: Earth cuts may be used.

D. Mix: ASTM C94/C94M, Option A.

1. Cement: ASTM C150, Type V.
2. Coarse Aggregate Size: 1-1/2 inches.
3. Design for Minimum Compressive Strength at 28 Days: 3,000 psi.

2.14 CONCRETE

A. Materials: ASTM C387 or ASTM C1480, packaged, dry, combined ingredients with Type V cement.

B. Mixing: In a clean metal container, mix entire package of dry materials by hand or machine. Following manufacturer’s instructions, add clean water in sufficient quantity to produce a slump of 2 inches to 3 inches.

2.15 CONDUCTORS

A. Conductors, ac: As specified in Section 26 05 05, Conductors.

B. Anode Header Wire: Single-conductor, 4 AWG stranded copper with 600-volt HMWPE insulation.

C. Anode Wire:

1. Single-conductor, 8 AWG stranded copper.
2. 600-volt HMWPE insulation. Acceptable anode wire is Permarad, as manufactured by Raychem Corp., Menlo Park, CA.
3. Furnish of sufficient length to extend splice-free from anode connection to anode junction box terminals plus 30 feet.

2.16 ANCILLARY MATERIALS

A. Compression Connectors: For in-line, tap, and multisplice compression connectors, furnish “C” taps made of conductive wrought copper, sized to fit wires being spliced.

1. Manufacturer and Product: Burndy; Type “YC.”

B. Splice Insulating Kits:

1. Tap Splice: 3M Co., Scotchcast 90-B1.
2. In-Line Splice: 3M Co., Scotchcast 82-A1.
3. Multi-Mold Splice: 3M Co., Scotchcast 85-12.

C. Warning Tape: Heavy-gauge, yellow plastic tape, 3 inches minimum width, labeled with “CAUTION: BURIED CABLES BELOW” in bold black letters for full length of tape. Make warning tape of a nontraceable material resistant to corrosive soil and intended for direct burial service.

D. Wire Connectors: One-piece, tin-plated crimp-on lug connector as manufactured by Burndy Co. or Thomas and Betts.

E. Earthfill: Native soil material free from rocks larger than 2 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious matter.

F. Backfill: Natural material from trench excavation with a maximum particle size of 1/4 inch and free from roots and organic matter and construction debris.

2.17 THERMITE WELD MATERIALS

A. General:

1. Wire sleeves, welders, and weld cartridges according to weld manufacturer's recommendations for each wire size and pipe or fitting size and material.
2. Welding materials and equipment shall be product of a single manufacturer.
3. Interchanging materials of different manufacturers will not be acceptable.

B. Molds: Graphite. Ceramic "One-Shot" molds are not acceptable.

C. Adapter Sleeves:

1. Furnish for 12 AWG and 2 AWG wires.
2. Prefabricated factory sleeve joint bonds or bond wires with formed sleeves made in field are acceptable.
3. Attach field-formed sleeves with appropriate size and type of hammer die furnished by thermite weld manufacturer.
4. Extend wire conductor 1/4 inch beyond end of sleeve.

D. Cast Iron Thermite Weld Cartridges: Use for cast and ductile iron pipe and fittings; maximum cartridge size 25 grams for steel and 32 grams for cast and ductile iron materials, respectively.

E. Welders and Cartridges:

Pipe Material	**Weld Type**	**Cartridge Size, Max.**
4 AWG Wire and Smaller:		
Steel	HA, VS, HC	25 gm
Ductile Iron	HB, VH, HE	32 gm
Cast Iron	HB, VH, HE	32 gm
2 AWG Joint Bonds:		
Steel	FS	25 gm
Ductile or Cast Iron	FC	32 gm
Concrete Cylinder Pipe	HA, GR	32 gm

F. Manufacturers:

1. Erico Products Inc. (Cadweld), Cleveland, OH.
2. Continental Industries, Inc. (Thermo-Weld), Tulsa, OK.

G. Thermite Weld Coating:

1. Thermite Weld Caps: Prefabricated weld cap with coating and suitable primer; Handy Cap with Royston Primer 747, as manufactured by Royston Laboratories, Inc.
2. Insulating Resin: 100 percent solids epoxy that can cure in submerged or buried conditions. At Contractor's option, bitumastic coating (Carboline Bitumastic 50 or equal) may be used if it is allowed to dry completely before covering.
3. Use products recommended by pipe or fitting manufacturer to repair spot damage at thermite weld connections not covered by standard pipeline coating repair procedure or thermite weld cap.

2.18 SACRIFICIAL ANODES - MAGNESIUM

A. Magnesium Anodes: Use high potential magnesium anodes. Follow the metallurgical composition of the magnesium anodes as listed below:

Element	Percent Composition
Aluminum	0.01 Maximum
Manganese	0.50 to 1.3
Copper	0.02 Maximum
Nickel	0.001 Maximum
Iron	0.03 Maximum
Other - (each)	0.05 Maximum
Other - (total)	0.30 Maximum
Magnesium	Balance

B. Magnesium Anode Current Capacity: Magnesium anodes require a current capacity of no less than 500 amp-hours per pound of magnesium.

C. Anode Backfill Material: Use chemical backfill material around all galvanic anodes. Backfill provides a reduced contact resistance to earth, provides a

uniform environment surrounding the anode, retains moisture around the anode, and prevents passivation of the anode.

1. All galvanic anodes come prepacked in a backfill material conforming to the following composition:
   a. Ground Hydrated Gypsum: 75 percent.
   b. Powdered Bentonite: 20 percent.
   c. Anhydrous Sodium Sulfate: 5 percent.
2. Have a grain size backfill such that 100 percent is capable of passing through a 20-mesh screen and 50 percent is retained by a 100-mesh screen.
3. Completely surround the anode with the backfill mixture within a cotton bag.
4. For standard cast magnesium ingots, the required weight of backfill follows:

Anode Weight (pounds)	Backfill Weight (pounds)	Total Weight (pounds)
9	15	24
17	25	42
20	50	70
32	38	70
48	48	96

D. Anode Lead Wires:

1. Use a 20-foot length of No. 12 AWG solid copper wire equipped with TW or THW insulation for standard lead wires for a galvanic anode.
2. Color code all anode lead wires green when terminated in test stations.

E. Lead Wire Connection to Magnesium Anode:

1. Cast magnesium anodes with a galvanized steel core with the weight of the core not to exceed 0.10 pound per linear foot.
2. Recess one end of the anode to expose the core for the lead wire connection.
3. Silver-solder the lead wire to the core and fully insulate the connection by filling the recess with an electrical potting compound.

2.19 SACRIFICIAL ANODES - ZINC

A. Zinc Anodes: Use high purity zinc anodes. The metallurgical composition of the zinc anodes conform to ASTM B418, Type II and the following:

Element	Percent Composition
Aluminum	0.005 Maximum
Cadmium	0.003 Maximum
Iron	0.0014 Maximum
Lead	0.003 Maximum
Zinc	Balance

B. Zinc Anode Current Capacity: Zinc anodes require a current capacity of no less than 335 amp-hours per pound of zinc.

C. Anode Backfill Material: Use chemical backfill material around all galvanic anodes. Backfill provides a reduced contact resistance to earth, provides a uniform environment surrounding the anode, retains moisture around the anode, and prevents passivation of the anode.

1. All galvanic anodes come prepackaged in a backfill material conforming to the following composition:
   a. Ground Hydrated Gypsum: 75 percent.
   b. Powdered Bentonite: 20 percent.
   c. Anhydrous Sodium Sulfate: 5 percent.
2. Have a grain size backfill such that 100 percent is capable of passing through a 20-mesh screen and 50 percent is retained by a 100-mesh screen.
3. Completely surround the anode with the backfill mixture within a cotton bag.
4. For standard cast zinc ingots, the required weight of backfill follows:

Anode Weight (pounds)	Backfill Weight (pounds)	Total Weight (pounds)
30	40	70
45	55	100
60	70	130

D. Anode Lead Wires: For the lead wire for the zinc anodes, use a 20-foot length of No. 12 AWG solid copper wire equipped with TW of THW insulation.

E. Lead Wire Connection to Zinc Anode:

1. Cast zinc anodes with a 1/4-inch diameter galvanized steel core.
2. Extend one end of the core beyond the anode for the lead wire connection.
3. Silver-solder the lead wire to the core and fully insulate the connection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Construct impressed current cathodic protection system for the following:

1. Buried steel pipe and appurtenances.

B. Conform to NFPA 70.

C. Provide metering facilities as required by electric utility for utility's installation of metering equipment, service conductors, and mounting of utility company equipment.

3.02 DEEP ANODE GROUND BED INSTALLATION

A. General:

1. Drilling, electrical logging, lowering of anodes, coke breeze placement, and backfilling shall be done in one continuous operation, and shall be observed by Contractor's Cathodic Protection Specialist.
2. Perform drilling and waste disposal in accordance with methods and procedures that comply with rules and regulations of state, city, county, or other governing bodies having jurisdiction. Seal hole with ground bed sealing material or as required by local well drilling regulations. The most stringent regulations apply.
3. Take necessary precautions to avoid entrance of foreign matter into hole, movement of soil strata, or collapsing of hole during progress of the Work. Should movement of soil strata or collapse of drilled hole interfere with proper completion of ground bed, recover wires and anode strings and ream or redrill hole.
4. Maintain a log describing depth and type of geological formations encountered during drilling.

B. Drilling:

1. Approximate location of ground beds is shown on Drawings. Coordinate actual location of ground bed hole in field with Owner before drilling begins.
2. Construct hole and set casing round, straight, and plumb.
3. Set surface casing prior to completion of the first 50 feet of the hole. Casing, other than surface casing, shall not be installed or left in hole unless in driller's estimation it is necessary for successful completion of the hole. Plastic casing may be installed in the inactive column, at Contractor's option, but shall not extend into the active column.
4. If steel casing is installed in the active column, it shall be cut below surface and top portion jacked to provide a minimum of 10 feet separation between upper casing section and top of active column. Complete cutting of steel casing before anodes are installed; jacking operations may be completed before or after installation of anode assembly at Contractor's option.
5. Overdrill the hole to compensate for sloughing or heaving during anode installation.

C. Electrical Logging:

1. Flush the hole and electrically log the hole in the presence of Owner to determine downhole characteristics for optimum anode elevations.
2. Acceptable Method of Electrical Logging: Make a resistance to earth reading as a short section of pipe is lowered down the hole. Test with suitable meters, a short section of weighted metallic pipe, connection to a low resistance ground, a wire reel with appropriate type, size, and amount of wire to reach bottom of the hole, and a method to measure downhole wire length or footage identification marking on wire to allow determination of test pipe depth.
3. Record resistance reading and depth from surface continuously or at 5-foot increments for entire hole depth.
4. Based on the results of the electrical log data and the driller's log of soil formations, Owner may modify anode spacing and drilled depth.

D. Lowering of Anodes:

1. Notify Engineer prior to beginning this Work.
2. Lower anodes after drilling is completed.
3. Install anodes and coke breeze on same day as the completion of drilling and electrical logging.

4. Anode Centralizers:
   a. Attach to each anode prior to lowering.
   b. If metal centralizers are used, apply tape to clamps and ends of rods to cover sharp edges to reduce potential for wire insulation damage during anode installation.
   c. If steel casing is used and extends into active column, anode centralizers shall be electrically isolated from casing by a method approved by Engineer.
5. Vent pipe shall be joined by threaded couplings; no glued joints will be allowed.
6. Attach deepest anode to predrilled vent pipe. Lower anode and vent pipe to bottom of hole. Lower remaining anodes individually.
7. Provide sufficient slack in anode wires to prevent damage during anode and coke breeze installation.
8. Damage to anodes or cut, gouged or scraped wire insulation will not be acceptable. No wire splices will be allowed inside deep anode ground bed.
9. If anodes are installed using a steel centering pipe, provide electrical isolation of centering pipe from steel casing, if steel casing is used in the active column. Include reverse fitting or other method to disconnect and remove steel centering pipe from upper portion of ground bed (inactive column).
10. If hole is drilled with mud, flush hole with clean water in a continuous process before or after the anodes are lowered, at Contractor's option, until return fluid is sufficiently clear to allow proper installation and settlement of anodes, vent pipe, and coke breeze.

E. Backfilling of Anode Hole:

1. Notify Owner prior to beginning the Work.
2. Keep hole full of water during installation of the coke breeze.
3. Prepare coke breeze slurry with water in accordance with manufacturer's written recommendations. Pump coke breeze slurry into hole through an additional plastic pipe. Pump coke breeze in an even and continuous manner from bottom of hole to top as plastic pipe is slowly withdrawn. Top-loading the coke breeze, by pouring coke breeze into the hole, will not be permitted.
4. At Contractor's option, coke breeze and anodes may be installed concurrently. Submit proposed alternative methods of anode and coke breeze installation to Owner for review and approval prior to beginning the Work.
5. Conduct resistance measurements between an appropriate grounded structure or pipeline and each anode lead as coke breeze is installed.

Start individual anode resistance measurements at bottom anode. When resistance measurement indicates that coke breeze level has covered bottom anode, connect test leads to next higher anode wire and monitor resistance measurement as coke breeze is installed. Use resistance measurements to monitor coke breeze level in drilled hole and detect possible coke breeze bridging problems during installation.

6. Install pea gravel to depth shown or as required by local drilling codes.

F. Placement of Seal:

1. Place sealing material in accordance with local and state regulations.
2. Place seal by pumping or forcing material from bottom to within 18 inches of finished grade. Place seal in such a manner that ensures entire filling of the space in one continuous operation.
3. Install sealing material in the annular space between casing and soil.

G. Anode Wire Termination: Cut a smooth hole in side of casing for routing wires to anode junction box. Install rubber grommet or pipe with plastic bushings on both ends in the hole to prevent damage to wire insulation by casing.

H. Ground Bed and Vent Pipe Termination: Place vent pipe through well cap, and connect steel portion of vent pipe to plastic vent pipe with appropriate threaded coupling, 6 inches minimum below grade. Place well cap in casing and torque bolts in accordance with manufacturer's recommendations.

3.03 SURFACE GROUND BED INSTALLATION

A. Anode Field Location: Establish and stake the anode locations in the field with wood lath for review and approval by Owner.

B. Anode Spacing/Depth: Install anodes in a vertical position at the spacings and depths shown on Drawings. Individual anode locations can be varied 10 feet maximum to allow adjustment for field conditions or to maintain separation from existing structures.

C. Vertical Anode: Install individual anodes in a vertical position at the approximate anode depth, hole location, and spacing shown on Drawings. Attach anode centralizer firmly to anode and carefully lower into drilled hole. Carefully pour coke breeze into drilled hole so as to avoid bridging or caving of the hole. Thoroughly compact coke breeze below, above, and around sides of the anode with no voids. Maintain anode in center of coke breeze column, and not in contact with native soil.

D. Drilling: Anode hole shall be nominal depth and diameter shown on Drawings. Overdrill anode hole as required to compensate for sloughing during anode and coke breeze installation. Take precautions to avoid entrance of foreign matter into hole, movement of soil strata, or collapsing of hole during progress of the Work. Should movement of soil strata or collapse of drilled hole interfere with the proper completion of ground bed installation, recover wire and anode, and ream or redrill hole. Drill holes and seal in accordance with rules and regulations of the state, city, county, or other governing bodies having jurisdiction.

E. Earthfill: Carefully place and compact above coke breeze in 6-inch lifts to a point 2 feet above coke breeze. Complete backfilling and compacting to grade. Stop backfill at grade to allow placing of topsoil, pavement, road base, or concrete where required.

F. Anode Lead-to-Anode Header Wire Connections: Connect anode lead wire to anode header wire with specified compression connectors with a suitable sized crimp tool for connector and wire sizes being spliced.

G. Wire Splice Insulation: Install splice kits according to manufacturer's recommendations. Make splices waterproof, suitable for direct burial. Provide 1-hour setting time prior to moving splice or placing splice in trench and backfilling.

H. Anode Header Cable: Install cables in center of trench. Maintain sufficient slack in wire to prevent cable from being unduly stressed or broken during backfill operations.

3.04 TRENCHING

A. Excavation: As specified in Section 31 23 16, Excavation.

B. Fill and Backfill: As specified in Section 31 23 23, Fill and Backfill.

C. Complete excavations and trenching regardless of type, nature, or condition of materials encountered, as required to accomplish specified construction to lines and grades shown.

D. Take care to avoid damage to existing structures and utilities during excavating and trenching process. Cathodic protection excavations and cable trenches shall be in the general location and route as shown. Contractor may modify location as approved by Owner as required to minimize possible damage to existing structures. Trench shall be of uniform depth and width,

level, smooth, and free of sharp objects. Hand trenching may be required in some areas to avoid damage to existing structures.

E. Sheet and brace excavations and trenches as necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workers, and the public.

F. Backfill trench with excavated backfill materials, tamp, and compact so that no subsequent settlement will occur. Do not use backfill material of frozen or consolidated debris. Leave trench with the excess backfill material neatly mounded not more than 4 inches above existing ground level for entire width of trench.

3.05 GUARDRAIL ASSEMBLY

A. Set posts plumb and straight in concrete footing.

3.06 CONDUITS

A. Install conduits in accordance with Section 26 05 33, Raceway and Boxes for Electrical Systems.

B. Secure conduits entering cabinets, junction boxes, or terminal boxes with double locknuts, one on outside and one on inside.

C. Install insulated bushings and insulated throat connectors on ends of rigid metallic conduit.

D. Use watertight couplings and connections. Install and equip boxes and fittings to prevent water from entering conduit or box. Seal unused openings.

3.07 ANODE TERMINAL BOX INSTALLATION

A. Connect rectifier positive lead and anode wires to junction box terminals with shunts, bus bars, and appropriate fasteners.

B. Label wires in terminal box with permanent brass tags identifying anode number and rectifier lead. Connect numbered anodes in consecutive order to anode terminals starting with number one at the top left-hand side. Maintain sufficient slack to keep wire from being unduly stressed, damaged, or broken during backfill.

3.08 RECTIFIER INSTALLATION

A. Provide conductors and electrical hardware necessary for rectifier installation. From disconnect switch to rectifier use 4 AWG single conductor stranded copper wire with 600-volt THWN insulation.

B. Install rectifier wire from rectifier negative terminal to pipeline. Install rectifier wire from rectifier positive terminal to anode terminal box.

C. Notify Engineer 10 working days prior to completion of rectifier, ground bed, and ac power service installation to allow scheduling of required energizing and testing.

3.09 AC POWER SERVICE

A. Provide alternating current power to rectifier disconnect switch in accordance with code and local power utility requirements. Power service installation shall meet or exceed local and NEC code requirements.

B. Coordinate installation of electrical power service with local power utility.

3.10 CONCRETE

A. Reinforcing: Accurately place in accordance with CRSI Recommended Practice.

B. Minimum Compressive Strength at 7 Days: 3,000 psi.

C. Placing, Consolidating, and Finishing: Follow ACI 301.

3.11 CONDUCTOR INSTALLATION

A. Install and pull conductors in accordance with Section 26 05 05, Conductors.

B. Rectifier to Pipeline and Anode Junction Box: Single-conductor, 4 AWG stranded copper with 600-volt High Molecular Weight Polyethylene (HMWPE) insulation 7/64 inch thick.

C. Arrange conductors neatly in rectifier and junction or terminal box. Cut to proper length, remove surplus wire, and attach terminal or connect to appropriate junction box or rectifier terminal.

D. Seal belowground conduit to prevent intrusion of foreign material after wire is in place.

E. Direct buried rectifier or galvanic anode wires shall be 36 inches deep, minimum, below finished grade. Wires shall be free of splices, except those approved by Engineer.

F. Bury warning tape approximately 12 inches above underground rectifier conductors and conduits. Align parallel to and within 2 inches of centerline of conduit or conductor run.

3.12 WIRE CONNECTIONS

A. Provide crimp tool and die recommended by manufacturer for wire and tap connector size.

B. Thermite Weld:

1. Use thermite weld method for electrical connection of copper wire to steel, ductile, and cast iron surfaces. Observe proper safety precautions, welding procedures, thermite weld material selection, and surface preparation recommended by the welder manufacturer. Ensure pipe or fitting wall thickness is of sufficient thickness that thermite weld process will not damage integrity of pipe or fitting wall or protective lining.
2. After weld connection has cooled, remove slag, visually inspect, and physically test wire connection by tapping with a hammer; remove and replace defective connections.
3. On pipe and fittings with dielectric linings, make weld connection on shop tab provided or on a thick metal section to minimize damage to lining and coating. After weld is made, coat weld with coating repair material.
4. Install a prefabricated thermite weld cap over each completed connection. Repair exposed metal surfaces not covered by thermite weld cap in accordance with coating manufacturer’s recommendations. Repair damage to pipe lining in accordance with lining applicator’s recommendations.
5. Make wire connections to concrete cylinder pipe by thermite welding to shop welded steel studs or plates provided on pipe for this purpose. Clean steel studs to bright metal before thermite welding. Coat completed wire connection with cement mortar as shown on Drawings.

C. Silver Solder:

1. Use for electrical connection of copper wire to thin-wall steel tubing (0.035-inch wall and less) or copper or stainless steel pipe.

2. Before connection is made, flux area around connection with suitable flux for materials being welded.
3. Weld copper sleeved wire to fluxed area with silver brazing alloy in such a manner that completed connection is free of cracks or crevices.
4. After connection is completed, remove remaining flux by wire brushing.
5. Coat the finished connections on copper pipe and steel tubing only.
6. After solvent cleaning, SSPC SP 1, apply one of the following:
   a. One coat of a vinyl butyral wash primer and two coats of coal-tar mastic.
   b. 12-mil total thickness polyethylene backed, butyl rubber adhesive pipeline tape, spirally applied with a 55 percent overlap of succeeding wraps for a distance of 4 inches to each side of connection.
   c. Thermite weld cap filled with coal-tar mastic and taped in place with electrical tape.

3.13 FIELD TESTING

A. Functional Testing:

1. Perform functional testing in presence of Engineer.
2. Leave rectifiers turned off during installation of cathodic protection ground beds.
3. When construction of each cathodic protection station is completed, notify Owner that installation is ready to be turned on.
4. At such a time as Engineer may indicate, energize installation. At this time, conduct operating test to demonstrate equipment is installed correctly and operating properly for initial Engineer approval.

B. Meters: Field test meters for accuracy; replace inaccurate meters.

C. Energizing and Testing: After cathodic protection stations have been constructed and individual function testing completed, conduct a final test witnessed by Engineer to demonstrate entire system operates properly.

3.14 INSTALLATION OF SACRIFICIAL ANODES

A. Location: Install sacrificial anodes at locations where the anodes will operate at maximum effectiveness.

B. Placement: Install anodes in native soil, in a vertically augured hole as shown on Drawings. If a vertical installation of the anodes is not feasible, the anodes may be installed horizontally.

C. Backfilling: After the hole is augured, lower the packaged anode into the hole and firmly tamp the soil around the package so that it is in intimate contact with the package.

D. Lead Wire: Run lead wires from the anodes underground at a minimum depth of 36 inches. Connect the wires through a test station as indicated on Drawings.

E. Handling: Handle galvanic anodes carefully to avoid damaging anode materials and wire connections.

END OF SECTION

SECTION 26 43 00
SURGE PROTECTIVE DEVICE

PART 1 GENERAL

1.01 SUBMITTALS

A. Submit product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.

B. Submit manufacturer's UL certified test data and nameplate data for each SPD.

C. Submit electrical single-line diagram showing location of each SPD.

1.02 QUALITY ASSURANCE

A. UL Compliance and Labeling:

1. For power and signal circuits, SPD devices shall comply with UL 1449 (latest edition) and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units that are listed and labeled by UL.
2. For telephone circuit protection, SPD devices shall comply with UL 497A.

B. ANSI Compliance: Use SPD devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

PART 2 PRODUCTS

2.01 GENERAL

A. All SPD devices for power circuits, provided under this section, shall be the product of a single manufacturer.

B. SPD devices shall be capable of performance at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 12,000 feet.

C. SPD devices shall be fused to disconnect the suppressor from the electrical source should the suppressor fail. The fusing shall allow full surge handling

capabilities and to afford safety protection from thermal overloads and short circuits.

D. Design SPD devices for the specific type and voltage of the electrical service. Single-phase and three-phase wye-configured systems shall have L-N, L-G, and N-G protection. Grounded delta-configured systems shall have L-L and L-G protection.

E. Power Filter: The SPD shall include a high frequency extended range power filter complimentary listed to UL 1283 as an electromagnetic interference filter.

2.02 MANUFACTURERS

A. Innovative Technology, VanGuard Series.

B. Advanced Protection Technologies, Inc.

C. General Electric.

2.03 MAIN DISTRIBUTION SPD

A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.

B. Surge current capacity shall be not less than the following:

1. L-N Capacity: 200 kA.
2. L-G Capacity: 120 kA.
3. N-G Capacity: 120 kA.

C. Suppressor housing shall be in an enclosure that has the same NEMA rating as the equipment it protects and painted to match.

D. UL 1449 maximum suppression voltage shall not be more than:

System Voltage	Phase	L-L or L-N Suppression Voltage
120	1	400
208Y/120	3	400
240	3	800
480Y/277	3	800

2.04 PANELBOARD SPD

A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location Category B.

B. Surge current capacity shall be not less than the following:

1. L-L Capacity: 80 kA.
2. L-N Capacity: 80 kA.
3. L-G Capacity: 80 kA.
4. N-G Capacity: 80 kA.

C. Suppressor shall be in an enclosure that has the same NEMA rating as the panel it protects or the SPD may be integral to a panelboard.

D. UL 1449 maximum clamp voltage shall not be more than:

System Voltage	Phase	L-L or L-N Clamp Voltage
120	1	400
208Y/120	3	400
240	3	800
480Y/277	3	800

2.05 ANNUNCIATION

A. Provide unit or separately mounted LED-type indication lights to show the normal and failed status of each module. Provide one normally open and one normally closed contacts which operate when the unit fails.

2.06 SURGE COUNTER

A. Provide each SPD rated above 100 kA with a counter displaying the number of voltage transients that have occurred on the unit input. The counter shall be battery backed and retain the count through system power outages.

2.07 PAIRED CABLE DATA LINE INTERIOR SUPPRESSORS

A. Provide units meeting IEEE C62.41, Location Category A.

B. Use bi-polar 1,500-watt silicon avalanche diodes between the protected conductor and earth ground.

C. Provide units with a maximum single impulse current rating of 80 amperes (10 by 1,000 microsecond-waveform).

D. Breakdown voltage shall not exceed 36 volts.

2.08 PAIRED CABLE DATA LINE EXTERIOR SUPPRESSORS

A. Provide units meeting IEEE C62.41, Location Category A.

B. Suppressors shall be a hybrid design with a minimum of three stages, utilizing solid-state components and operating bi-directionally.

C. Suppressors shall meet or exceed the following criteria:

1. Maximum single impulse current rating of 10,000 amperes (8 by 20 microsecond-waveform).
2. Pulse Life Rating: 3,000 amperes (8 by 20 microsecond-waveform): 2,000 occurrences.
3. Maximum clamping voltage at 10,000 amperes (8 by 20 microsecond current waveform), shall not exceed the peak of the normal applied signal voltage by 200 percent.

PART 3 EXECUTION

3.01 APPLICATION REQUIREMENTS

A. Install SPD when indicated on the Drawings and:

1. Main Distribution SPD in or near each low-voltage switchgear (load center).
2. Main Distribution SPD in or near each motor control center.
3. Panelboard SPD In or near each distribution panelboard unless otherwise indicated.

B. Electronic Equipment Paired Cable Conductors: Install data line suppressors at the low voltage input and output of each piece of equipment, including telephone cable entrance.

1. Use secondary protectors on lines that do not exit the structure.
2. Use primary protectors on lines that exit and enter the structure.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Install suppressors according to manufacturer’s recommendations.

B. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with all conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.

C. Connecting wires shall be as short as possible with gently twisted conductors, tied together, to prevent separation. Connecting wires shall not exceed 24 inches in length at any point.

D. Field installed conductors shall be the same as specified for building wire, not smaller than No. 8 AWG and not larger than No. 4 AWG. Device leads shall not be longer than the length recommended by the manufacturer, unless specifically reviewed and approved by the manufacturer.

E. Provide dedicated disconnecting means for SPD devices installed at main service entrance location, switchgear, and motor control centers. Provide dedicated 30-60-ampere circuit breakers (size dependent upon wire size used) with number of poles as required, as disconnecting means for SPD devices installed at panelboards. The interrupting capacity of the circuit breakers shall be that specified for the other breakers at that location.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; trees, stumps, brush, roots and shrubs; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

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

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

E. Stripping: Removal of topsoil remaining after applicable scalping is completed.

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

1.02 QUALITY ASSURANCE

A. Prior to commencing clearing, grubbing, and stripping, obtain Engineer's approval of staked clearing, grubbing, and stripping limits.

1.03 SCHEDULING AND SEQUENCING

A. Protection:

1. Throughout the Project, protect existing site improvements, including streets, drives, and Underground Facilities to remain, if any and adjacent property and structures. Repair damage caused by Contractor to original condition or replace in kind, to satisfaction of Engineer, at no additional cost to Owner.
2. Protect trees, shrubs, vegetation, and grassed areas to remain by providing temporary fencing, barricades, wrapping, or other methods shown, specified, or accepted by Engineer. Correct at Contractor's

expense damage caused by Contractor outside the limits of clearing Work.

3. Do not remove trees without approval of Engineer, unless shown or indicated for removal.
4. Do not locate construction equipment, stored materials, or stockpiles within drip line of trees and vegetation to remain.

B. Site Preparation:

1. Prepare Site only after adequate erosion and sediment controls are in place.
2. Delineation of Clearing and Grubbing Limits:
   a. Locate and clearly flag trees and vegetation to remain, and other materials to remain in the clearing and grubbing limits. Locate and clearly flag salvable vegetation to be relocated.
   b. Provide flagging to delineate limits of areas to be cleared or grubbed. Review at Site with Engineer before commencing removal of trees, vegetation, and other materials to be removed.
   c. Replace flagging that is lost, removed, or destroyed, until clearing and grubbing Work is complete and Engineer allows removal of flagging.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or Site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.02 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation: 5 feet beyond top of cut slopes.
2. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping and Scalping: 2 feet beyond toe of permanent fill.
3. Waste Disposal:
   a. Clearing: 5 feet beyond perimeter.
   b. Scalping and Stripping: Not required.

c. Grubbing: Around perimeter as necessary for neat finished appearance.

4. Structures: 15 feet outside of new structures.
5. Roadways: Clearing, grubbing 20 feet from centerline.
6. Overhead Utilities:
   a. Clearing and Grubbing: Entire width of easements and rights-of-way.
   b. Scalping and Stripping: Wherever grading is required.
7. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 CLEARING

A. Clear areas within limits shown or specified.

B. Fell trees so that they fall away from facilities and vegetation not designated for removal.

C. Cut stumps not designated for grubbing flush with ground surface.

D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.04 GRUBBING

A. Grub areas within limits shown or specified.

3.05 SCALPING

A. Do not remove sod until after clearing and grubbing is completed and resulting debris is removed.

B. Scalp areas within limits shown or specified.

3.06 STRIPPING

A. Do not remove topsoil until after scalping is completed.

B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

C. Stripping will be done where the proposed excavation will occur in areas where undisturbed topsoil may be present. In such areas, the upper 4 inches of soil will be carefully removed and placed near the excavation. Coordinate exact locations in field with Owner.

3.07 TREE REMOVAL OUTSIDE CLEARING LIMITS

A. Remove Within Project Limits:

1. Dead, dying, leaning, or otherwise unsound trees that may strike and damage Project facilities in falling.
2. Trees designated by the Engineer.

B. Cut stumps off flush with ground, remove debris, and if disturbed, restore surrounding area to its original condition.

3.08 SALVAGE

A. Trees, shrubs, and other vegetation requiring removal to facilitate the Work, and that will be transplanted elsewhere at the Site, shall be carefully balled and burlapped or placed in temporary pots, and stored at the Site in an acceptable area. Work involving removing and relocating trees, shrubs, and other vegetation shall be under the direction the Engineer, or other professional acceptable to Engineer, hired by Contractor.

3.09 DISPOSAL

A. Clearing and Grubbing Debris:

1. Dispose of debris offsite.
2. Burning of debris onsite will not be allowed.
3. Woody debris may be chipped. Chips may be sold to Contractor’s benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
4. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B. Scalpings: As specified for clearing and grubbing debris.

C. Segregate topsoil strippings and stockpile separately from other soils

END OF SECTION

SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM): D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface or Prepared Subgrade: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

D. Subgrade: Surface of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

E. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 10 00, Site Clearing; and Section 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A. Under Earthfill: Compact upper 6 inches to minimum of 90 percent relative compaction as determined in accordance with ASTM D 1557

B. Under Pavement Structure, Floor Slabs On Grade, or Granular Fill Under Structures: Compact the upper 6 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D 1557

3.03 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

A. Proof-roll subgrade with wheeled equipment weighing a minimum of 10 tons to detect soft or loose subgrade or unsuitable material, as determined by Engineer.

3.05 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact.
2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 REFERENCES

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

1. Occupational Safety and Health Administration (OSHA): 29 CFR, Part 1926.650.

1.02 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings: Modifications to the Work proposed due to design of sheeting, shoring, bracing, cofferdams, and similar excavation supports.

B. Informational Submittals:

1. Excavation Plan, Prior to starting excavation operations, submit written plan to demonstrate compliance with OSHA 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
   a. Name of Contractor's "competent person" in responsible charge of excavation and fill Work.
   b. Methods and sequencing of excavation.
   c. Proposed locations of stockpiled excavated material.
   d. Proposed onsite and offsite spoil disposal sites.
   e. Numbers, types, and sizes of equipment proposed to perform excavations.
   f. Anticipated difficulties and proposed resolutions.
   g. Reclamation of onsite spoil disposal areas.

1.03 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.04 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.05 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02 41 00, Demolition, prior to excavating.

B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.

C. Excavation Support: Install and maintain, as specified in Section 31 41 00, Shoring, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not overexcavate without written authorization of Engineer.

C. Remove or protect obstructions as shown and as specified.

D. Continuously control excavation water during course of construction, including weekends and holidays and during periods of work stoppages.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Greater than 4-inch Outside Diameter or Width: minimum 12 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank, exclusive of trench supports.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between, except as noted on Drawings.
3. Increase trench widths by thicknesses of sheeting.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work, or will exceed external load capacity of specified pipe thickness.

3.04 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.05 TRENCH EXCAVATION

A. Excavate the pipe trench subgrade to the depth required to install bedding material, as shown on Drawings, for the full width of the trench.

B. Where rock is encountered in the trench, excavate to a minimum of 6-inch depth below subgrade or as determined by the Engineer to be necessary.

C. For pipe trench in which PVC or HDPE pipe is to be laid ensure that no rocks larger than 1-inch in any dimension are on the trench walls within 4 inches of the pipe wall.

3.06 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads. In no case allow stockpiled excavated material to be within 5 feet of the edge of trenches or top of excavation side slope.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

F. Stockpile at locations directed by Owner.

3.07 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or not needed for fill or backfill, in designated spoil disposal and storage areas.

B. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   e. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   f. D2487, Classification of Soils for Engineering Purposes (Unified soil Classification System).
   g. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Lift: Loose (uncompacted) layer of material.

F. Geosynthetics: Geotextiles, geogrids, or geomembranes.

G. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

H. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.
2. 1 foot outside outermost edge at surface of roadways or shoulder.
3. 0.5 foot outside exterior at spring line of pipes or culverts.

I. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

J. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use. Classify soils in accordance with ASTM D2487.

K. Imported Material: Materials obtained from sources offsite, suitable for specified use.

L. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

M. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer's specifications with application and installation instructions for proprietary materials and items.
2. Samples: Imported material taken at source.

B. Informational Submittals:

1. Manufacturer's data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structural section or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

C. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

D. Refer to Section 31 23 23.15, Trench Backfill, for topsoil replacement requirements.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Collect samples in accordance with ASTM D75. Clearly mark samples to show source of material and intended use. Collect enough samples to support testing specified below.

B. Gradation Tests:

1. As necessary to locate acceptable sources of imported material.
2. During production of processed or imported material, one test every 1,500 cubic yards of material delivered. This applies to all processed or imported fill materials.

2.02 EARTHILL

A. Well-graded fill materials for general fill and embankment zones. Excavated from required excavations and designated borrow sites, free from rocks larger than 4 inches, from roots and other organic matter, contamination, cinders, trash, debris, and other deleterious materials.

B. Material containing more than 10 percent gravel, stones, or shale particles is unacceptable.

C. Provide imported material of equivalent quality, if required to accomplish Work.

2.03 GRANULAR FILL

A. 1-inch minus crushed gravel or crushed rock.

B. Free from dirt, clay balls, and organic material.

C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 5 percent by weight passing No. 200 sieve.

2.04 SAND

A. Free from clay, organic matter, or other deleterious material.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

Sieve Size	Percent Passing by Weight
1/4-inch	100
No. 4	95 - 100
No. 200	0 - 8

2.05 GRANULAR DRAIN MATERIAL

A. Gradation: ASTM C117 and ASTM C136.

Sieve Size	Percent Passing By Weight
2 inches	100
1-1/2 inches	90 - 100
3/4 inch	0 - 15
3/8 inch	0 - 5
No. 4	---
No. 16	---
No. 50	---
No. 200	---

2.06 GRANULAR FILTER MATERIAL

A. Clean, hard, durable gravel, free from foreign materials and washed.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

Sieve Size	Percent Passing by Weight
1/2 inch	95 - 98
3/8 inch	54 - 64
No. 4	0 - 3

2.07 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.08 BASE COURSE ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses.

2.09 FOUNDATION STABILIZATION ROCK

A. Crushed rock or pit run rock.

B. Uniformly graded from coarse to fine.

C. Free from excessive dirt and other organic material.

D. Maximum 2-1/2-inch particle size.

2.10 CRUSHED ROCK

A. Clean, hard, durable crushed rock, free from foreign materials and washed.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136.

C. Base Course:

Sieve Size	Percent Passing by Weight
2 inches	-100
1-1/2 inches	95 - 100
3/4 inch	55 - 75
1/4 inch	35 - 50
No. 10	4 - 60

A. Finish Grade Rock:

Sieve Size	Percent Passing by Weight
2 inches	-100
1-1/2 inches	90 - 100

Sieve Size	Percent Passing by Weight
1 inch	30 - 65
3/4 inch	0 - 15

D. Access Road Surfacing: As specified in Section 32 11 23, Aggregate Base Courses.

PART 3 EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.

2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

B. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 6-inch maximum thickness and compact each lift to minimum of 90 percent relative compaction above the pip zone and provided the pipe in not under a paved road or unpaved vehicle travelled way.

C. Other Areas: Backfill with selected earthfill or imported granular fill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 8-inch maximum uncompacted thickness and compact each lift to minimum 90 percent relative compaction above the pipe zone and where not under structures or paved roads as determined in accordance with ASTM D1557.

3.03 BACKFILL AROUND TANKS

A. Backfill above top of tank with earthfill placed in lifts of maximum 8-inch uncompacted depth. Compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D1557 Method.

3.04 EARTHFILL

A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:

1. Allow for topsoil where required.
2. Maximum 8-inch thick loose lifts.
3. Place and compact fill across full width of embankment, ensuring fill is placed in equal depths on opposite sides of structures and tanks.

4. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

B. Refer to Section 31 23 23.15, Trench Backfill, for placement in trenches.

3.05 FIELD QUALITY CONTROL

A. Gradation:

1. One sample from each 1,500 cubic yards of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density and Moisture Control Tests:

1. During placement of all fill materials, test at least once for every 12-inch lift every 500 square feet of compacted area, or one test for every 25 lineal feet of trench. Test in accordance with ASTM D6938, nuclear gauge testing.
2. Confirm results of nuclear gauge testing by performing at least once sand-cone test for each fill material. Test in accordance with ASTM D1556. Notify Engineer immediately of significant discrepancies between the results from the different testing methods.
3. Proof roll fill materials that are too coarse to be tested in accordance with ASTM D6938. Proof roll with a loaded water truck, dump truck, or similar vehicle.

3.06 SAND BLANKET OVER VAPOR RETARDER

A. Place sand in manner that avoids damage to underlying vapor retarder.

B. Moisten sand and thoroughly compact it with a vibratory plate compactor.

3.07 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23, Aggregate Base Courses.

3.08 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Footings: as specified in Section 03 30 00, Cast-in-Place Concrete.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill.
4. Trenches:
    a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
    b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
    a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
    b. Steep Slopes (Steeper than 3:1):
        1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
        2) Backfilling overexcavated areas is prohibited, unless in Engineer's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.09 CRUSHED ROCK

A. Base Course:

1. 6-inch thick layer.
2. Installed after Site grading and structural construction is complete.
3. Compact to at least 95 percent relative compaction as determined by ASTM D1557.

B. Finish Grade:

1. 3-inch thick layer.
2. Installed over base course.
3. Densify with at least three passes of a vibratory roller.

3.10 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 32 11 23, Aggregate Base Courses.

END OF SECTION

SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

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

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
   h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
   j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.

H. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

I. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer's descriptive literature for marking tapes and tracer wire.
2. Samples:
   a. Trench stabilization material.
   b. Bedding and pipe zone material.
   c. Granular drain.
   d. Granular backfill.
   e. Earth backfill.
   f. Sand(s).
   g. Geotextile.

B. Informational Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 MARKING TAPE

A. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: 3 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
7. Manufacturers and Products:
   a. Reef Industries; Terra Tape, Sentry Line Detectable.
   b. Mutual Industries; Detectable Tape.
   c. Presco; Detectable Tape.

B. Color: In accordance with APWA Uniform Color Code.

Color*	Facility**
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines

*As specified in NEMA Z535.1, Safety Color Code.
**Coordinate in advance with Owner for color and custom wording for tape over FW, RW, and CA pipes.

2.02 TRACER WIRE

A. Material: Minimum 12-gauge solid copper or copper jacket with a steel core, with high-density polyethylene (HDPE) or high-molecular weight polyethylene (HMWPE) insulation suitable for direct bury.

B. Splices: Use wire nut or lug suitable for direct burial as recommended by tracer wire manufacturer.

C. Manufacturers:

1. Copperhead Industries, LLC.
2. Performance Wire & Cable Inc.
3. Pro-line Safety Products Company.

2.03 TRENCH STABILIZATION MATERIAL

A. Granular Backfill:

1. Clean gravel or crushed rock, reasonably well-graded from coarse to fine.
2. Maximum Particle Size1-1/2-inch
3. Dry sand, accepted by Engineer, may be provided for trenches above maximum groundwater level.

2.04 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. Pipe Under 18-Inch Diameter: 3/4-inch maximum particle size, except 1/4 inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
3. Perforated Pipe: Granular drain material.
4. Conduit and Direct-Buried Cable:
   a. Sand, clean or clean to silty, less than 10 percent passing No. 200 sieve.
   b. Individual Particles: Free of sharp edges.
   c. Maximum Size Particle: Pass a No. 4 sieve.
   d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.05 GRANULAR DRAIN MATERIAL

A. As specified in Section 31 23 23, Fill and Backfill.

2.06 EARTHFILL OR EARTH BACKFILL

A. Provide as specified in Section 31 23 23, Fill and Backfill.

2.07 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.

B. Materials:

1. Cement: ASTM C150/C150M, Type V.
2. Aggregate: ASTM C33/C33M, Size 7.
3. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
   a. ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.

b. Test in accordance with ASTM C1012/C1012M to verify sulfate resistance is acceptable.

4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.08 CONCRETE BACKFILL

A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete.

2.09 GRAVEL SURFACING ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses.

2.10 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. Earth backfill, including specified class.
2. Trench stabilization material.
3. Bedding and pipe zone material.

B. Certify Laboratory Performance of Mix Designs:

1. Controlled low strength material.
2. Concrete.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, duct bank or precast concrete underground utility trench system. Do not place concrete, lay pipe, conduit, direct-buried cable, duct bank or precast concrete underground utility trench system in water.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify engineer. Engineer will determine depth of overexcavation required, but in no case less than that specified in Section 31 23 16, Excavation.

3.03 GEOTEXTILE INSTALLATION

A. Where shown and as specified except as follows:

1. Extend geotextile for full width of trench bottom and up the trench wall to the top of the pipe zone, or base material for manholes and miscellaneous structures.
2. Anchor geotextile to trench walls prior to placing trench stabilization or bedding material.
3. Provide 24-inch minimum overlap at joints.
4. Install in accordance with manufacturer’s recommendations.

3.04 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.05 BEDDING

A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness: As follows:

1. Pipe 6 Inches and Smaller: 4 inches.
2. Pipe 8 Inches to 36 Inches: 6 inches.
3. Pipe 42 Inches and Larger: 8 inches.
4. Conduit: 4 inches.
5. Direct-Buried Cable: 3 inches.
6. Duct Banks: Three.
7. Precast Concrete Underground Utility Trench System: 6 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.06 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following above the top of pipe, conduit direct buried cable or duct bank:

1. Pipe: 12 inches.
2. Conduit: 12 inches, unless shown otherwise.
3. Direct-Buried Cable: 6 inches, unless shown otherwise.
4. Duct Bank: 12 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under

haunches with a shovel to ensure voids are completely filled and pipe conduit or duct bank is fully resting on the bedding before placing each succeeding lift.

E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor. Take care to avoid damaging pipe and pipe coating.

3.07 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of buried piping, at depth of 1 foot above top of pipe. Coordinate with piping installation drawings.

1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.

3.08 TRACER WIRE INSTALLATION AND TESTING

A. Install tracer wire continuously along centerline of nonmetallic buried piping.

B. Attach wire to top of pipe using tape at maximum of 10-foot intervals. In areas where depth of cover is excessive for allowing detection of tracer wire with electronic pipe locator, install tracer wire within pipe backfill directly above pipe centerline at a minimum depth of 4 feet.

C. Install splices in accordance with manufacturer’s instructions for direct bury applications. Tie ends of wire to be joined in a knot as required to reduce tension on splice.

D. Bring tracer wire to surface at each valve box, curb box, vault, air valve, blowoff valve, hydrant, or pipeline marker. Tracer wire shall be brought to surface at least every 1,000 feet. If distance between pipe appurtenances exceeds 1,000 feet, install valve box to allow access to tracer wire. Mark valve box cover with the word “TRACER”. Coil enough excess tracer wire at each appurtenance to extend wire 12 inches above ground.

E. Test continuity of tracer wire using electronic pipe locator in presence of Engineer prior to paving.

3.09 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Earthfill or Earth Backfill:

1. Place in uncompacted loose lifts not exceeding thickness of 8 inches.
2. Mechanically compact each lift to a minimum of 95 percent relative compaction under roads or travelled ways, paved or unpaved and under structures; 90 percent compaction in all other areas prior to placing succeeding lifts.
3. Leave trench with backfill material neatly mounded across the entire trench width, but not more than 6 inches above the adjacent ground surface.
4. Maintain trench level with the existing adjacent grade.
    a. Estimate and provide amount of backfill material required so that after normal settlement, settled surface will match adjacent ground surface.
    b. Neatly windrow material over trench, and remove excess.
    c. Correct excess or deficiency of backfill material apparent after settlement and within correction period by regrading, and disposing of excess material or adding additional material where deficient.

C. Concrete Backfill:

1. Place above bedding.
2. Minimum Concrete Thickness: 6 inches on top and sides of pipe.
3. Do not allow dirt or foreign material to become mixed with concrete during placement.

4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
5. Prevent flotation of pipe.
6. Begin and end concrete backfill within 4 inches of a pipe joint on each end.
7. Do not encase pipe joints except within the limits of the concrete backfill.

D. Controlled Low Strength Material:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
3. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.
4. In other areas fill trench section as shown.

3.10 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 4 inches of backfilled trenches in areas that had undisturbed topsoil before the start of construction.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.11 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Concrete Pavement: Replace settled slabs as specified in Section 32 12 16, Asphalt Paving.

E. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.

F. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.12 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 32 00
SOIL STABILIZATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Action Submittals: Product data for commercial products.

B. Informational Submittals:

1. Copies of delivery invoices or other proof of quantities and products.
2. Manufacturer’s Installation Instructions: Commercial products.

1.02 DELIVERY, STORAGE, AND PROTECTION

A. As specified in Section 01 60 00, Common Product Requirements (to be completed).

1.03 SEQUENCING AND SCHEDULING

A. Complete work in a given area within 10 days after completing ground disturbing activities in that area.

B. Coordinate activities with Owner and notify Owner at least 3 days in advance before starting soil stabilizing work.

1.04 MAINTENANCE

A. Maintain applied and installed products until all Project work is completed.

PART 2 PRODUCTS

2.01 SOIL STABILIZING AGENTS

A. Soil-Tac by Soilworks, LLC.

B. Gorilla Snot by Soilworks, LLC.

C. PM10-50.

D. Or Owner-approved equal.

2.02 EROSION CONTROL MATTING

A. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.

B. Manufacturers:

1. Akzo Industries, Asheville, NC.
2. North American Green, Evansville, IN.

2.03 REINFORCED PLASTIC COVERING

A. Co-extruded, copolymer laminate reinforced with nonwoven grid of high strength nylon cord submersed in a permanently flexible adhesive media allowing for equal tear resistance in all directions.

B. Black in color and ultraviolet stabilized.

C. Physical Requirement (Minimum Average Roll Values):

1. Tear Strength: 130 pounds.
2. Elongation: 620 percent.

D. Manufacturers:

1. Reef Industries, Inc., Houston, TX.
2. Griffolyn Co., Houston, TX.

PART 3 EXECUTION

3.01 SOIL PREPARATION

A. Shape, grade, and compact the ground in disturbed areas to create a smooth uniform surface, free of holes and abrupt offsets, before applying or installing any soil stabilization products.

B. Prepare only soil that was disturbed by Project activities.

C. Apply water for moisture conditioning as needed to control dust and achieve compaction.

3.02 SOIL STABILIZING AGENTS

A. Spray only after soil has been prepared and approved by Owner.

B. Apply in accordance with manufacturer's installation instructions.

3.03 EROSION CONTROL MATTING

A. Place on slopes 3H:1V and steeper and where shown on Drawings. Staple/stake in place and with the appropriate overlap in accordance with manufacturer's instruction.

3.04 REINFORCED PLASTIC COVERING

A. Place where shown on Drawings.

B. Install in single thickness, strips parallel to direction of drainage.

C. Maintain tightly in place by using sandbags on ropes with a maximum 10-foot grid spacing in all directions.

D. Tape or weight down full length, overlap seams at least 12 inches.

E. Remove at final acceptance, unless notified otherwise by Engineer.

3.05 FIELD QUALITY CONTROL

A. Notify Owner upon completion of soil preparation. Owner will determine if the prepared soil meets requirements. Provide at least 1 day advance notice.

B. Notify Owner upon completion of application or installation. Owner will, within 15 days of receipt, determine if the application or installation meets requirements.

END OF SECTION

SECTION 31 41 00
SHORING

PART 1 GENERAL

1.01 REFERENCES

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

1. California Code of Regulations, Title 8, Chapter 4, Subchapter 4.

1.02 DEFINITIONS

A. Adjacent Structures Stability: The stability of the foundation(s) of adjacent structures whose location may create surcharges, changes in soil conditions, or other disruptions that have the potential to extend into the failure zone of the excavation or trench.

B. Competent Person: An individual who is capable of identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate or control these hazards and conditions.

C. Protective System: A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, and from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

D. Sheeting: The members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

E. Shield (Shield System): A structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure.

F. Shoring (Shoring System): A structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

G. Support System: Structures such as underpinning, bracing, and shoring that provide support to an adjacent structure or underground installation or to the sides of an excavation or trench.

H. Surcharge: An excessive vertical load or weight caused by spoil, overburden, vehicles, equipment, or activities that may affect trench stability.

1.03 SUBMITTALS

A. Informational Submittals:

1. Excavation support plan.
2. Movement monitoring plan.
3. Trench excavation plan.
4. Movement measurement and data and reduced results indicating movement trends.
5. Design drawings and complete calculations of the sheeting and shoring system, including but not limited to sheeting size, wale, racker, anchor systems, struts, earth anchors, anchor piles, tie rods or other components pertinent to the design.

1.04 QUALITY ASSURANCE

A. Provide surveys to monitor movements of critical facilities.

B. Material Standards: Furnish lumber for shores, wale and sheeting of grading required by the American Lumber Standards for the particular application.

C. Design Criteria: Design and construct temporary sheeting and shoring which is to be used as an aid in construction. Prepare design in conformance with applicable requirements of Article 6, “Excavations, Trenches, Earthwork” of the Construction safety Orders of California State Division of Occupational Health and Safety for shoring in California. Refer to applicable Arizona regulations for shoring in Arizona.

D. In addition, base sheet-piling design on the material requirements specified herein. Designs submitted under this Section must be signed by a civil or structural engineer duly registered in the State of California (or Arizona where appropriate).

1.05 ALTERNATIVES

A. The use or application of alternative methods and materials, and the employment of proprietary systems under lease or franchise in lieu of that specified herein, may be allowed. Demonstration of suitability and compliance with these Specifications and acceptance of the Engineer shall be required.

B. If the proposed trench protection system includes the use of a shield, submit the shield design for approval by Cal-OSHA. Premanufactured shields, usually referred to as "trench boxes" or "trench shields," shall be allowed when approved as suitable by the Engineer. Job built shields shall be in accordance with Cal-OSHA 1926.652(c)(3) or (c)(4). Furnish structural details indicating the maximum pressure the shield is capable of withstanding, the trench configuration and supporting calculations indicating the maximum permissible and anticipated pressure against the shield. In portions of the trench occurring near existing facilities, use sheeting or other acceptable methods in lieu of a shield. Refer to applicable Arizona regulations for shoring in Arizona.

PART 2 PRODUCTS

2.01 MATERIALS

A. Lumber:

1. Temporary Shores, Wales and Sheeting: Furnish structural grade planks, beams, and posts as defined and specified for stress-grade lumber in the American Lumber Standards. Lumber may be rough, untreated, in random lengths and shall be of standard width and thicknesses.

B. Sheet Piling:

1. Material: Provide sheet pile manufactured from steel conforming to ASTM A328, or from steel conforming to ASTM A572, Grade 42.
2. Dimensions and Section Properties: Furnish standard rolled sections PZ, PDA, PSA, or PS for steel sheet piling used for cofferdams or trench shoring. Use weights, dimensions and section properties that are appropriate for the intended use, as demonstrated by the design (refer to Articles References and Definitions above).
3. Pre-manufactured Hydraulic Shoring or Trench Boxes: Furnish tabulated data from manufacturer demonstrating system is suitable for application per CCR 8 §1541.1. “Requirements for Protective Systems” (Appendix D).

PART 3 EXECUTION

3.01 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed the Work.

3.02 EXCAVATION SUPPORT PLAN

A. Prepare excavation support plan addressing following topics:

1. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
2. Design assumptions and calculations.
3. Methods and sequencing of installing excavation support.
4. Proposed locations of stockpiled excavated material.
5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
6. Anticipated difficulties and proposed resolutions.

3.03 MOVEMENT MONITORING PLAN

A. Provide movement monitoring plan for shoring used in areas adjacent to existing structures where, in the opinion of the Engineer, adjacent structure stability may be affected.

B. Where required per above, prepare movement monitoring plan addressing following topics:

1. Survey control.
2. Location of monitoring points.
3. Plots of data trends.
4. Interval between surveys.

3.04 REMOVAL OF EXCAVATION SUPPORT

A. Remove excavation support in a manner that will maintain support as excavation is backfilled.

B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.

C. Remove excavation support in a manner that does not leave voids in the backfill.

3.05 TRENCHES

A. Provide trench excavations exceeding 4 feet in depth with adequate safety systems meeting the requirements of Cal-OSHA, CCR Title 8, Subchapter 4. Refer to applicable Arizona regulations for trenching in Arizona.

B. For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of California Labor Code Section 6707, applicable local construction safety orders, and federal requirements. Refer to applicable Arizona regulations for trenching in Arizona.

3.06 PROTECTION OF EXISTING FACILITIES

A. The Contractor shall protect all existing utilities and improvements not designated for removal and shall restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than they were prior to such damage or temporary relocation, all in accordance with the requirements of the Contract Documents.

B. Take all reasonable precautions to prevent damage to such structures. The requirements described herein apply to all types of structures that may be adversely affected by foundation construction.

C. The Contractor shall verify the exact locations and depths of all utilities and the Contractor shall make exploratory excavations of all utilities that may interfere with the Work.

D. Contractor shall record condition of structures prior to excavation and monitor for potential movement of each structure in accordance with the approved Monitoring Plan.

E. The Contractor shall restrict compaction operations as necessary to assure no damage occurs to adjacent building(s). This may require the use of smaller compaction equipment than is usually employed for trench backfill and roadway embankment compaction operations when in the vicinity of buildings sensitive to vibrating or other impact-type activities.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. T11, Standard Method of Test for Materials Finer Than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing.
   b. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   c. T89, Standard Specification for Determining the Liquid Limit of Soils.
   d. T90, Standard Specification for Determining the Plastic Limit and Plasticity Index of Soils.
   e. T96, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   f. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in) Drop.
   g. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.
   h. T190, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   i. T265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.
   j. T310, Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
2. ASTM International (ASTM):
   a. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   b. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   c. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

d. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
e. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
f. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

1.03 CONSTRUCTION AND MATERIALS STANDARDS

A. Work pertaining to this Section shall be in conformance except as modified herein with the current edition of State of California Business, Transportation and Housing Agency Department of Transportation (CalTrans) Standard Specifications, hereinafter referred to as the Standard Specification.

1.04 SUBMITTALS

A. Action Submittals:

1. Samples: Submit for specified materials 20 days prior to delivery to Site.

B. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

C. Certified results of in-place density tests from independent testing agency.

PART 2 PRODUCTS

2.01 AGGREGATE BASE

A. Refer to notes shown on Drawings and requirements herein.

2.02 BASE COURSE

A. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted.

B. Material shall conform to Standard Specifications, Section 26, Class 2 Aggregate Base, 3/4 inch maximum gradation.

C. Physical Qualities:

1. Abrasion, AASHTO T96: 35 percent maximum wear.
2. Fractured Face: 75 percent minimum particles.
3. Liquid Limit, AASHTO T89: Maximum 30 percent.
4. Plasticity Index, AASHTO T90: Maximum 6 percent. Nonplastic.
5. Sand Equivalency, ASTM D2419: 35 percent, minimum.
6. Resistance (R) Value, AASHTO T190: 75 minimum.
7. Soundness, ASTM C88: 12 percent, maximum.
8. Flat and Elongated Particles, ASTM D4791: 8 percent, maximum.

D. Gradation, AASHTO T27, Based on U.S. Standard Sieves:

Table 1
Gradation Percent Passing by Weight

Sieve Designation	**Material**		
(Square Opening)	**Aggregate Base Course**	**Leveling Course**	**Gravel Surfacing**
50 mm (2")		85-100	
38 mm (1-1/2")			
25 mm (1")	100		
19 mm (3/4")	90-100		100
4.75 mm (1/4")	35-60	40-90	50-78
2.00 mm (No. 10)			35-65
1.20 mm (No. 16)			
425 μm (No. 40)	10-25		13-35
177 μm (No. 80)			
150 μm (No. 100)			

Table 1
Gradation Percent Passing by Weight

Sieve Designation	Material		
(Square Opening)	Aggregate Base Course	Leveling Course	Gravel Surfacing
75 μm (No. 200)	2-9	0-25	4-15

2.03 LEVELING COURSE AND GRAVEL SURFACING

A. Clean, tough, uniform quality, durable fragments of crushed rock, free from flat, elongated, soft or disintegrated pieces, or other objectionable matter occurring either free or as coating on stone. Gradation as specified in Table 1.

B. Physical Qualities: Same as for base course, except for plasticity index for gravel surfacing can range between 4 percent to 12 percent.

2.04 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in Section 31 23 13, Subgrade Preparation.

B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials on soft, muddy, subgrade.

3.02 EQUIPMENT

A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

3.03 HAULING AND SPREADING

A. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway or prepared surface without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.04 CONSTRUCTION OF COURSES

A. Untreated Aggregate Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.
5. Should aggregate not compact properly into a firm, unyielding surface remove and replace section with new aggregate. Removed material shall be disposed of off-site, or at the discretion of the Engineer, blended with other common backfill.
6. Blade or broom surface to maintain true line, grade, and cross-section.

B. Leveling Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread on roadway or preceding course to depth, grade, and cross-section shown.

4. Lightly blade surface and roll until thoroughly compacted to line and grade shown.
5. Maintain moisture levels to prevent loss of fines during processing.

C. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 3 inches.
2. Completed Course Total Thickness: As shown.
3. Spread on preceding course in accordance with cross-section shown.
4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

A. Commence compaction of each layer of base after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by AASHTO T99.

B. Roll each layer of material until material does not creep under roller before succeeding layer is applied.

C. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain specified densities.

E. Place and compact each lift to required density before succeeding lift is placed.

F. Remove floating or loose stone from surface of preceding course before placing leveling course.

G. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

H. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate Base and Leveling Course: Within plus or minus 0.04 foot of grade shown at any individual point.

C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.

D. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

3.07 DRIVEWAY RESURFACING

A. Replace gravel surfacing on driveways that were gravel surfaced prior to construction.

B. Provide compacted gravel surfacing to depth equal to original, but not less than 4 inches.

C. Leave each driveway in as good or better condition as it was before start of construction.

3.08 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Provide Engineer at least 2 hours advance notification prior to testing.
2. Show proof that areas meet specified requirements before requesting that Engineer identify density test locations.
3. Refer to Table 2 for minimum sampling and testing requirements for aggregate base course and surfacing.

Table 2
Minimum Sampling and Testing Requirements

Property	Test Method	Frequency	Sampling Point
Gradation	AASHTO T11 and AASHTO T27	One sample every 500 tons	Roadbed after processing
Moisture Density (Maximum Density)	ASTM D1557, Method D	One test for every aggregate grading produced	Production output or stockpile

Table 2
Minimum Sampling and Testing Requirements

Property	Test Method	Frequency	Sampling Point
In-Place Density and Moisture Content	ASTM D1556 (sand cone) or D6938 (nuclear)	One for each 200 ton but at least every 2,000 sq ft of area	In-place completed, compacted area

3.09 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
   b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
   c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
   d. M140, Standard Specification for Emulsified Asphalt.
   e. M208, Standard Specification for Cationic Emulsified Asphalt.
   f. T166, Standard Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens.
   g. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
   h. T230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
   i. T245, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
   j. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus.
   k. T247, Standard Method of Test for Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor.
   l. T283, Standard Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage.
   m. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate (Method A).
2. Asphalt Institute (AI):
   a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
   b. Superpave Series No. 2 (SP-2), Superpave Mix Design.

3. ASTM International (ASTM):
   a. D2041, Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
   b. D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   c. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   d. D5821, Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
   e. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.02 DEFINITIONS

A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.

B. RAP: Reclaimed asphalt pavement.

1.03 CONSTRUCTION AND MATERIALS STANDARDS

A. Work pertaining to this Section shall be in conformance except as modified herein with the current edition of State of California Department of Transportation (CalTrans) Standard Specifications, hereinafter referred to as the Standard Specification.

1.04 SUBMITTALS

A. Action Submittals:

1. Samples:
   a. Mix Constituents: Representative Samples of materials to be incorporated into the Work.
   b. Core Samples of Compacted Asphalt Concrete: 6 inches.

B. Informational Submittals:

1. Asphalt Concrete Mix Formula:
   a. Submit minimum of 15 days prior to start of production.
   b. Submittal to include the following information:
      1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
      2) Bulk specific gravity for each aggregate constituent.

3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
4) Properties as stated in this section for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
5) Percent of asphalt lost due to absorption by aggregate.
6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.
7) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
8) Optimum mixing temperature.
9) Optimum compaction temperature.
10) Temperature-viscosity curve of asphalt cement to be used.
11) Brand name of any additive to be used and percentage added to mixture.

2. Test Report for Asphalt Cement:
   a. Submit minimum 10 days prior to start of production.
   b. Show appropriate test method(s) for each material and the test results.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed), for the following materials:
   a. Aggregate: Gradation, source test results as defined in this section.
   b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
   c. Prime Coat: Type and grade of asphalt.
   d. Tack Coat: Type and grade of asphalt.
   e. Additives.
   f. Mix: Conforms to job-mix formula.
4. Statement of qualification for independent testing laboratory.
5. Test Results:
   a. Mix design.
   b. Asphalt concrete core.
   c. Gradation and asphalt content of uncompacted mix.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F or air temperature is lower than 40 degrees F. Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

A. Prime Coat: Grade SC-250 liquid asphalt in accordance with Standard Specification Sections 39 and 93.

B. Tack Coat: SS1H Grade Anionic Asphaltic Emulsion in accordance with Caltrans Standard Specification Section 94.

C. Asphalt Binder: PG 70-10 in accordance with CalTrans Standard Specification Sections 39, 92 and 93.

D. Sand (Blotter Material): As specified in Section 90-1.02C(3) of the Standard Specifications.

2.02 ASPHALT CONCRETE MIX

A. General:

1. Mix formula shall not be modified except with written approval of Engineer.
2. Source Changes:
   a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
   b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by Engineer to confirm that properties are in compliance with design criteria.
   c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

B. Composition: Hot-plant mix of aggregate, mineral filler if required and paving grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.

C. Aggregate:

1. Coarse:
   a. Material retained on a 0.093-inch sieve.
   b. Minimum 75 percent by weight of individual pieces having two or more fractured faces, and 90 percent by weight having at least one fractured face.
2. Fine:
   a. Material passing a 0.093-inch sieve.
   b. Clean, sound, durable, angular shaped particles produced by crushing.
   c. Plasticity Index: Maximum 6.
   d. Liquid Limit: Maximum 25, when tested in accordance with ASTM D4318.
3. Natural Sand: Shall not be used.

D. Mineral Filler: In accordance with AASHTO M17.

E. Asphalt Cement: Paving Grade 70-10.

PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control:

1. In accordance with Section 01 50 00, Temporary Facilities and Controls (to be completed).
2. Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

A. In accordance with Standard Specifications.

3.04 PREPARATION

A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
2. Remove existing material to a minimum depth of 1 inch.
3. Paint edges of meet line with tack coat prior to placing new pavement.

C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with this section.

B. Tack Coat:

1. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
2. Do not apply more tack coat than necessary for the day’s paving operation.
3. Touch up missed or lightly coated surfaces and remove excess material.
4. Application Rate:
   a. Minimum 0.05 to 0.15 gallon per square yard of asphalt (residual if diluted emulsified asphalt) of surface area.
   b. Apply at rate, within range specified, sufficient to assure good bonding, but not so heavy that surplus asphalt flushes into asphalt concrete being placed.

C. Pavement Mix:

1. Prior to Paving:
   a. Sweep primed surface free of dirt, dust, or other foreign matter.
   b. Patch holes in primed surface with asphalt concrete pavement mix.
   c. Blot excess prime material with sand.
2. Place asphalt concrete pavement mix in one single lift.
3. Compacted Lift Thickness:
   a. Minimum: Twice maximum aggregate size, but in no case less than 1 inch.
   b. Maximum: 4 inches.
4. Total Compacted Thickness: As shown.
5. Apply such that meet lines are straight and edges are vertical.
6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
7. Joints:
   a. Offset edge of each layer a minimum of 6 inches so joints are not directly over those in underlying layer.
   b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
   c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
9. After placement of pavement, seal meet line by painting a minimum of 6 inches on each side of joint with cut-back or emulsified asphalt. Cover immediately with sand.

D. Compaction: Uniformly compact each course to target density arrived at in compaction control strip.

E. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
2. Completed Surface or Wearing Layer Smoothness:
   a. Uniform texture, smooth, and uniform to crown and grade.
   b. Maximum Deviation: 1/8 inch from lower edge of a 12-foot straightedge, measured continuously parallel and at right angle to centerline.

c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.

3. Transverse Slope Maximum Deviation: 1/4 inch in 12 feet from rate of slope shown.
4. Finished Grade:
   a. Perform field differential level survey on maximum 50-foot grid and along grade breaks.
   b. Maximum Deviation: 0.02 foot from grade shown.

F. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by Engineer.
2. Preparation:
   a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
   b. Seal in dry weather and when temperature is above 35 degrees F.
3. Application:
   a. Fill cracks over 1/16 inch in width with asphalt-sand slurry or approved crack sealer prior to sealing.
   b. When sealing patched surfaces and joints with existing pavements, extend minimum 6 inches beyond edges of patches.

3.06 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Application:

1. Patch Thickness: 3 inches or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 to 300 pounds per linear inch. Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 1/4 inch or minus 0 inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.07 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T230 and AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

C. Testing Frequency:

1. Quality Control Tests:
   a. Asphalt Content, Aggregate Gradation: Once per every 500 tons of mix or once every 4 hours, whichever is greater.
   b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 1,000 tons or once every 8 hours, whichever is greater.

2. Density Tests: Once every 500 tons of mix or once every 4 hours, whichever is greater.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 DEFINITIONS

A. Standard Specifications, as used in this section, refer to PG&E Standard Specification Section L-50, Property Fence and Gates, dated October 19, 1998.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
      1) Fence, gate posts, rails, and fittings.
      2) Chain link fabric.
      3) Gates and hardware.
      4) Gate operators, motors, and mounting arrangements, switches, and controls; include operating instructions.
      5) Gate access system, including access control features, power and control wiring diagrams, and operating instructions.
2. Samples (submit only if requested by Engineer):
   a. Chain Link Fabric: Approximately 6 inches square.
   b. Posts, Rails, Braces, Wire, and Ties: Approximately 6 inches long.
   c. Fittings: One each.
   d. PVC or Polymer Coated Fabric Including Manufacturer's Color Selections: Approximately 6 inches square.

B. Informational Submittals:

1. Manufacturer's recommended installation instructions.
2. Evidence of Supplier and installer qualifications.
3. Test Reports: Field test results for compliance of installation of chain link fence, gates, and gate operators.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Automatic Gate Operator System Supplier: 5 years' experience in gate operator systems.
2. Automatic Gate Operator System Installer: Experienced installer who has completed chain link fences and gates similar in material, design, and extent to those indicated for Project and whose work has resulted with a record of successful in-service performance with a minimum 3 years' experience.

B. Design, supply of equipment and components, installation, and on-call service shall be product of individual company with record of installations meeting requirements specified.

C. Preinstallation Conference: Conduct conference at project Site with gate installer to verify layout and operations of automatic gate operating system.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.05 SCHEDULING AND SEQUENCING

A. Complete necessary Site preparation and grading before installing chain link fence and gates.

B. Interruption of Existing Utility Service: Notify Engineer of utility 72 hours prior to interruption of utility services. Do not proceed with interruption of utility service without written permission from utility Engineer.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work are specified elsewhere.

1. Faulty operations of gate operators and controls.

2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
3. Deflection of fence fabric beyond limits.

PART 2 PRODUCTS

2.01 GENERAL

A. Refer to the Standard Specifications and Drawings.

B. Match style, finish, and color of each fence component with that of other fence components.

C. Chain link fence fabric shall be approved by the PG & E Engineering Department.

D. Color Coating for Posts, Top and Brace Rails: ASTM F1043, minimum 10 mils thickness over zinc coating to match color of chain link fabric.

PART 3 EXECUTION

3.01 GENERAL

A. Install chain link fences and gates in accordance with the Standard Specifications, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for a complete fence and gate installation.

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

3.02 PREPARATION

A. Clear area on either side of fence to the extent specified in Section 31 10 00, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.

B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 POST SETTING

A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.

B. Set posts with minimum embedment below finished grade as shown and specified and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

C. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter. Before concrete sets, crown and finish top of concrete to readily shed water.

3.04 CHAIN LINK FABRIC

A. Do not install fabric until concrete has cured minimum 7 days.

B. Apply fabric to outside of enclosing framework. Pull fabric taut to provide a smooth and uniform appearance free from sag, without permanently distorting fabric diamond or reducing fabric height. Tie fabric to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

3.05 FIELD QUALITY CONTROL

A. Post and Fabric Testing: Test fabric tension and line post rigidity according to ASTM F1916.

B. Gate Tests:

1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
3. Confirm that latches and locks engage accurately and securely without forcing and binding.

C. Automatic Gate Operator:

1. Energize circuits to electrical equipment and devices.
2. Adjust operators, controls, safety devises, and limit switches.
3. Start units to confirm proper motor rotation and unit operation free of binding. Test and adjust all gate controls for proper operation.
4. Replace damaged and malfunctioning controls and equipment.
5. Lubricate hardware, gate operator and other moving parts.

3.06 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site to train Owner's personnel to adjust, operate, and maintain gates.

3.07 CLEANUP

A. Remove excess fencing materials and other debris from Site.

3.08 SUPPLEMENT

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

1. Property Fence and Gates.

END OF SECTION

PROPERTY FENCE AND GATES L-50

Department:	Gas System Maintenance and Technical Support	**Section:**	System Integrity
Approved by:	K. A. Sloat	**Approved by:** S. Y. Chwistek	**Date:** 10-19-98

Rev. #00: This document replaces PG&E Drawings 059659, 059660, 059661, 059662, 059663, 059664 and 059665. For a description of the changes, see Page 14.

Purpose and Scope

This gas standard provides specifications, dimensions, construction instructions and grounding criteria for property fence and gates.

General Requirements for Design and Construction

1. The standard property fence shall be 7’ high with 3 rows of barbed wire on extension arms located over 6’ of chain-link fence fabric.
2. Exceptions
   A. Where local ordinances prohibit barbed wire, chain-link fence fabric shall be 7’ high.
   B. Where the fence is closer than 5’ to exposed energized equipment, the fence shall be 10’ high.
   C. The fence shall have 7’ of chain-link fence fabric and 6 rows of barbed wire at generating stations, substations, gas compressor stations, pressure limiting stations, gas regulating stations, and other gas facilities which contain equipment that handles the flow of gas by other than a manually operated valve.
3. Materials

   All components for a given installation shall be furnished by the same supplier.

   Steel pipe used for posts, rails, braces and gate frames shall conform to the specifications of American Society for Testing and Materials (ASTM) A120.

   Structural and roll-formed shapes shall be ASTM A36, hot-dipped galvanized per ASTM A123 for galvanized coating.

   Hardware, except tie wire and barbed wire, shall comply with ASTM A153 for galvanized coating.

   Barbed wire shall conform to the specification of ASTM A121, Class I. It shall consist of two strands of 12-1/2 gauge wire, twisted with 4-point, 14-gauge barbs that are spaced at 5” on center (O.C.)

   Extension arms shall be designed to carry, and to securely anchor, 3 rows of barbed wire, equally spaced. In addition, the arms shall have adequate strength to support a vertical load of 200 pounds at the outer end.

   Chain-link fence fabric shall be fabricated from 9 gauge wire. The size of the mesh shall be 2”. The chain-link fence fabric shall be twisted with barbed selvage on top and knuckled selvage on the bottom. Fabric shall be coated with either zinc, aluminum or plastic as specified in this standard and in the contract.

   A. Zinc-coated steel chain-link fence fabric shall conform to ASTM A392 and shall have a Class I zinc coating.
   B. Aluminum-coated steel chain-link fence fabric shall conform to ASTM A491(2).
   C. Plastic-coated steel chain-link fence fabric shall be thermally extruded over zinc-coated steel wire or aluminum-coated steel wire, or thermally bonded over plastic-primed steel wire (at manufacturer’s option). The required thickness of the coatings on steel wire shall be mandated by Table III of the Federal Specification RR-F-191/1 (GSA-FSS). Color selection shall be approved by the PG&E Engineering Department.

   Chain-link fabric (where rustake fencing is specified) shall be fabricated from 9-gauge wire. Mesh shall be 3-1/2”. The selvage top and bottom shall be knuckled. Zinc coating shall conform to ASTM A392, Class I. Redwood pickets shall be Grade A stained redwood, 3/8” x 2-3/8”. Do not use rustake fencing without coordinating its installation with the PG&E Security Department.

Property Fence and Gates

4. Temporary Chain-link Fence

   The information on Page 1 applies to permanent fencing. For temporary fencing, use a driven steel tee section. Steel pipe or channel section fence posts, and chain-link fence fabric, use extension arms and barbed wire where temporary fencing also provides site security.

Notes Regarding Fences

1. See Page 1 for standard fence requirements.
2. Post spacing shall not exceed 10’ centers. For a 7’ chain-link fabric fence with redwood pickets, use 8’ centers for post spacing.
3. Concrete for footings shall have a minimum compressive strength of 2,500 pounds per square inch (psi) at 28 days.
4. Chain-link fence fabric shall be stretched and securely fastened to the posts with nails and top and bottom tension wire, hog rings or metal bands.
5. Tension wires shall be manufactured of 7-gauge galvanized coil spring, and shall be tightly stretched.
6. The chain-link fence fabric shall be fastened to the end corner and gate posts with 1/4” x 3/4” stretcher bars and not less than 1/8” x 3/4” stretch bar bands, unless 3-1/2” x 3-1/2” roll-formed terminals with integral lock loops for attaching fabric are used.
7. Barbed wire shall be installed on extension arms. Each wire shall be pulled taut. Wire shall be attached to the end corner and gate posts with wire stretching bands.
8. Changes in the line where the angle of deflection exceeds 30° shall be considered a corner. Corner posts shall be installed at those locations.
9. The exposed top surfaces of the concrete post footings shall be steel troweled to a slope. This provides a neat appearance and helps to shed water.
10. Provide V-type barbed wire extension arms and 6 rows of barbed wire when the PG&E Security Department requires its installation and at all energized stations.
11. Except for rustake fences, top rails shall not be included on property fences.

Table 1 Fence Posts and Braces

Galvanized Chain-link Fabric; Aluminum-coated Chain-link Fabric; and Plastic-coated, Galvanized Chain-link Fabric				
Fabric Height	Fence Framing	Posts		Braces
		Line	Terminal	
6’ - 0” 7’ - 0” and 8’ - 0”	Standard Weight Pipe	2-3/8” O.D. 3.65 Lbs./Ft.	2-7/8” O.D. 5.79Lbs-/Ft.	1-5/8” O.D. 2.27 Lbs./Ft.
	Roll Form Section	1-7/8” x 1-5/8” 2.28 Lbs./Ft.	3-1/2” Square 4.85 Lbs./Ft.	1-5/8” x 1-1/4” 1.35 Lbs./Ft.
	Aluminum Shapes	2-1/2” O.D. Schedule 40	2-1/2” Square 2.98 Lbs./Ft.	2” O.D. Schedule 40

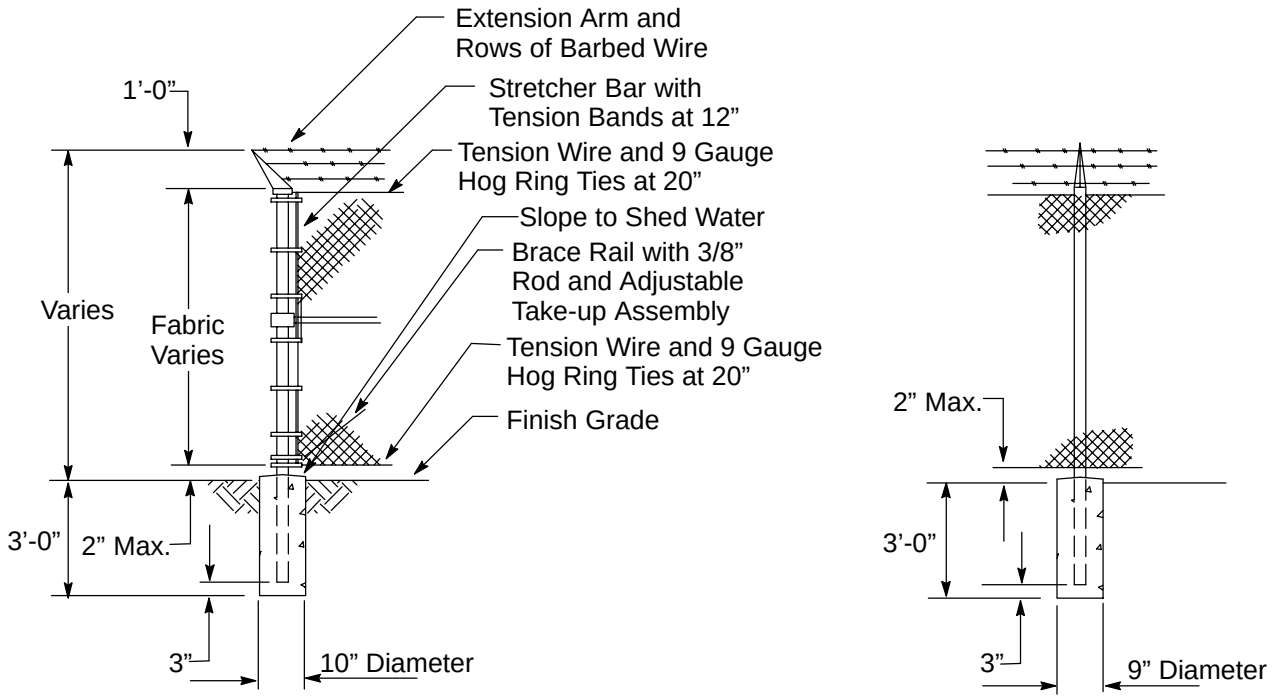
O.D. – outside diameter

Property Fence and Gates

Table 2 Fence Posts and Rails

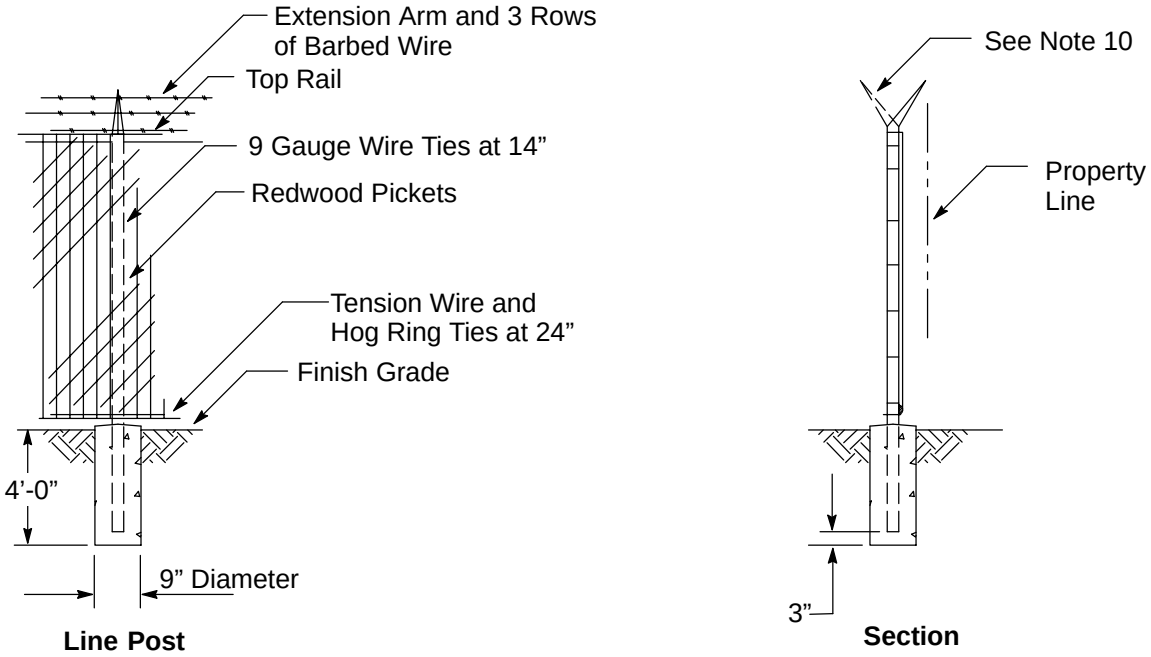
Galvanized Chain-link Fabric; Aluminum-coated Chain-link Fabric; and Plastic-coated, Galvanized Chain-link Fabric				
Fabric Height	Fence Framing	Posts		Rails and Braces
		Line	Terminal	
6’ - 0” 7’ - 0” and 8’ - 0”	Standard Weight Pipe	2-7/8” O.D. 5.79 Lbs./Ft.	2-7/8” O.D. 5.79 Lbs./Ft.	1-5/8” O.D. 2.27 Lbs./Ft.
6’ - 0” 7’ - 0” and 8’ - 0”	Roll Form Section	2-1/4” x 1-5/8” 2.64 Lbs./Ft.	3-1/2” x 3-1/2” 4.85 Lbs./Ft.	1-5/8” x 1-1/4” 1.35 Lbs./Ft.
	Aluminum Shapes	2-1/2” Square 2.9 Lbs./Ft.	2-1/2” Square 2.9 Lbs./Ft.	2” O.D. Schedule 40

Property Fence and Gates



Terminal Post **Line Post**

Figure 1
Chain-link Fabric Fence



Line Post **Section**

Figure 2
Chain-link Fabric Fence with Redwood Pickets

Property Fence and Gates

Notes Regarding Gates

The following instructions are mandatory and shall be followed, except where specifically stated.

1. Provide a gate keeper for each leaf over 5’ wide. Gate keepers are mechanical devices that secure the free end of the gate when the gate is in the full open position.
2. Construct gate frames from 1-1/2” nominal-diameter standard weight pipe. The ASTM A120 requires that the frame’s corners must be welded or fitted and the frame must be trussed with 3/8” adjustable rods.
3. Attach the required chain-link fence fabric to the gate frame by using the appropriate stretcher bars and tie wires. Space the tension connections at 1’ intervals.
4. Hang the gate with galvanized, heavy-duty, industrial, pressed-steel hinges. Use a socket hinge on the bottom of the gate to connect it with the ball end of the gate frame.
5. Install extension arms on the end posts to carry 3 rods of barbed wire. Align the barbed wire horizontally with the barbed wire on the adjacent fence.
6. Use fork-type latches for a single gate. Another option is the plunger-bar latch which secures the gate by its full height.
7. Use fork-type latches with a center drop-rod for double gates. Another option is the plunger-bar latch which secures the gate by its full height and is used in conjunction with a gate stop. Locking devices shall be constructed so that the center drop rod or plunger bar can not be raised when locked.

Table 3 8’–0” High Gate-Minimum Gate Posts and Gate Footings

Table of Gate Face Material	Gate Leaf	Post Size (Outside Diameter)	Footing	
			Diameter of Footings	Depth of Footings
Chain-link Fabric	Up To and Including 6’-0” Wide	3”	12”	48”
	Over 6’-0” and Up To and Including 13’-0” Wide	4”	14”	48”
Chain-link Fabric with Redwood Pickets	Up To and Including 6’-0” Wide	4”	12”	48”
	Over 6’-0” and Up To and Including 13’-0” Wide	6-5/8”	18”	48”

Property Fence and Gates

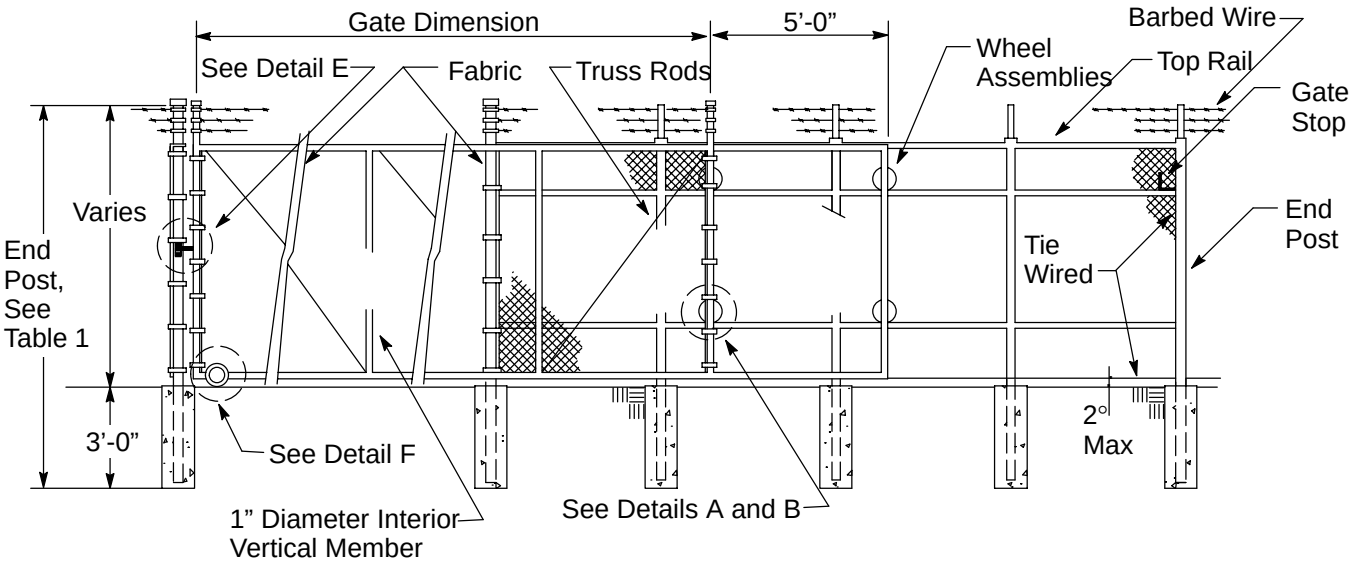


Figure 3
Rolling Gate (Elevation)

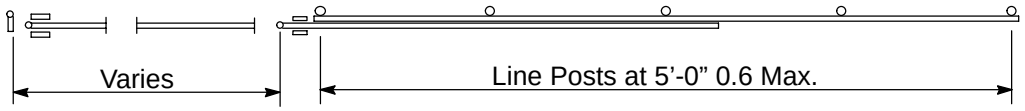


Figure 4
Rolling Gate (Plan)

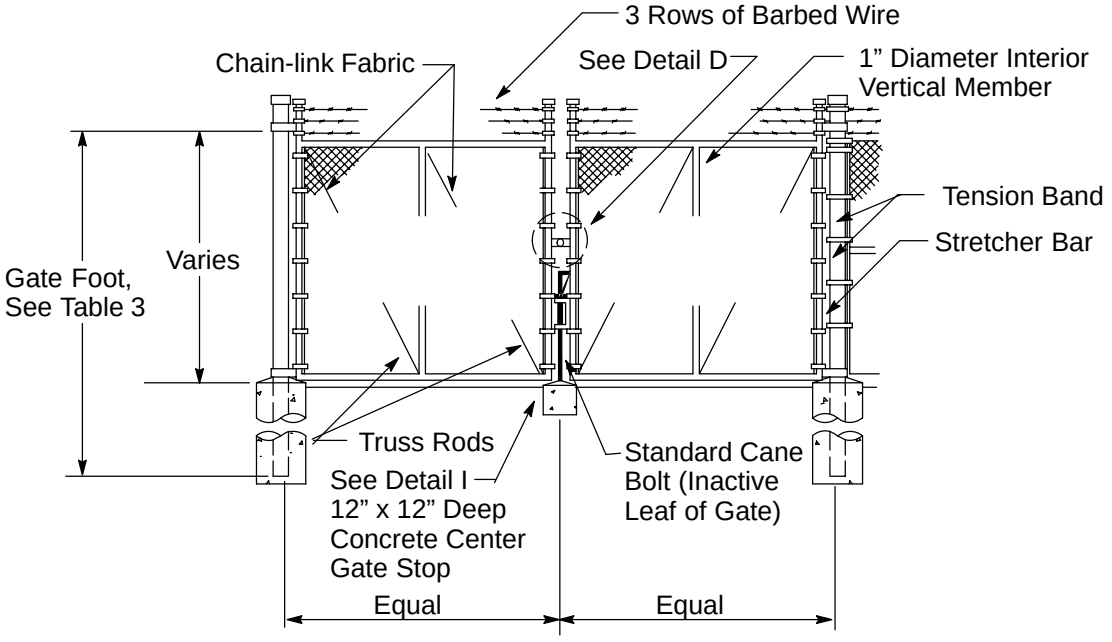
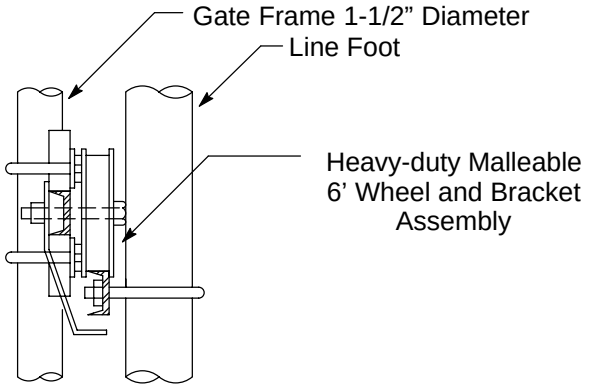
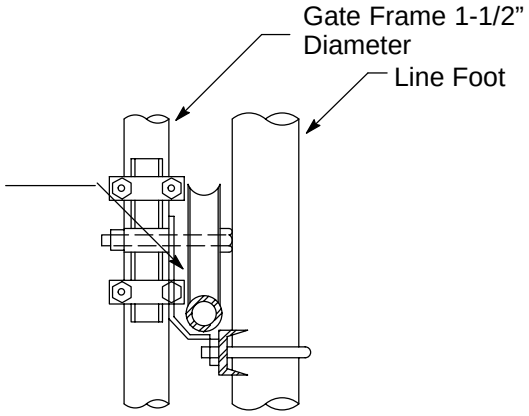


Figure 5
Standard Swing Gate (Elevation)

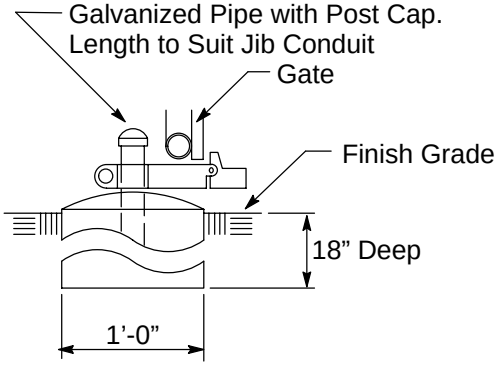
Property Fence and Gates



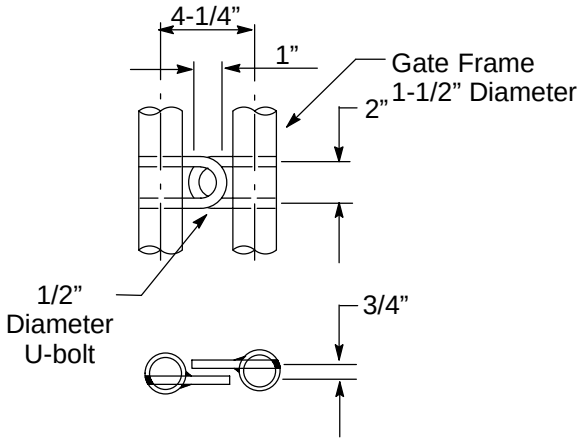
Detail A
Rear Wheels for Channel Track,
Scale: 3” = 1’-0”



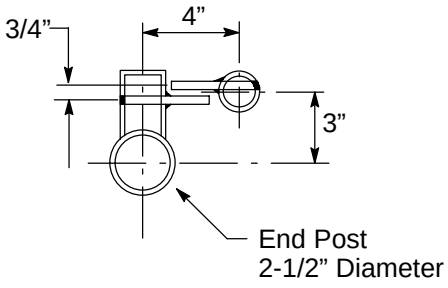
Detail B
Rear Wheels for Pipe Track,
Scale: 3” = 1’–0”



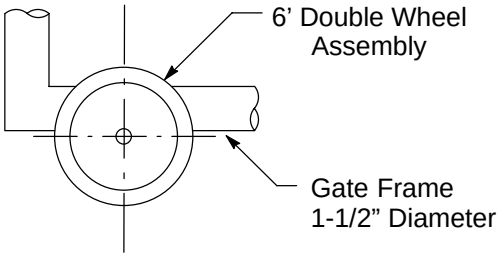
Detail C
Gate Keeper,
Scale: 1-1/2” = 1’-0”



Detail D
Padlock for Standard Swinging Gate

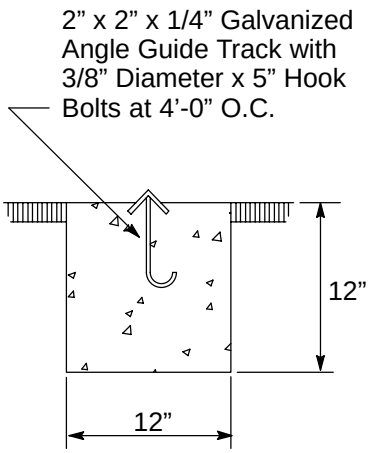


Detail E
Padlock for Rolling Gate,
Scale: 3” = 1’-0”



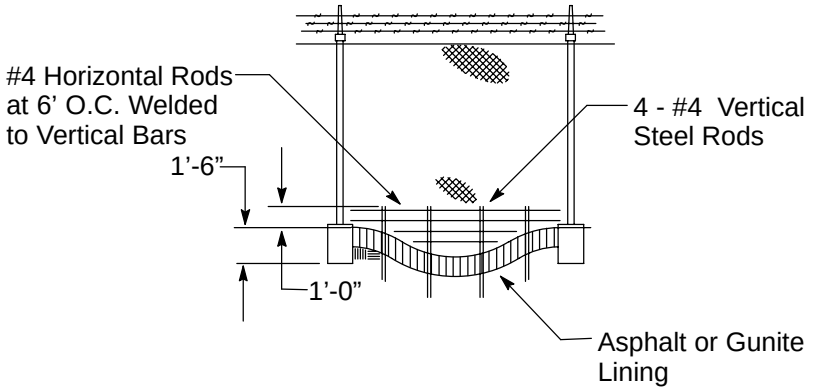
Detail F
Front Wheels for Rolling Gate,
Scale: 3” = 1’-0”

Property Fence and Gates

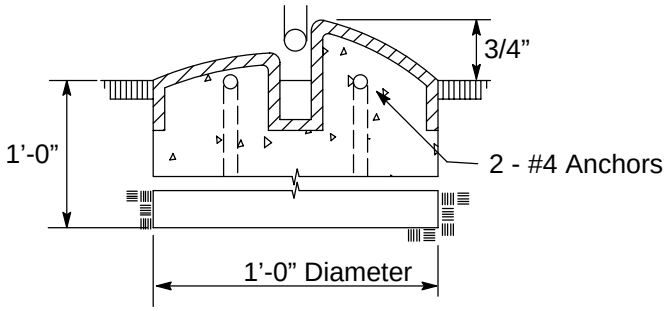


Note: Angle Track to be 1’-0” Longer than Gate Opening.

Detail G
Rolling Gate Guide Track



Detail H
Drainage Trench Detail



Note: Stop to be Supplied by PG&E and Installed by Contractor.

Detail I
Center Gate Stop Detail For Ornamental Swing Gate or
Rustic Gate. For Chain Fabric Gate, Use Masters No. 15911 Stock.

Property Fence and Gates

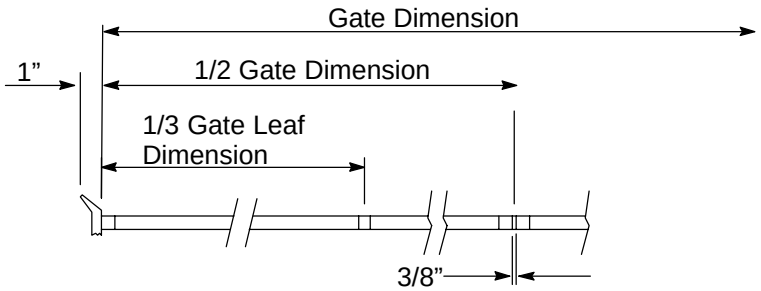


Figure 6
Part Plan Section of Ornament Gate

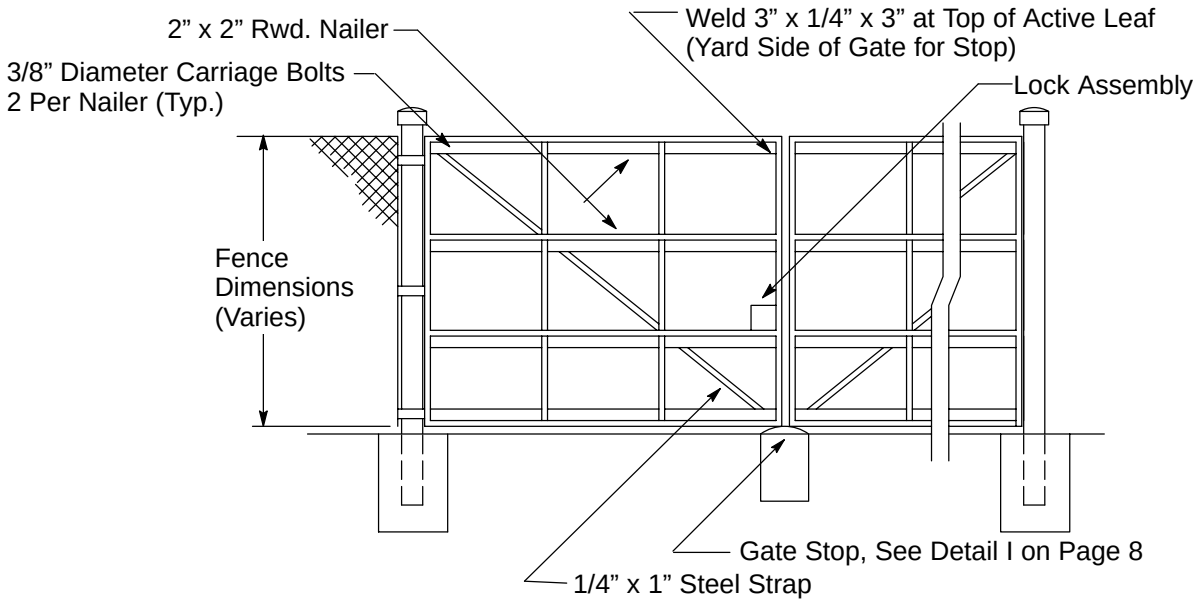
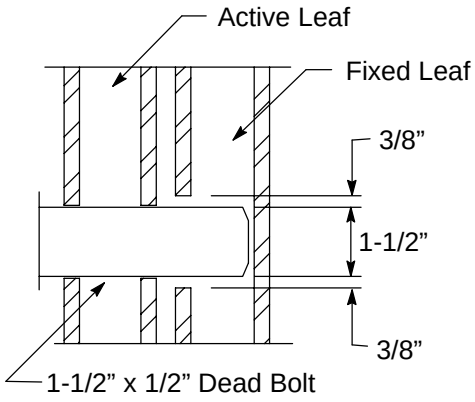


Figure 7
Elevation Of Gate Frame



Detail J
Latch

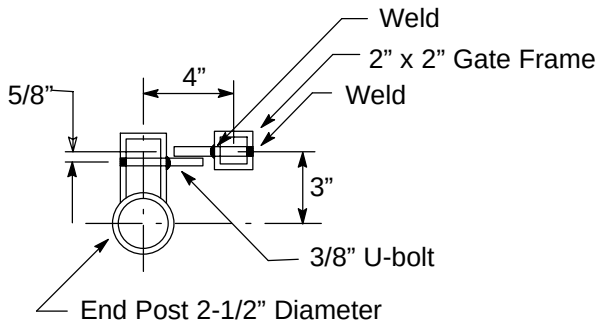


Figure 8
Alternate Padlock Detail

Property Fence and Gates

Installing the Cane Bolt

1. Install one bolt into the cane bolt guide.
2. Slide one bolt and guide into the gate frame and weld the bottom plate to the frame.
3. Install the cane bolt handle and thread top member, see Detail K.

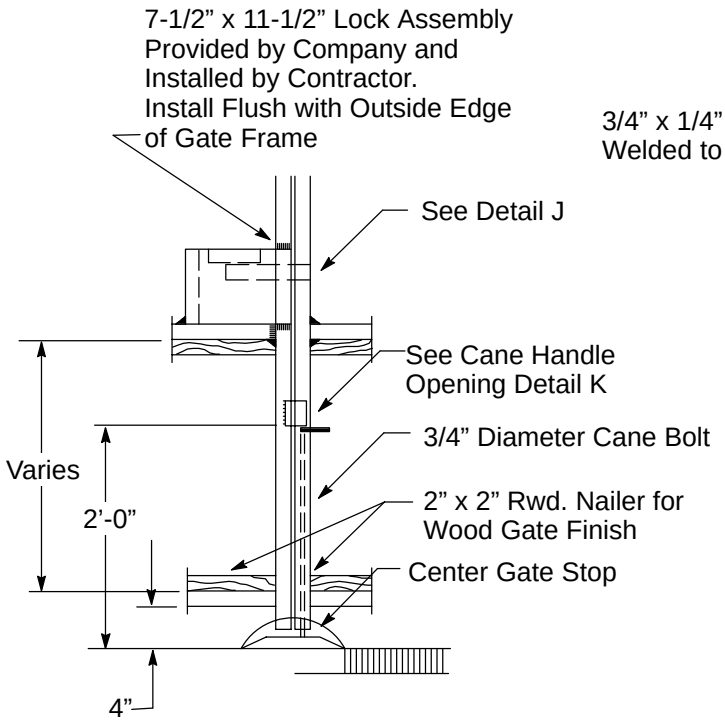
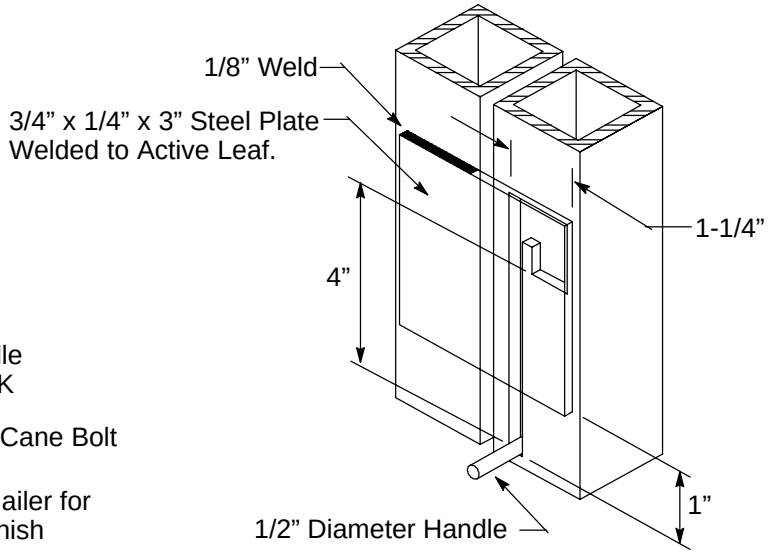
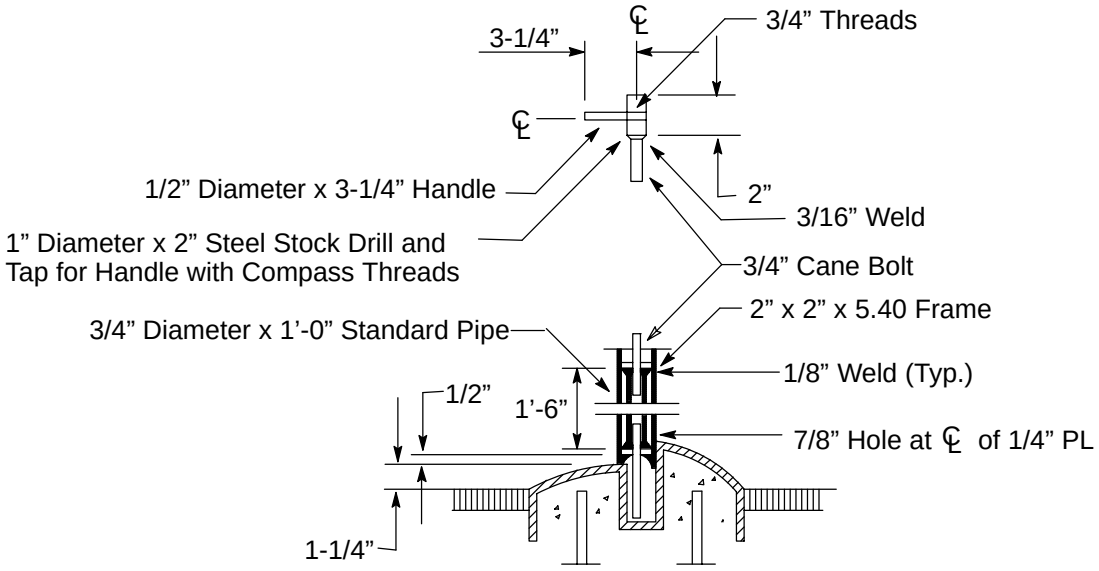


Figure 9
Detail Elevation of Cane Bolt and Lock



Detail K
Cane Handle Opening



Detail L
Cane Bolt and Center Gate Stop

Property Fence and Gates

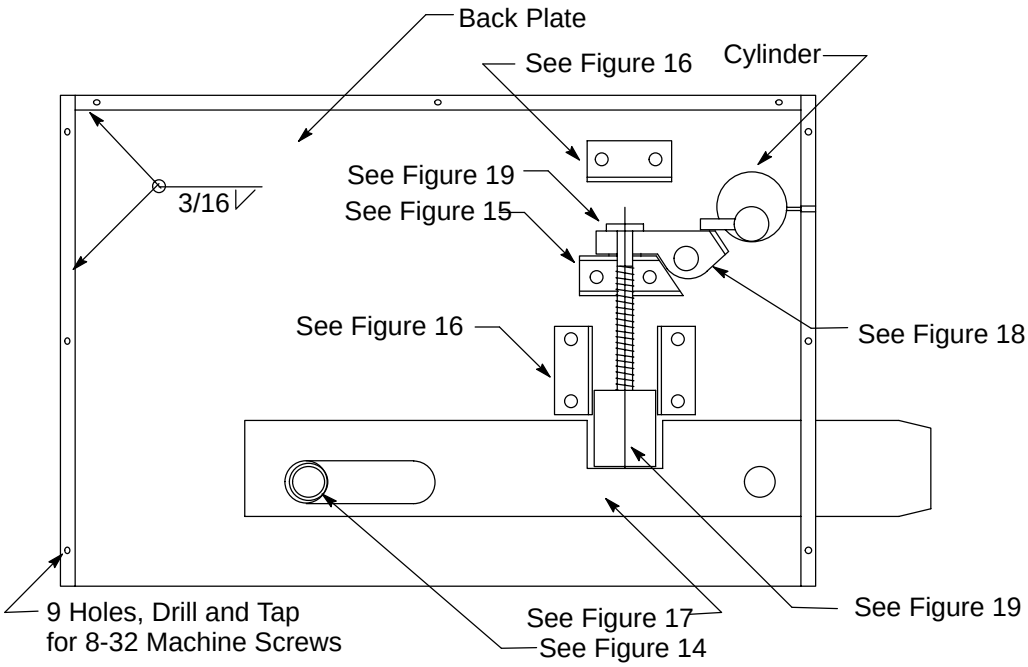
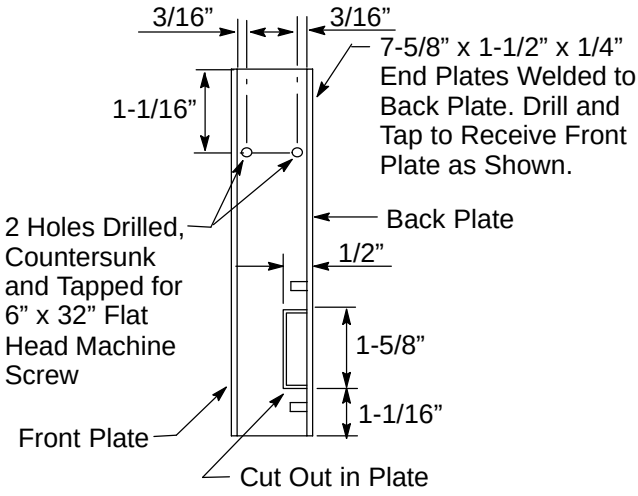
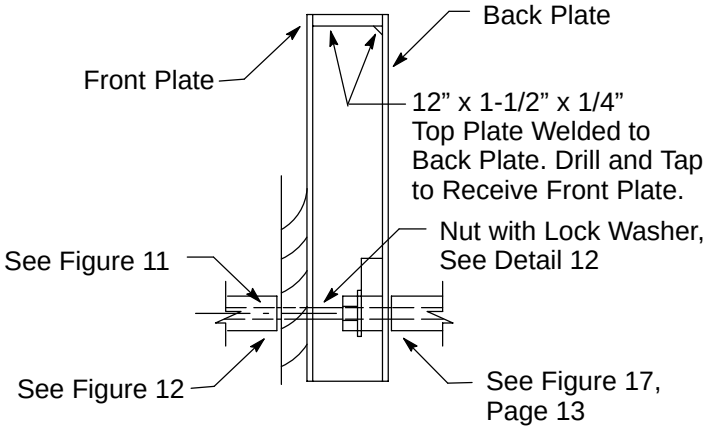


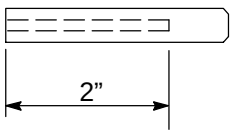
Figure 10
Lock Assembly



Detail M
End Plate



Section A-A



Note: 2 - 3/4” Diameter x 5” Long, Stainless Steel Rods, Drill and Tap to Receive 1/4” Rod

Figure 11
Handle

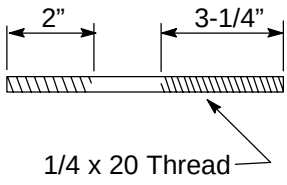


Figure 12
1/4” x 7-5/8” Threaded Rod

Property Fence and Gates

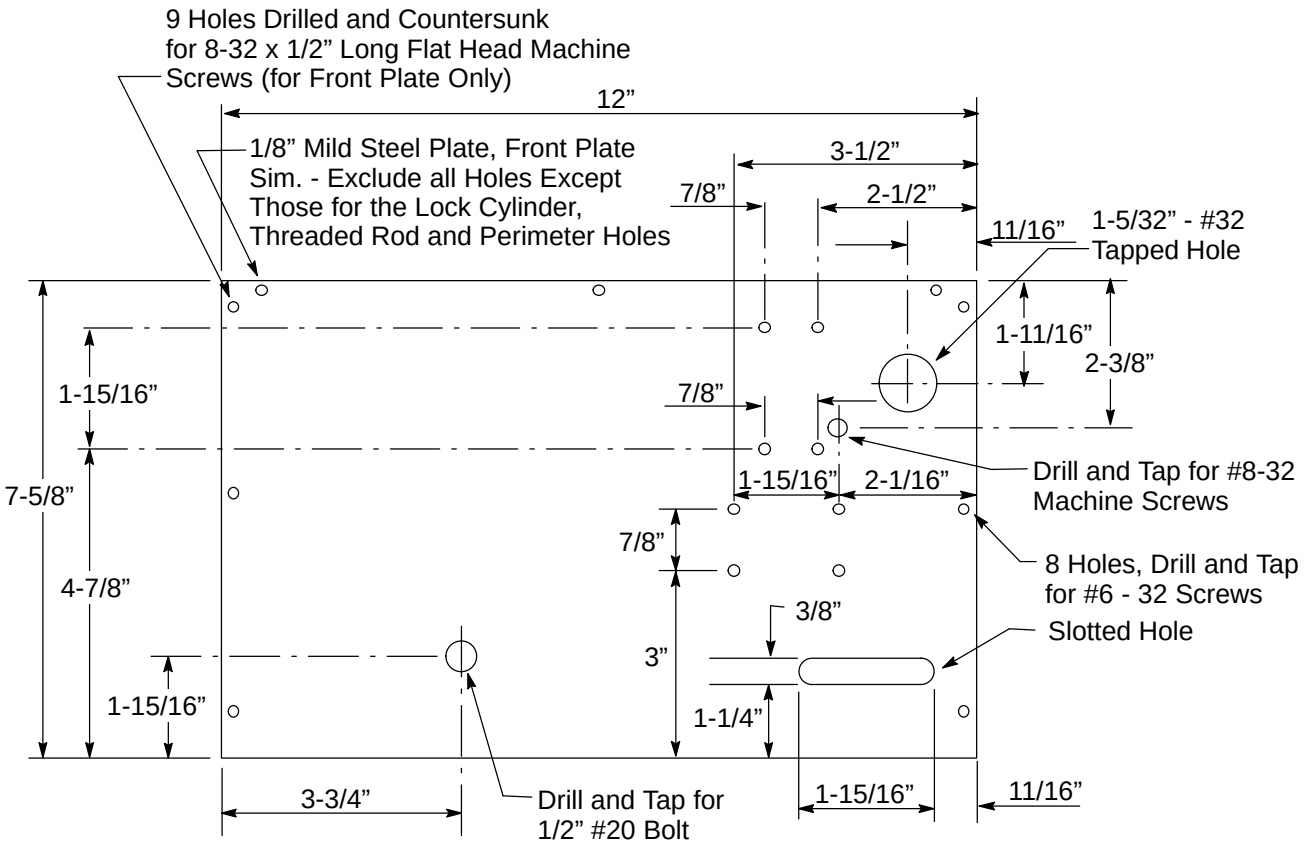


Figure 13
Back Mounting Plate

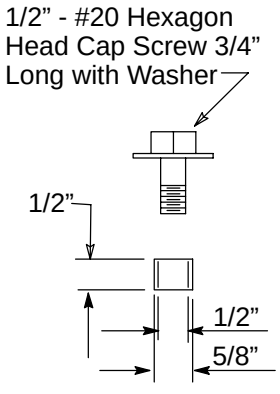


Figure 14
Sleeve

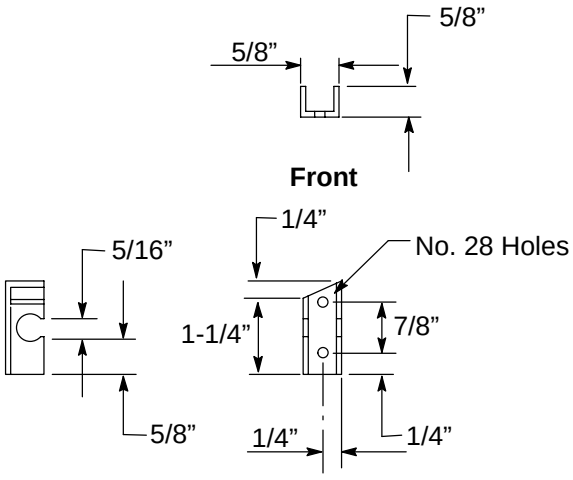


Figure 15
Guide

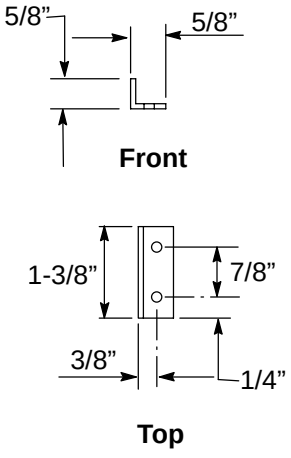


Figure 16
Guide

Property Fence and Gates

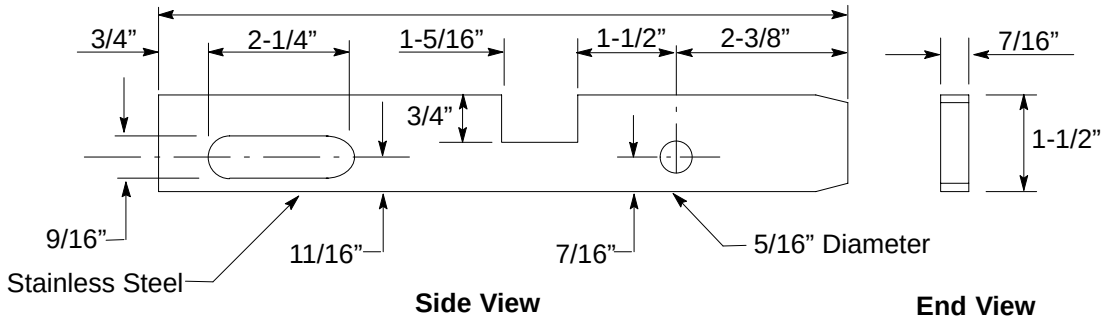


Figure 17
Latch Bar

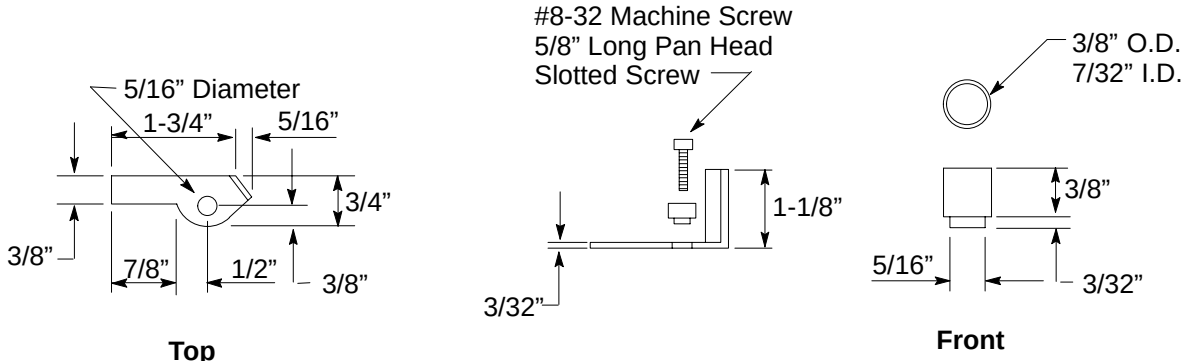


Figure 18
Latch Bolt Lever

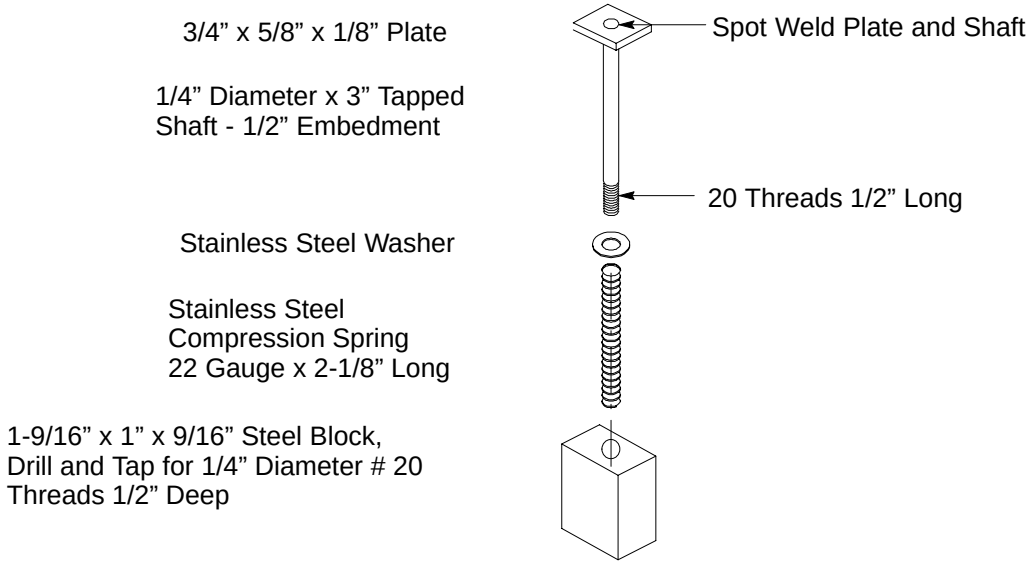
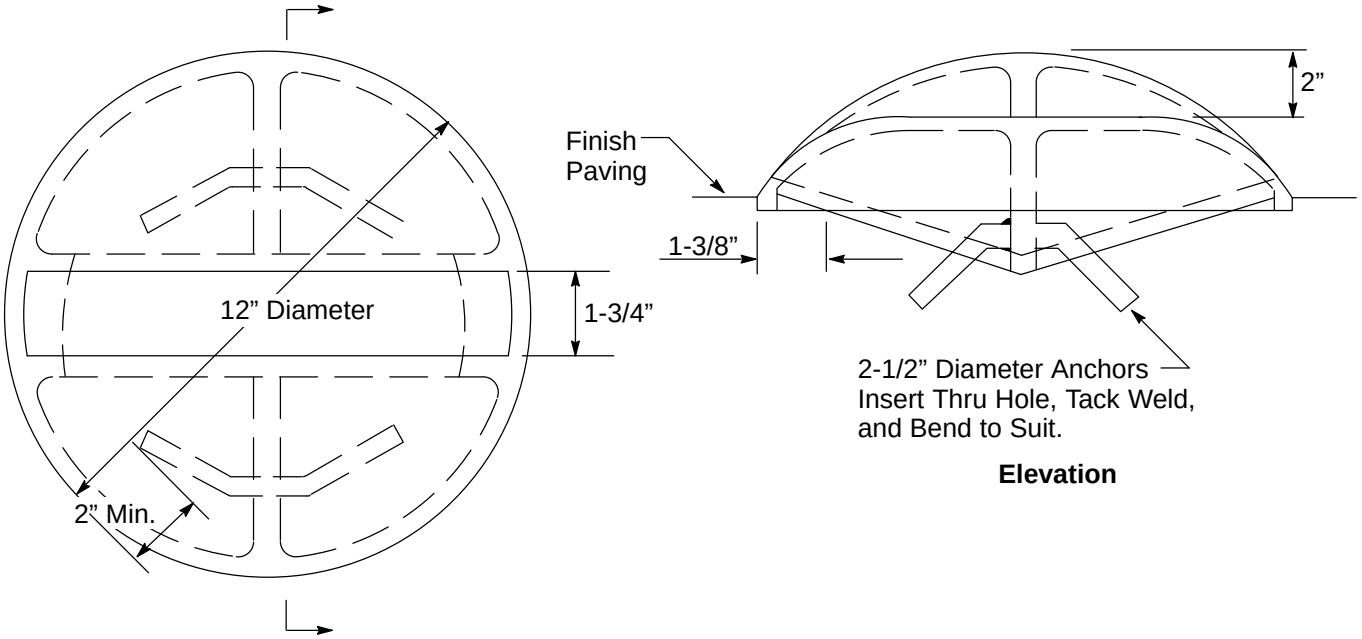


Figure 19
Latch Bolt Assembly

Property Fence and Gates

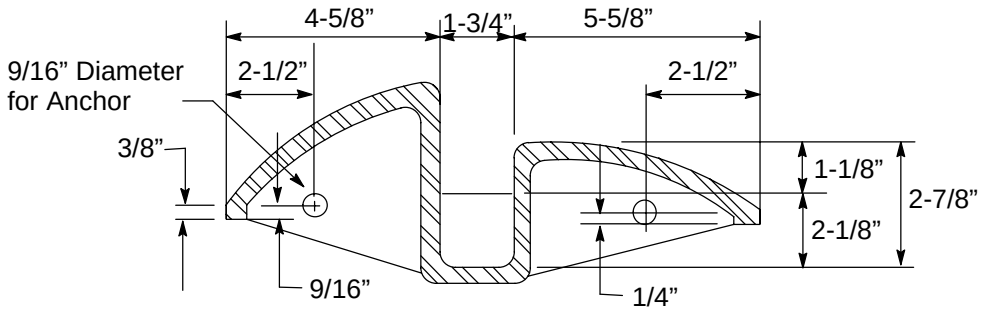
Notes

1. The material for the gate stop is to be cast iron throughout.
2. The material thickness is to be 3/8” throughout.



Plan
PG&E Code 170106

Elevation



Section B-B

Figure 20
Center Gate Stop Fabrication Drawing

Revision Notes

Revision 00 has the following changes:

1. Converted PG&E Drawings 059659, 059660, 059661, 059662, 059663, 059664 and 059665 to Gas Standard L-50.
2. Rearranged contents; completely revised text, tables and graphics numbering streams.
3. Reset revision number stream to zero.
4. This document is part of Change 44.

SECTION 33 05 01.02
DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): T99, Standard Method of Test for the Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
2. American Society of Mechanical Engineers (ASME):
   a. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   b. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
3. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Fittings.
   f. C116/A21.16, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
   g. C150/A21.50, Thickness Design of Ductile-Iron Pipe.
   h. C151/A21.51, Ductile-Iron Pipe. Centrifugally Cast, for Water.
   i. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   j. C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
   k. C606, Grooved and Shouldered Joints.
4. ASTM International (ASTM):
   a. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   b. A563, Standard Specification for Carbons and Alloy Steel Nuts.
   c. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.

d. D1330, Standard Specification for Rubber Sheet Gaskets.
e. D1922, Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method.
f. D2000, Standard Classification System for Rubber Products in Automotive Applications.
g. D4976, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

5. International Organization for Standardization (ISO): 9001, Quality Management Systems – Requirements.
6. Section 33 12 16, Water Utility Distribution Valves.
7. Section 31 23 23.15, Trench Backfill.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: 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.

B. Informational Submittals:

1. Field Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Method of isolation.
   d. Method of conveying water from source to system being tested.
   e. Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
3. Test documentation form and results.

1.03 QUALITY ASSURANCE

A. Pipe manufacturer shall be ISO 9001 registered or provide the services of an independent inspection agency.

B. Prior to start of manufacturing, manufacturer not meeting or having ISO registration requirements shall submit name of at least two independent inspection agencies for approval.

1. Independent inspection agency shall be responsible, on a daily basis, for sample monitoring of chemical and mechanical tests, sample visual inspection of quality assurance tests performed on in-process pipe and fittings, and sample visual and dimensional inspection on finished products.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Ductile iron pipe shall be manufactured, lined, coated, and tested domestically in the United States of America.

B. Pipe:

1. General:
   a. Pipe shall be new and recently manufactured. Refurbished pipe shall not be provided.
   b. Lined and coated as specified.
2. Meet requirements of AWWA C150/A21.50, AWWA C151/A21.51, and AWWA C111/A21.11.
3. Centrifugally cast, grade 60-42-10 iron.
4. Pressure rating of pipe from 4 inches to 12 inches in diameter shall be 350 psi.
5. Grooved end pipe shall be minimum Class 52.

C. Joints:

1. Push-On Joint: Rated at minimum working pressure equal to pipe material design.
2. Restrained Joint:
   a. Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe.
   b. Manufacturers and Products:
      1) American Cast Iron Pipe; Flex-Ring, Field Flex-Ring, and Lok-Ring.
      2) Pacific States Pipe; Thrust-Lock.
      3) U.S. Pipe; TR Flex and HP Lok.

3. Mechanical Wedge Action Type Joint:
   a. Use only in areas where adjoining to fixed points where laying length is determined in field.
   b. Prior to purchase and installation, type and application of this joint shall be approved by Engineer.
4. Use of set screws for restraint or field-lock gaskets shall not be allowed.
5. Grooved Joint:
   a. Flexible type radius cut grooved, conforming to AWWA C606.
   b. Manufacturer: Victaulic Company of America.

D. Fittings:

1. Fittings shall be new and recently manufactured. Refurbished fittings will not be accepted.
2. Mechanical, Push-On, Flanged, or Restrained Joint: In accordance with the following table:

Minimum Pressure Ratings for AWWA C110/A21.10 and C115/A21.15 Ductile Iron Fittings		
Diameter (inches)	**Rubber Gasket Joints (Push-on, Mechanical, Restrained) (psi)**	**Flanged Joints (psi)**
3 to 24	250	250
30 to 48	250	250
Minimum Pressure Ratings for AWWA C153/A21.53 Ductile Iron Fittings		
Diameter (inches)	**Rubber Gasket Joints (Push-on, Mechanical, Restrained) (psi)**	**Flanged Joints**
3 to 24	250	Not included in C153/A21.53 (refer to the C110/A21.10 Standard)
30 to 48	250	Not included in C153/A21.53 (refer to the C110/A21.10 Standard)
54 to 64	250	250 psi

3. Rubber Gasket Joints Including Mechanical Joints, Push-On Joints, and Flanged Joints: In accordance with AWWA C111/A21.11.
4. Mechanical Joint Fittings: In accordance with AWWA C110/A21.10 and AWWA C153/A21.53.
5. Grooved End Fittings:
   a. Radius cut grooved, flexible type conforming to AWWA C110/A21.10 and AWWA C153/A21.53.
   b. Manufacturers:
      1) Victaulic Company of America.
      2) Gustin-Bacon.

E. Welded Outlet: Only weld to pipe in manufacturer's shop.

F. Lining: Pipe and fittings for clean water applications shall be cement-lined and asphaltic seal coated in accordance with AWWA C104/A21.4.

G. Coating: Asphaltic type, 1 mil thick, in accordance with AWWA C151/A21.51.

H. Polyethylene Encasement:

1. Virgin polyethylene raw material conforming to requirements of ASTM D4976.
2. Elongation: 800 percent, minimum, in machine and transverse direction (ASTM D882).
3. Tensile Strength: 3,600 psi, minimum.
4. Dielectric Strength: 800V per mil-thickness, minimum.
5. Propagation Tear Resistance: 2,550-gram force (gf), minimum, in machine and transverse direction (ASTM D1922).
6. Tube Form: Conform to AWWA C105/A21.5.
7. Film: 0.008 inch (8 mil) thick, minimum.
8. Number of Film Layers: One.

I. Bolting:

1. Flanged Connection Bolts: Carbon steel, ASTM A307, Grade A hex bolts and ASTM A563, Grade A hex head nuts.
2. Grooved End Connections Bolts: Manufacturer's standard.

J. Gaskets:

1. Flat Faced Flange Gaskets:
   a. Pipe Smaller Than 54 Inches: Rated for working pressure 150 psi to 250 psi, 1/8 inch thick, red rubber (SBR), hardness 80

(Shore A), rated to 200 degrees F, conforming to ASME B16.21, AWWA C207, and ASTM D1330, Grade 1 and Grade 2.

2. Grooved End Joint Gaskets: Halogenated butyl, conforming to ASTM D2000 and AWWA C606.

2.02 SOURCE QUALITY CONTROL

A. Factory Tests:

1. General: See Section 33 12 16, Water Utility Distribution Valves, for pressure testing, flushing and system sterilization as required. Fire systems will not need Sterilization.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect pipe and fittings to ensure no cracked, broken, or otherwise defective materials are being used.

3.02 PREPARATION

A. Trenching as specified in Section 31 23 23.15, Trench Backfill:

1. When specified, grade bottom of trench by hand to specified line and grade with proper allowance for pipe thickness and pipe base. Trench bottom shall form a continuous and uniform bearing and support for pipe between bell holes.
2. Before laying each section of pipe, check grade and correct irregularities found. Grade may be disturbed for removal of lifting tackle.

B. Bell (Joint) Holes: At each joint, dig bell holes of ample dimensions in bottom of trench, and at sides where necessary, to permit joint to be made properly and to permit easy visual inspection of entire joint.

C. Pipe shall have a minimum cover below finished grade of 3 feet.

3.03 INSTALLATION

A. General:

1. Provide and use proper implements, tools, and facilities for safe and proper prosecution of the Work.
2. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of a crane, slings, or other suitable tools and equipment, in such a

manner as to prevent damage to pipe materials, protective coatings and linings.

3. Do not drop or dump pipe materials into trench.

B. Cleaning Pipe and Fittings:

1. Remove lumps, blisters, and excess coal tar 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.

C. Laying Pipe:

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.
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.

D. Joining Push-On Joint Pipe and Mechanical Joint Fittings:

1. Join pipe with push-on joints and mechanical joint fittings in 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.

E. Ball Joint Pipe:

1. Assemble and install in accordance with manufacturer's recommendations.
2. Hydrostatic Test:
   a. Conduct on ball joint pipe independent of other pipe systems/type being installed.
   b. Conduct test in accordance with requirements of these Specifications and manufacturer's recommendations.

F. Cutting Pipe:

1. General: Cut pipe for inserting valves, fittings, or 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.
2. Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.
3. Dressing Cut Ends: Dress cut end of mechanical joint pipe to remove sharp edges or projections, which may damage rubber gasket. Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.

G. Field Welding:

1. Use of field welded outlets will not be allowed. Welding for outlets shall be performed only in pipe manufacturer's shop.
2. Field installed outlets may be installed with saddle approved by Engineer. Opening in pipe shall be machined cut and not with cutting torch.
3. Field welding of bars for restrained joint systems will not be allowed unless approved by Engineer. Welding shall be performed in pipe manufacturer's shop.

H. Line and Grade:

1. Minimum Pipe Cover: 3 feet, unless otherwise indicated.
2. No high points will be allowed between air valves.
3. Maintain pipe grade between invert elevations to provide minimum clearance at air valve locations of 4 feet from existing ground surface to top of pipe.

4. Install air valves as shown and field verify intervening low points. When field conditions warrant, exceptions may be made upon approval of Engineer.
5. Deviations exceeding 6 inches from specified line or 1 inch from specified grade will not be allowed without express approval of Engineer.
6. Pipeline sections that are not installed to elevations shown or installed as approved by Engineer shall be reinstalled to proper elevation.

I. Thrust Restraint:

1. Restrained joints. Use of thrust blocking will not be allowed except as approved by the Engineer.
2. Primary method of restraint shall be through use of restrained joint pipe. Thrust blocking shall be used where detailed on Drawings and as approved by Engineer.

J. Polyethylene Encasement:

1. Encase pipe, fittings, and valves where specified in accordance with AWWA C105/A21.5, 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.

K. Clearance:

1. Separate water lines from underground structures, 12 inches minimum, unless otherwise shown.
2. Water lines shall be laid at least 10 feet laterally from existing or proposed sewers, unless otherwise shown.
3. When storm sewers are encountered, a 12 inch minimum vertical separation and a 5 foot minimum lateral separation shall be maintained.

3.04 TESTING

A. For System Testing, see Section 33 12 16, Water Utility Distribution Valves. Includes system sterilization for domestic water systems.

END OF SECTION

SECTION 33 05 13
MANHOLES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): M198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Standard Specification for Gray Iron Castings.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A536, Standard Specification for Ductile Iron Castings.
   e. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   f. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
   g. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
   h. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   i. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   j. C150/C150M, Standard Specification for Portland Cement.
   k. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
   l. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. C443, Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
   n. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   o. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

p. C990, Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants.
q. C1311, Standard Specification for Solvent Release Sealants.
r. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
s. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
t. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
u. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
v. F594, Standard Specification for Stainless Steel Nuts.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings including details of construction, reinforcing and joints, anchors, lifting, external straps, erection inserts, and other items cast into members.
2. Product Data:
   a. Concrete mix design.
   b. Manhole frame to structure seals.
   c. Manhole frame to structure anchor bolt.
   d. Rubber gaskets and sealants.
   e. External joint wrap.

B. Informational Submittals:

1. Experience Record:
   a. Precast concrete production capabilities.
   b. Evidence of current PCI plant certification.
2. Calculations: Proposed details and design calculations for stresses in precast concrete members for loading conditions including earth pressures and transportation, handling, and erection. Calculations shall be stamped by engineer registered in the same state as the Project.
3. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
4. Test Reports: Precast manufacturer’s concrete test cylinders.
5. Certified load test data for precast manhole steps.
6. Manufacturer’s recommended installation instructions.

7. Field quality control report.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years' experience producing precast concrete products of quality specified.
2. Precast Plant: PCI certified plant with current certification.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials of Construction and Service Conditions:

1. Screws, Bolts, or Nuts: Type 304 stainless steel conforming to ASTM F593 and ASTM F594.
2. Gaskets: Internal and external seals shall be made of materials that have been proven to be resistant to the following exposures and conditions:
   a. Sanitary sewage.
   b. Corrosion or rotting under wet or dry conditions.
   c. Gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide, and other trace gases at installation site.
   d. Biological environment in soils and sanitary sewers.
   e. Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
   f. Temperature ranges, variations, and gradients in construction area.
   g. Variations in moisture conditions and humidity.
   h. Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.
   i. Vibrations because of traffic loading.
   j. Fatigue failure because of repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression. Material shall remain flexible allowing repeated movement.
3. Materials shall be compatible with each other and manhole materials.
4. Designed to provide a 20-year service life.

B. Structures shall meet requirements of ASTM C478, this specification and the following:

1. Concrete:
   a. Cement: Meet requirements of ASTM C150/C150M.
   b. Compressive Strength:
      1) Minimum 4,000 psi.
      2) Minimum strength shall be confirmed at 7 days by making two standard cylinders per manhole for testing.
   c. Concrete mix design shall include Xypex C-500 or C-1000 based upon mix design at dosage recommended by manufacturer for installation.
2. Reinforcement: Grade 60, unless otherwise specified.
3. Ring: Custom made with openings to meet indicated pipe alignment conditions and invert elevations.
4. Floor: Minimum 6 inches below pipe to provide clearance for grouting channels.
5. Joint:
   a. Form joint contact services with machined castings.
   b. Surfaces shall be parallel with nominal 1/16-inch clearing and tongue equipped with recess for installation of O-ring rubber gasket.
6. Gasket: Meet requirements of ASTM C443.

2.02 PRECAST MANHOLES

A. Riser Sections:

1. Fabricate in accordance with ASTM C478.
2. Diameter: Minimum 48 inches.
3. Wall Thickness: Minimum 4 inches or 1/12 times inside diameter, whichever is greater.
4. Top and bottom surfaces shall be parallel.
5. Joints: Tongue-and-groove and confined O-ring with rubber gaskets meeting ASTM C443.

B. Cone Sections:

1. Eccentric.
2. Same wall thickness and reinforcement as riser section.
3. Top and bottom surfaces shall be parallel.

C. Base Sections and Base Slab:

1. Base slab integral with sidewalls.
2. Fabricate in accordance with ASTM C478.

D. Manhole Extensions:

1. Concrete grade rings; maximum 6 inches high.
2. Fabricate in accordance with ASTM C478.

E. Joint Seal Manufacturers and Products:

1. Butyl Gaskets:
   a. Hamilton Kent, Sparks, NV; Kent-Seal No. 2.
   b. Henry Company, Houston, TX; Ram-Nek.
   c. Trelleborg Engineered Solutions, Park Hills, MO; NPC Bidco C-56.
2. Confined Plastic or Rubber O-Ring:
   a. As recommended by precasting manufacturer.
   b. Meet requirements of ASTM C443.
3. External Wrap:
   a. Sealing Systems, Inc., Loretto, MN; Gator Wrap.
   b. Henry Company, Houston, TX; RU116 Rubr-Nek External Joint Wrap.
   c. Trelleborg Engineered Solutions, Park Hills, MO; NPC External Joint Wrap.
   d. Cretex Specialty Products, Waukesha, WI; Cretex Wrap.

F. Polypropylene Steps:

1. Fabricate from minimum 1/2 inch, Grade 60, steel bar meeting ASTM A615/A615M.
2. Polypropylene encasement shall conform to ASTM D4101.
3. Minimum Width: 13 inches, center-to-center of legs.
4. Embedment: 3-1/2-inch minimum and 4-1/2-inch minimum projection from face of concrete at point of embedment to center of step.
5. Cast in manhole sections by manufacturer.
6. Load Test: Capable of withstanding ASTM C478 vertical and horizontal load tests.

2.03 CAST-IN-PLACE MANHOLES

A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

B. Reinforcing Steel: As specified in Section 03 21 00, Reinforcing Steel.

2.04 MANHOLE FRAMES AND COVER

A. Castings:

1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
2. Cast Iron: ASTM A48/A48M Class 30B or 35B.
3. Ductile Iron: ASTM A536, Grade 60-40-12.
4. Plane or grind bearing surfaces to ensure flat, true surfaces.

B. Cover: True and seat within ring at all points with the word SEWER or DRAIN in 2-inch raised letters.

2.05 MANHOLE FRAME CONNECTION TO STRUCTURE

A. Butyl Sealant:

1. Conform to ASTM C1311, or AASHTO M198 and ASTM C990.
2. Trowelable or cartridge applied.
3. Manufacturers and Products:
   a. Tremco Commercial Sealants and Waterproofing, Beachwood, OH; Tremco Butyl Sealant.
   b. Bostik, Middleton, MA; Chem-Calk 300.
   c. Press-Seal Gasket Company, Fort Wayne, IN; EZ-Stik #3.

B. External Wrap:

1. Meet requirements of ASTM C923.
2. Construct of high quality rubber that will provide flexible watertight seal around joint.
3. Thickness: Minimum 60 mils.
4. Consist of a top and bottom section and be sealed to structure, frame top, and bottom with mastic as applicable.
5. Length: Extend from manhole frame and extension ring to cone section.
6. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.
7. Manufacturers and Products:
   a. Sealing Systems, Inc., Loretto, MN; Infi-Shield.
   b. Trelleborg Engineered Systems, Milford, NH; NPC Flexrib Frame-Chimney Seals.
   c. Cretex Specialty Products, Waukesha, WI; X-85 Seal.

C. Internal Wrap or Sealing Membrane:

1. Meet requirements of ASTM C923.
2. Minimum internal thickness of 3/16 inch or as recommended by manufacturer for installation climate.
3. Designed for application and have a demonstrated history of accommodating differential expansion between frame and concrete.
4. Width: Minimum 8 inches.
5. Expansive type wraps shall be fabricated of high quality rubber or urethane.
6. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.
7. Wrap shall not restrict access to manhole.
8. Manufacturers and Products:
   a. Sealing Systems, Inc., Loretto, MN; Flex-Seal Utility Sealant.
   b. Trelleborg Engineered Systems, Milford, NH; NPC Flexrib Frame-Chimney Seals.
   c. Cretex Specialty Products, Waukesha, WI; Internal Manhole Chimney Seal.

D. Frame to Structure Anchor Bolts:

1. 3/4-inch-diameter HAS stainless steel bolts; minimum 6-5/8-inch embedment.
2. Manufacturer and Product: Hilti; HVA Capsules Adhesive Anchoring System.

2.06 MORTAR

A. Standard premixed in accordance with ASTM C387/C387M, or proportion one part portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.

B. Admixtures: May be included; do not exceed the following percentages of weight of cement:

1. Hydrated Lime: 10 percent.
2. Diatomaceous Earth or Other Inert Material: 5 percent.

C. Mix Consistency:

1. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.

2. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.

2.07 BACKFILL AROUND AND UNDER MANHOLE

A. Structural fill as specified in Section 31 23 23, Fill and Backfill.

2.08 FLEXIBLE JOINTS FOR SEALING PIPES IN MANHOLE

A. Manufacturers and Products:

1. NPC, Inc., Milford, New Hampshire; Kor-N-Seal flexible rubber boot with stainless steel accessories.
2. A-LOK Products, Inc., Tullytown, PA; Z-LOK XP or A-LOK flexible connectors.

B. Doghouse Manhole/Manhole Over Existing Pipe (where use of a boot is not possible):

1. Green Streak; hydrophilic waterstop CJ-0725-3k.

2.09 SOURCE QUALITY CONTROL

A. Prior to delivery of precast manhole sections to Site, yard permeability tests may be required at point of manufacture. Engineer or Owner will select precast sections not to exceed 5 percent of the total project quantity to test from material which is to be supplied to Project. Test specimens shall be mat tested and meet permeability test requirements of ASTM C14.

B. Concrete Testing: Test two concrete test cylinders for each manhole. Compressive strength shall be tested in accordance with ASTM C31/C31M, ASTM C39/C39M, and ASTM C192/C192M.

C. Inspection:

1. Material Quality:
   a. Manufacturing process and finished sections shall be subject to inspection and approval by Owner and Engineer.
      1) Inspections may take place at manufacturer’s plant, at Site after delivery, or at both.
      2) Sections not meeting requirements of this Specification or that are determined to have defects which may affect durability of structure are subject to rejection.

3) Sections rejected after delivery shall be removed and replaced.
4) Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Owner and Engineer.
5) If structure cannot be repaired it shall be removed and replaced entirely at Contractor's expense.

2. At the time of inspection the sections will be carefully examined for compliance with ASTM C478 and with manufacturer's drawings. Sections will be inspected for general appearance, dimensions, scratch strength, blisters, cracks, roughness, and soundness. Surface shall be dense and close textured.
3. Imperfections may be repaired, subject to approval of Engineer, after demonstration by manufacturer that strong and permanent repairs result.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to installation inspect materials:

1. Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
2. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Owner and Engineer.
3. Remove and replace structure that cannot be repaired.

B. If needed, dewater excavation during construction and testing operations.

3.02 EXCAVATION AND BACKFILL

A. Excavation: As specified in Section 31 23 16, Excavation.

B. Backfill: As specified in Section 31 23 23, Fill and Backfill.

3.03 INSTALLATION OF PRECAST MANHOLES

A. Concrete Base:

1. Precast:
   a. Place on compacted structural fill.
   b. Properly locate, ensure firm bearing throughout, and plumb first section.

2. Cast-in-Place:
    a. Invert: Minimum 8 inches below lowest connecting pipe.
    b. First section of manhole shall be cast in concrete base.

B. Sections:

1. Inspect precast manhole sections to be joined.
2. Clean ends of sections to be joined.
3. Do not use sections with chips or cracks in tongue.
4. Locate precast steps in line with each other to provide continuous vertical ladder.

C. Preformed Plastic Gaskets or Rubber O-Ring:

1. Use only pipe primer furnished by gasket manufacturer.
2. Install gasket material in accordance with manufacturer’s instructions.
3. Completed Manhole: Rigid and watertight.

D. Mortar Joints:

1. Thoroughly wet joint with water prior to placing mortar.
2. Place mortar on groove of lower section prior to section installation.
3. Fill joint completely with mortar of proper consistency.
4. Trowel interior and exterior surfaces smooth on standard tongue-and-groove joint.
5. Prevent mortar from drying out and cure by applying approved curing compound or comparable approved method.
6. Do not use mortar mixed for longer than 30 minutes.
7. Chip out and replace cracked or defective mortar.
8. Completed Manhole: Rigid and watertight.

E. External Joint Wraps: Install in accordance with manufacturer’s instructions.

F. Extensions:

1. Provide on manholes in streets or other locations where change in existing grade may be likely.
2. Install to height not exceeding 12 inches.
3. Lay grade rings in mortar with sides plumb and tops level.
4. Seal joints with mortar as specified for sections and make watertight.

3.04 MANHOLE INVERT

A. Construct with smooth transitions to ensure unobstructed flow through manhole. Remove sharp edges or rough sections that tend to obstruct flow.

B. Where full section of pipe is laid through manhole, break out top section and cover exposed edge of pipe completely with mortar. Trowel mortar surfaces smooth.

3.05 MANHOLE FRAMES AND COVERS

A. Install concrete grade rings as required to set covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

B. Set frames in three equally spaced beads of butyl sealant that run full circumference of frame.

C. Anchor frame to manhole with specified bolts.

D. Install interior manhole frame to structure seals in accordance with manufacturer's instructions. Seal shall cover grade rings.

3.06 CAST-IN-PLACE MANHOLE

A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

B. Reinforcing Steel: As specified in Section 03 21 00, Reinforcing Steel.

C. Steps:

1. Install manhole steps at 16 inches on center, plus or minus 1/4-inch tolerance, and locate to provide a continuous vertical ladder.
2. Do not vary spacing between any two adjacent steps by more than 1/2 inch.
3. Distance between wall of manhole and center of rung, measured at point of embedment, shall be not less than 4 inches or more than 6-1/4 inches.

3.07 MANHOLE PIPING

A. Drop Assembly: See Drawings for detail of installation requirements.

B. Flexible Joints:

1. Provide in pipe not more than 1-1/2 feet from manhole walls.

2. Where last joint of pipe is between 1-1/2 feet and 6 feet from manhole wall, provide flexible joint in manhole wall.

C. Stubouts for Future Connections:

1. Provide same type and class of pipe as specified for use in service connection, lateral, main, or trunk sewer construction. Where there are two different classes of pipe at manhole use higher strength pipe.
2. Grout pipe in precast walls or manhole base to provide watertight seal or use flexible joints as specified herein.
3. Maximum Length: 1-1/2 feet outside manhole wall.
4. Construct invert channels as shown. Unless otherwise approved by Engineer, match inside top elevation of service connection pipe to inside top elevation of outlet pipe.
5. Test Plugs:
   a. Install rubber-gasketed plugs in end of stubouts with gasket joints similar to sewer pipe being used.
   b. Plugs shall withstand internal or external pressures without leakage.
   c. Adequately brace plugs against hydrostatic or air test pressures.

D. Permanent Plugs: Clean interior contact surfaces of pipes to be cut off or abandoned as shown, and construct plug as follows:

1. Pipe 18 Inches or Less in Diameter: Concrete plug in end, minimum 2 feet long.
2. Pipe 20 Inches and Larger: Concrete plug in end, minimum 4 feet long.
3. Plugs shall be watertight and capable of withstanding internal and external pressures without leakage.

3.08 MANHOLES OVER EXISTING PIPING

A. Maintain flow through existing pipelines at all times.

B. Concrete Pipe: Apply bonding agent on surfaces in contact with concrete.

C. Construct base under existing piping.

D. Construct manhole as detailed in Drawings.

E. Apply minimum of two complete wraps of hydrophilic waterstop centered on pipe in wall.

F. Place a minimum of 24 inches of concrete around each pipe penetration outside manhole against undisturbed soil or compacted aggregate unless otherwise detailed.

G. Grout channel through manhole.

H. Saw cut out or demolish existing pipe within new manhole using method approved by Engineer.

I. Protect new concrete or grout for 7 days after placing concrete.

3.09 CONNECTIONS TO EXISTING MANHOLES

A. Core manhole bases and grouting, as necessary.

B. Seal pipe in manhole using flexible connector.

C. Regrout to provide smooth flow into and through manholes.

D. Provide diversion facilities and perform work necessary to maintain flow during connection.

3.10 FIELD QUALITY CONTROL

A. Hydrostatic Testing:

1. When, in Engineer's opinion, groundwater table is too low to permit visual detection of infiltration leaks, hydrostatically test manholes.
2. Procedure: Plug inlets and outlets and fill manhole with water to height determined by Engineer.
3. Manhole may be filled 24 hours prior to time of testing, if desired, to permit normal absorption into pipe walls to take place.
4. Leakage in each manhole shall not exceed 0.1 gallon per hour per foot of head above invert.
5. Repair manholes that do not meet leakage test, or do not meet specified requirements from visual inspection.
6. If more than 25 percent of manholes tested fail the hydrostatic test, test all or as many manholes as Engineer deems necessary.

END OF SECTION

SECTION 33 05 23.16
UTILITY PIPE JACKING

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section covers installation of steel cased carrier pipe beneath Interstate 40 (I-40) in Arizona by trenchless methods. It also covers installation of steel cased carrier pipes beneath National Trails Highway (NTH) in California.

B. Furnish all labor, materials, and equipment necessary to do all work and related items as shown on Drawings, specified herein, or incidental to property execution of the work to complete the pipe jacking at the required locations.

C. The Owner shall be responsible for all coordination with the Burlington Northern Santa Fe (BNSF) railroad, the Arizona Department of Transportation (ADOT), California Department of Transportation (Caltrans), San Bernardino County, Mohave County, private property owners, and all other right of way holders.

D. The Owner will obtain all permits necessary to access rights of way. Contractor shall be familiar with all permits and shall comply with all requirements.

E. Obtain railroad protective insurance for all work performed within 50 feet of railroad tracks.

F. Coordinate with BNSF and pay all costs associated with flaggers whenever work within 25 feet of the tracks is performed. Include Owner in all BNSF communications.

1.02 DEFINITIONS

A. Carrier Pipes:

1. In Arizona: Water pipe.
2. In California: Water pipe, electrical conduit, and communication conduit.

B. Casing Pipe: Sleeves through which carrier pipe will be placed.

C. Boring and Jacking: Method of installing casing pipe by cutting, hand mining, or boring an opening in soil materials, simultaneously advancing casing pipe through it by hydraulic jacks. Spoil shall be removed from the casing via auger flighting, hand excavation with muck carts or conveyor belts, or other methods.

1.03 REFERENCES

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

1. American Water Works Association (AWWA): C200, Steel Water Pipe - 6 in. (150 mm) and Larger.
2. ASTM International (ASTM):A139/A139M, Standard Specification for Electric-Fusion (Arc), Welded Steel Pipe (NPS 4 and Over).
3. Arizona Department of Transportation (ADOT) Policy for Accommodating Utilities on Highway Rights of Ways.
4. Burlington Northern Santa Fe (BNSF) Railroad – Utility Accommodation Manual.
5. CalTrans Encroachment Permits Manual.
6. San Bernardino County Encroachment Regulations.

1.04 DESIGN CRITERIA

A. Design shaft excavation support systems to withstand lateral earth pressures, ground loads, unrelieved hydrostatic pressures, bottom heave, equipment loads, applicable traffic and construction loads, and other surcharge loads to allow safe construction of shafts without appreciable movement or settlement of ground, and to prevent damage to or movement of adjacent structures, streets, utilities and trees.

B. Design excavation support systems and casing installation equipment to be compatible with anticipated geologic conditions and meet requirements in Section 31 41 00, Shoring.

C. Subsurface conditions are assumed to include the presence of cobbles up to 10 inches in diameter based on prior nearby explorations. Average cobble content over the total length of the crossing and within the volume of the casing will be on the order of 10 percent by volume. The cobbles will be of high strength with a UCS of up to 25,000 psi. In Arizona, the Contractor shall anticipate up to four personnel interventions to the leading end of the auger to remove clasts in order to permit forward progress of the casing. The locations of the interventions will be spaced on average at 20 percent length increments along the alignment.

D. Design cathodic protection in accordance with Section 26 42 00, Cathodic Protection.

1.05 SUBMITTALS

A. Action Submittals:

1. Casing pipe material including the standard to which it is manufactured, outside diameter, wall thickness, joint configuration, and grout ports.
2. Details of casing spacers, including recommended spacing.
3. Details of end seals.
4. Contact Grout Work Plan and Methods:
   a. Submit Work plan, for each type of contact grouting required, including contact grouting methods and details of equipment, grouting procedures and sequences, injection pressures, monitoring and recording equipment, pressure gauge calibration data, methods of controlling grout pressure, method of transporting grouting equipment and materials within the pipe, and provisions to protect interior of pipe and shaft supports.
   b. Submit details of grout mix proportions, admixtures, including manufacturers' literature, and laboratory test data verifying the strength of the proposed grout mix.
5. Geophysical exploration work plan, including geophysical contractor qualifications.
6. Refer to Section 26 42 00, Cathodic Protection, for submittals related to cathodic protection.

B. Informational Submittals:

1. Boring and jacking plan, submitted before mobilization, consisting of working drawings and written procedures describing in detail the proposed method and entire operation, including but not limited to:
   a. Boring and receiving pits.
   b. Dewatering.
   c. Methods of removing soils, installing carrier pipe, and installing casing pipe.
   d. Size, capacity, and arrangement of equipment.
   e. Backstop.
   f. Shaft base material.
   g. Type of cutter head.
   h. Method of monitoring and controlling line and grade.
   i. Detection of surface movement.

2. Documentation that contractor performing the Work in this section has experience required below.
3. Manufacturer's certificate of compliance for steel casing pipe.
4. Contact Grout Reports and Records: Maintain and submit daily logs of grouting operations, including grouting locations, pressures, volumes, grout mix pumped, and time of pumping. Note any problems or unusual observations on logs.
5. Geophysical survey results.

1.06 QUALITY CONTROL

A. Contact Grout Strength Tests: Prepare samples for 24-hour and 28-day compressive strength tests according to ASTM C31 for cylinders or ASTM C109 for cubes. Prepare cylinder molds at least 2 inches in diameter and 4 inches long. Prepare grout cubes either 2 inches or 50 millimeters square. Test samples according to ASTM C39 or C109 as applicable. Take grout for the cylinders or cubes from the nozzle of the contact grout injection line. Provide at least one set of four samples for each 100 cubic feet of grout injected but not less than one set for each grouting shift, unless directed otherwise by the Owner.

1.07 QUALITY ASSURANCE

A. Design Professional: Submittals for facilities requiring structural design shall be signed and stamped by a professional civil or structural engineer registered in the applicable state.

B. Qualifications: Bore and jack operations shall be performed by a qualified Contractor with at least 5 years of experience involving work of a similar nature.

C. Provide a professional Land Surveyor licensed in the applicable state who has prior experience in similar underground projects to be responsible for line-and-grade control.

D. Allow access to the Owner and furnish necessary assistance and cooperation to aid the Owner in observations, measurements, data, and sample collection, including, but not limited to the following:

1. Allow Owner full access to the jacking and reception shafts prior to, during, and following jacking operations. Access includes, but is not to be limited to, visual inspection of installed casing and verification of line and grade. Provide safe access in accordance with safety regulations.

2. Allow Owner full access to the spoil material. Allow the Owner to collect soil samples from the spoil removal system a minimum of once per installed casing section, or every 8 feet, whichever is more often, and at any time when changes in soil conditions or obstructions are apparent or suspected.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Unload and handle materials with equipment of adequate capacity.

B. Store materials only at locations approved by Owner.

1.09 PROJECT CONDITIONS

A. Bore so as not to interfere with, interrupt, or endanger surface and activity thereon.

1. Minimize subsidence of surface, structures, and utilities above and in vicinity of bore.
2. Support ground continuously to prevent loss of ground and keep perimeters stable.
3. Be responsible for settlement resulting from operations.
4. Repair and restore damaged property to its condition before being disturbed.

1.10 SAFETY

A. Be responsible for safety on the Site. Utilize methods of construction to ensure the safety of the Work, personnel onsite, and the public. Perform Work in accordance with current applicable regulations and safety requirements of the federal, state, and local agencies. Comply with applicable provisions of 29 CFR Part 1926, Subpart S, Underground Construction and Subpart P, Excavations, by OSHA.

B. No gasoline powered equipment is permitted in jacking and receiving shafts and pits. Diesel, electrical, hydraulic, and air powered equipment is acceptable, subject to applicable local, state, and federal regulations and other site-specific requirements.

C. Furnish and operate a temporary ventilation system in accordance with applicable safety requirements when personnel are in the shaft or in the casing. Perform required air and gas monitoring. Provide a ventilation system to provide a sufficient supply of fresh air and maintain an atmosphere free of toxic or flammable gasses in underground Work areas.

PART 2 PRODUCTS

2.01 STEEL CASING PIPE

A. Materials, Design, Fabrication, Handling, and Testing of Steel Casing Pipe: Conform to the requirements of ASTM A139, AWWA C200 and AWWA Manual M11 “Steel Pipe – A Guide for Design and Installation,” except as modified herein.

B. Steel Casing Pipe: New, smooth-wall, carbon steel pipe conforming to ASTM A139, Grade B.

C. Permalok Steel Casing Pipe: New, smooth-wall, carbon steel pipe conforming to ASTM A515, Grade 60, or ASTM 572, Grade 42, with a T5 joint profile.

D. Hydrostatic testing of steel pipe used for casings is not required.

E. Casing pipe shall be cathodically protected in accordance with Section 26 42 00, Cathodic Protection.

F. Dimensional Tolerances: Bear sole responsibility for furnishing and installing steel casing pipe with dimensional tolerances in accordance with ASTM A139:

1. When pipe ends have to be field beveled for welding, bevel the ends on the outside to an angle of 35 degrees with a tolerance of plus or minus 2-1/2 degrees and with a width of root face 1/16 inch plus or minus 1/32 inch.

G. Prior to delivery of the pipe, furnish and install end/internal bracing as recommended by the manufacturer, for protection during shipping, storage, and installation.

H. Shall be suitably insulated from underground conduits carrying electric wires on railroad property.

2.02 CARRIER PIPE

A. Carrier pipe shall conform to the drawings and requirements in Section 40 50 10, Underground Piping, and other applicable specification sections.

B. Emergency shutoff valves shall be installed as shown and specified.

C. Markers shall be placed inside the casing at each right-of-way line identifying utilities crossing railroad or highway property; 6-inch-wide warning tape shall be used. In addition place tape outside ends of casing.

2.03 GROUT FOR CONTACT GROUTING OUTSIDE CASING

A. Neat cement grout with a minimum two sacks of cement per cubic yard.

2.04 CASING SPACERS

A. Fabrication:

1. Spacer Band Material: Polyethylene.
2. Spacer Width: 12 inches.
3. Spacer Runners:
   a. Suitable for supporting weight of carrier pipe.
   b. Manufactured of material having a low coefficient of friction and designed to support the carrier pipe without damage or excessive wear.
4. Size: Sufficient to provide a minimum clearance of 1 inch between outside of carrier pipe bells or couplings and inside of casing.

2.05 CASING END SEALS

A. Synthetic 1/8 inch thick rubber, conical shape, pull on or wrap around style with Type 304 stainless steel bands and butyl mastic adhesive strips.

B. Manufacturers:

1. Pipeline Seal and Insulator, Inc. (PSI), Houston, TX.
2. Advance Product Systems, Inc., Lafayette, LA.
3. Cascade Waterworks Mfg., Co., Yorkville, IL.

2.06 SACRIFICIAL ANODES

A. Designed by Contractor in accordance with Section 26 42 00, Cathodic Protection.

PART 3 EXECUTION

3.01 EXISTING UTILITIES

A. Conduct a utility locating survey at the shaft/pits and along the pipe alignment before starting ground disturbing activities.

B. Confirm location of all known existing utilities by soft-dig methods before starting excavation activities. Coordinate with affected utilities for utility observers and include Owner in communications. Backfill utility-locate holes with sand.

3.02 GEOPHYSICAL EXPLORATION

A. Conduct a direct resistivity geophysical survey prior to start of ground disturbing work.

B. The geophysical survey shall be performed by a qualified Contractor with at least 5 years of experience involving work of a similar nature.

C. Use geophysical equipment and methods capable of detecting buried metal or other objects that could interfere with test pit excavation or boring.

D. Survey pipe alignment and boring pit areas.

E. Coordinate survey with Owner and right-of-way holders.

F. Provide results at least 1 week before mobilizing drilling equipment or starting ground disturbing activities, whichever is earlier.

3.03 SHAFT/PIT INSTALLATION

A. Notify Owner not less than 5 working days before beginning shaft excavation.

B. Methods of construction for shafts/pits shall be such as to ensure the safety of the Work, Contractor’s employees, the public, existing utilities, and adjacent property and improvements, whether public or private. Any required sheeting, shoring, or bracing shall be designed and provided by the Contractor. Excavation shall conform to the requirements of Section 31 23 16, Excavation.

C. Before beginning construction of shaft/pit, adequately protect existing structures, utilities, trees, shrubs, and other existing facilities.

D. Provide complete groundwater control for excavations at all times as needed to complete work.

E. Perform shaft/pit excavations using appropriate excavation or large hole drilling methods, as required.

F. Place fencing, gates, lights, and signs, as necessary, as required by BNSF, ADOT, and San Bernardino County as specified around shafts and staging areas to provide for public safety.

G. At a minimum, inspect shaft/pit excavations daily to check safety of excavation and structural integrity of support system.

H. Unless shown otherwise, jacking or boring pits must be placed a minimum of 30 feet from the traveled roadway. With prior Owner approval jacking or boring pits may be allowed less than 30 feet from the traveled roadway under the following restrictions:

1. Protected by guardrail, temporary concrete barrier or other ADOT or San Bernardino approve approved barrier.
2. Fenced to preclude public access.
3. Work vehicles and equipment are restricted to the fenced area.
4. Pit is located outside the pavement structure.
5. Access to the pits cannot be made from the traveled roadway.

I. Jacking or boring pits must be kept to the minimum size necessary and placed at a minimum of 30 feet from the centerline of railroad tracks or no closer than the toe of slope for fill sections. Any open pit left unattended shall be property marked and barricaded.

J. Manage spoil in accordance with the requirements of Section 31 23 16, Excavation.

3.04 GENERAL INSTALLATION PROCEDURES

A. Provide a casing pipe that is leak free along the entire length. Install in a manner that prevents the formation of a waterway along its length. Casing shall have an even bearing on the surrounding soil throughout and shall have a slight slopes to one end.

B. Install the casing by jacking it through the earth, while excavating by boring or mining methods, to the lines and grades shown on Drawings. No open excavation will be permitted where jacking or boring is specified or shown on Drawings.

C. Equipment Selection: Select necessary equipment and methods to install casing and carrier pipe as shown on Drawings. Selected equipment shall be capable of accurate alignment and grade control, and shall protect against subsidence or other disturbance of ground, existing utilities, and existing

structures. Equipment shall be capable of providing a smooth, continuous and uniform operation leaving no exterior voids along the casing pipe.

D. As pipe is jacked forward, excavate and remove soil through pipe. Do not allow excavation to precede jacking operation.

E. Lubrication of Casing Exterior: Bentonite slurry, minimum of 0.2 pounds per gallon concentration of bentonite clay, may be used to lubricate exterior of casing during installation. Drilling system shall not deposit more than 1 part drilling fluid per 1 part soil excavated (by volume) to prevent erosion and/or saturation of the soil.

F. If voids occur, provide grout holes and fill with pressure grout before installing carrier pipe.

G. Stabilize disturbed areas as specified Section 31 32 00, Soil Stabilization.

H. The Contractor shall be responsible for all costs related to damage to the right-of-way or other facilities. Method of repairs shall be settled with the appropriated asset manager's representative.

3.05 CASING INSTALLATION—BORE AND JACK METHOD

A. Verify casing pipe minimum wall thickness is adequate for anticipated jacking loads.

B. Diameter of hole shall not exceed outside diameter of casing pipe by more than 3/4 inch.

C. Where unstable soil conditions are found to exist, boring operations shall be conducted in a manner that will not be detrimental to the facility being crossed.

D. Tolerance shall be as follows:

1. Horizontal Tolerance: 12 inches, maximum.
2. Vertical Tolerance: 6 inches, maximum.
3. The tolerances assume that minimum cover will be maintained.

E. Provide positive means of continuously checking line and grade to confirm allowable tolerance has been achieved.

F. If necessary to abandon a bored hole, remedial measures shall be taken by Contractor, subject to review by project Owner and approval of Owner of facility being crossed.

G. Once the jacking operation has commenced the tunnel face shall be shored whenever work is stopped for more than 2 hours. Contractor shall use all necessary methods to prevent freezing of the casing pipe and ensure the head is stable at all times during pipe jacking.

H. The driving end of the pipe shall be properly protected against damage, and the intermediate joints shall be similarly protected by the use or sufficient bearing shims to properly distribute the jacking stresses. Any section of casing pipe showing signs of damage shall be removed and replaced or repaired to the satisfaction of the Owner.

3.06 CORRECTION OF GRADE

A. If required grade tolerance has not been achieved, use one of the following methods to correct grade:

1. Place concrete or grout in invert of casing as required to achieve proper grade.
2. Use casing spacers of varying height.
3. Install rails inside casing that allows complete carrier pipe encasement.

3.07 CONTACT GROUTING EQUIPMENT

A. Provide equipment for mixing and injecting grout to satisfactorily mix and agitate the grout and force it into the grout holes, in a continuous flow at the desired pressure. Provide pumps capable of continuously developing a sustained pressure of 15 pounds per square inch at the grout hole connection.

B. Provide two pressure gauges, one at the grout pump and one at the collar of each hole being grouted. Check the accuracy of the gauges periodically with an accurately calibrated pressure gauge. Make available a minimum of two spare pressure gauges on site.

C. Provide the grouting equipment with a meter to determine the volume of grout injected. Calibrate the meter in cubic feet to the nearest one-tenth of a cubic foot.

D. Maintain the grouting equipment in satisfactory operating condition throughout the course of the Work to ensure continuous and efficient performance during grouting operations.

E. Provide suitable stop valves at the collar of each hole for use in maintaining pressure as required until the grout has set.

F. Provide grout hoses with an inside diameter not less than 1-1/4 inches nor greater than 2 inches and capable of withstanding the maximum water and grout pressures to be used.

3.08 MIXING AND INJECTION OF CONTACT GROUT

A. Provide materials free of lumps when put into the mixer. Constantly agitate the grout mix. Install grout that flows unimpeded and completely fill voids. Waste grout not injected after 90 minutes of mixing.

B. Operate and control the grouting process so that the grout will be delivered uniformly and steadily. The locations of contact grout holes in the pipe are to be determined by Contractor and shown on Shop Drawings. Drilling grout holes through pipe will not be permitted.

C. Recirculate grout mixes when any new mix is batched or after adding water, fluidifier, or sand to mix. Recirculate mix for at least 2 minutes prior to pumping grout into grout hole.

D. Grouting will be considered completed when less than one cubic foot of grout of the accepted mix and consistency can be pumped in 5 minutes under the specified maximum pressure. After the grouting is finished, close the valve before the grout header is removed and remain closed until grout has set.

E. The maximum sustained grouting pressure shall be 15 pounds per square inch (psi) or 1/2 psi per foot of earth cover, whichever is less, at the grout hole collar connection unless otherwise approved in writing by the Owner.

3.09 CONTACT GROUTING OF TUNNELED CASING

A. Commence contact grouting outside of the casing pipe within 24 hours following the completion of each tunneled drive of 24 inches or greater in diameter. Conduct grouting operations continuously until completed.

B. Install contact grout ports in the pipe prior to grouting. Provide grout ports threaded to accept valve fittings and plugs.

C. Attempt to hook up and pump grout at every tunneled pipe grout port or coupling unless approval is granted by the Owner in writing to omit grouting of selected ports.

D. Inject grout through the tunneled pipe grout connections in such a manner as to completely fill voids outside the pipe resulting from, or encountered during, tunneling operations. Control grout pressure so as to avoid damaging the pipe, and to avoid movement of the surrounding ground or improvements.

E. Grout to generally progress sequentially in a constant upgradient direction from one grout port to the next grout port in the sequence indicated in the approved submittals.

F. During the grouting operations, clean and make ready for grouting the sufficient contact grout ports ahead of the port to be grouted. Attach valves or other suitable devices and place in the fully open position on ungrouted ports within the maximum grout communication distance.

G. For any hole ahead of the grouting operation, with a valve attached, and the valve in the open position, such hole shall be considered grouted if grout issues forth of the same consistency and color, and at the same rate as that being pumped. Replace grout plugs in pipe at the completion of grouting.

H. Seal pipe grout fittings with screw type plugs upon completion of grouting.

3.10 CARRIER PIPE INSTALLATION

A. Entire length of casing shall be installed, contact grouted, completed and approved by Owner before any carrier pipe is placed therein. Repair defects in casing pipe or leakage at joints.

B. Install casing spacers to each length of carrier pipe in such a manner that electrical continuity will not occur between casing pipe and carrier pipe. Spans between spacers shall be per casing spacer manufacturer’s recommendations.

C. Check each joint makeup and pipe segment prior to pushing carrier pipe segments into casing.

D. Lubricate casing spacer with drilling mud or flax soap. Do not use petroleum-based lubricants or oils.

E. Ensure that thrust loads will not damage carrier pipe joints.

F. Provide timbers or other material to cushion between the end of the pushed pipe pad and the jacking equipment.

G. Close end of casing pipe around carrier pipe with a casing end seal.

3.11 REMOVAL OF SHAFT/PIT SUPPORT SYSTEM

A. Removal of support system shall be performed in a manner that will not disturb or harm adjacent construction or facilities.

B. Fill voids created by removal of support system with clean sand as approved by Owner.

3.12 BACKFILLING OF SHAFTS/PITS

A. Seal shaft/pit opening and backfill at shafts when no longer required.

B. Backfill shall be earthfill as specified in Section 31 23 23, Fill and Backfill.

C. Stockpile excess soil at location selected by Owner and manage in accordance with Section 31 23 16, Excavation.

3.13 CATHODIC PROTECTION

A. Design and provide packaged cathodic anodes, in accordance with Contractor design and Section 26 42 00, Cathodic Protection, after installing pipes but before backfilling.

END OF SECTION

SECTION 33 12 16
WATER UTILITY DISTRIBUTION VALVES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. C500, Metal-Seated Gate Valves for Water Supply Service.
   b. C504, Rubber-Seated Butterfly Valves.
   c. C509, Resilient-Seated Gate Valves for Water Supply Service.
   d. C515, Reduced-Wall Resilient-Seated Gate Valves for Water Supply Service.
   e. C550, Protective Interior Coatings for Valves and Hydrants.
2. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
3. Section 31 23 23.15, Trench Backfill.
4. Section 33 05 01.02, Ductile Iron Pipes and Fittings.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data sheets for each make and model. Indicate service where used.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Product data sheets for coating and lining products.

B. Informational Submittals:

1. Manufacturer’s Certificate of Compliance.
   a. Butterfly valves, full compliance with AWWA C504.
   b. Resilient-seated gate valves, full compliance with AWWA C509.
2. Method for hydrostatic testing.
3. Tests and inspection results.

PART 2 PRODUCTS

2.01 GENERAL

A. Valve same size as adjoining pipe, unless otherwise indicated.

B. Valve ends to suit adjacent piping.

C. Valves shall have no leakage (drip tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in referenced valve standard.

D. Valve to open by turning counterclockwise, unless otherwise specified.

E. Valve materials in contact with or intended for drinking water service shall comply with requirements of NSF/ANSI 61 and other applicable federal, state, and local requirements.

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

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

2.02 GATE VALVES

A. General:

1. AWWA gate valves to be in compliance with referenced AWWA standard.
2. Provide 2-inch operating nut for buried valves.
3. Mark AWWA gate valves with manufacturer’s name or mark, year of valve casting, valve size, and working water pressure.
4. Repaired AWWA gate valves will not be allowed.

B. Gate Valves:

1. Nonrising Stem (NRS) Valves: Gate valves 4 inches to 12 inches in diameter shall be iron body, bronze mounted, with resilient seat, water

working pressure 175 psig, inside screw and O-ring seal turning counterclockwise to open, complying with AWWA C509.

a. The resilient seat shall be mechanically retained or bonded (ASTM D429) on the valve wedge disc or gate which shall close against a corrosion-resistant surface.
b. Valve stem shall be brass or bronze with minimum yield strength of 20,000 psi and minimum tensile strength of 60,000 psi.
c. Valve Operators: Except for use with post-indicators, furnish buried valves with 2-inch nut for socket wrench operation. Exposed valves shall be hand wheel operated.
d. Valves used with post-indicators shall be constructed for connection thereto.
e. End of valves shall accommodate or be adapted to pipe installed.

C. Factory Finishing of Gate Valve:

1. In accordance with Section 09 90 00, Painting and Coating.
2. Lining and Coating:
   a. Interior Lining:
      1) Manufacturer’s standard.
      2) In accordance with AWWA C550.
   b. Exterior Coating:
      1) If valve and operator will not be subsequently field-coated, factory-applied coating shall be either two-part liquid material or heat-activated (fusion) material.
      2) In accordance with AWWA C550.
      3) Dry Film Thickness: Minimum 10 mils.

D. Post-Indicator:

1. Adjustable type with built-in 18-inch adjustment span, UL rated. Provide with tamper switch as specified herein. Furnish with a padlock and angle wrench that can be locked at side of post when not in use. Lock indicator in open position. Padlock shall be pin tumbler mechanism, five or more pins, 2-inch solid brass case, steel shackle, and with chain and shackle, length as required. Chain to be securely fastening to post-indicator. Padlocks shall be keyed the same. Provide four sets of keys to the Owner.
2. Provide a mechanical-type supervisory switch to provide supervision against closures or tampering with a post-indicator operated valve. Removal of cover shall actuate the same switch used for the valve signal. Switch shall be UL listed and FM approved. Switch shall be suitable for use in wet locations. Provide one single-pole, double-throw

(Form C) contact. The switch mechanism shall have a minimum rated capacity of 5 amps 125V ac, 0.24 amp 24V dc. Switch shall be Notifier PIV Series.

E. Valve Box: Cast iron extension box 5-1/4-inch shaft with screw or slide adjustment and flared base. Minimum thickness of metal shall be 3/16 inch. Box shall be adapted without full extension to depth of cover required over pipe at valve location. Cast the word water in cover. Provide three T-handle socket wrenches of 5/8-inch round stock long enough to extend 2 feet above top of deepest valve box. Where the depth of the operating nut is more than 4 feet, operating extension shall be provided to bring the operating nut to a point 6 inches below the surface of the ground or pavement.

PART 3 EXECUTION

3.01 PREPARATION OF TRENCH

A. As specified in Section 31 23 23.15, Trench Backfill.

B. Pipe shall have a minimum cover below finished grade of 3 feet.

C. Bedding Material: as specified in Section 31 23 23.15, Trench Backfill.

3.02 INSTALLATION

A. Valve - General:

1. Preparation: Carefully inspect valve before laying. Do not use cracked, broken, or defective pieces.
2. Handling: Use only the implements, tools, and facilities for the safe and proper protection of materials and workers. Do not use chains or cables for lifting or moving materials. Carefully lower into the trench to prevent damage. Do not dump or drop on ground or into trenches.
3. Protection: Prevent foreign material from entering the valve. When laying is not in progress, plug ends of the valve to prevent trench water and foreign materials from entering. Replace all damaged pipe.
4. Permissible Deflection at Joints: In accordance with the manufacturer's recommendation.

B. Valves, Stems, and Boxes:

1. Valves:
   a. Before installation, valves shall be thoroughly cleaned of foreign material with particular attention to removing oils and grease from the valves' interior waterway, discs, and seats.
   b. Install with stems vertical unless directed otherwise.
2. Extension Stems:
   a. Provide stem extension such that operating nut is not deeper than 3 feet below finish grade. For extensions greater than 2 feet in length, provide an extension centering plate of sufficient diameter to maintain the operating nut over the valve wrench nut.
   b. Fasten stem or extension to valve operating nut using cap screw or other fastening device.
3. Valve Boxes: Center and set plumb over the wrench nuts of the valves. Set so they do not transmit shock or stress to the valves. Set the valve box covers flush with the surface of the finished pavement or ground as shown or such other elevation as may be directed. Cut extensions to the proper length so the valve box does not ride on the extension when set at grade.
4. Backfill Around Valve Boxes: Place backfill around the valve boxes and thoroughly compact to a density equal to that specified for the adjacent trench and in such a manner that will not damage or displace the valve box from proper alignment or grade. Misaligned valve boxes shall be re-excavated, plumbed, and backfilled at the Contractor's expense.
5. Testing: Valves shall be tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test. Repair joints that show signs of leakage prior to final acceptance. If there are any special parts of the operators that might be damaged by the pipeline test, they shall be properly protected. The Contractor will be held responsible for any damage caused by the testing.

C. Post Indicators: Post indicators shall have the valve status viewing window turned so that it can be viewed from the nearest adjacent roadway.

3.03 FUNCTIONAL AND HYDROSTATIC TESTING

A. Functional Test:

1. Test that valves open and close smoothly under operating pressure conditions.

2. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.
3. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.

3.04 HYDROSTATIC TESTS PIPE AND VALVES

A. General:

1. Make pressure and leakage tests on newly laid pipe. Furnish necessary equipment and material, make taps in the pipe as required, and conduct the tests. The test shall be conducted between valved sections of the pipeline or as reviewed by the Engineer. The Engineer will monitor the tests.
2. Furnish the following equipment and materials for the tests:

Amount	Description
Two	Graduated containers
Two	Pressure gauges
One	Hydraulic force pump reviewed in advance by the Engineer
	Suitable hose and suction pump as required

3. Conduct the tests after the trench has been backfilled or partially backfilled with the joints left exposed for inspection or when completely backfilled as permitted by the Engineer. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least 5 days have elapsed after the concrete thrust blocking is installed. If high-early-strength cement is used for the concrete thrust blocking, the time may be cut to 3 days.
4. Conduct the pressure test in the following manner unless otherwise reviewed by the Engineer: After the trench has been backfilled or partially backfilled as hereinbefore specified, fill the pipe with water, expelling all air during the filling. The test pressure at the lowest point in the system shall be as follows:
   a. Domestic Water System: 1-1/2 times the working pressure or pressure class on the pipe but not less than 50 pounds per square inch.
   b. Fire Water System: 200 psi.

B. Duration: The duration of each pressure test shall be 2 hours unless otherwise directed by the Engineer.

C. Procedure: Slowly fill the pipe with water and allow to stand for 24 hours. Expel all air from the pipe by installing 3/4-inch manual air release valves at all high points whether shown on Drawings or not. Apply and maintain the specified test pressure by continuous pumping if necessary for the entire test period. The test pressure shall be calculated for the point of lowest elevation or as specified by the Engineer. The pump suction shall be in a barrel or similar device or metered so that the amount of water required to maintain the test pressure may be measured accurately.

D. Leakage: Leakage shall be defined as the quantity of water necessary to hold the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{ND\sqrt{P}}{7{,}400}$$

In the above formula:
L = allowable leakage in gallons per hour.
N = number of joints in the length of pipe tested.
D = nominal diameter of pipe in inches.
P = average test pressure during the leakage test in pound-per-square-inch gauge.

E. Correction of Excessive Leakage: Visible leaks and leakage in excess of the allowances stated above shall be repaired and retested until satisfactory results are obtained.

3.05 FLUSHING

A. Before sterilizing, flush foreign matter from the pipeline. Provide hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties. Flushing flows shall be as specified in the following table:

Flushing Flows	
Pipe Size (Inches)	**Flow Rate (gpm)**
2	50

Flushing Flows	
Pipe Size (Inches)	**Flow Rate (gpm)**
4	250
6	550
8	1,000
10	1,500
12	2,000

1. In cases where the water supply to the system will not produce the stipulated flow rate, the maximum flow rate available should be used.
2. If water is supplied from more than one source or from a looped system, divisional valves shall be closed to produce a high-velocity flow through each single line.

3.06 POTABLE WATER SYSTEM STERILIZATION

A. General:

1. Use this Specification to sterilize potable water systems prior to being placed in service.
2. Pipelines intended to carry potable water shall be sterilized before being placed in service. Sterilizing procedures shall conform to AWWA C651 as hereinafter modified or expanded.

B. Sterilizing Mixture:

1. Sterilized mixture shall be a chlorine-water solution having a minimum free chlorine residual of 40 to 50 ppm. The sterilizing mixture shall be prepared by injecting a liquid chlorine gas-water mixture or a calcium or sodium hypochlorite and water mixture into the pipeline at a measured rate while fresh water is allowed to flow through the pipeline at a measured rate so that the combined mixture of fresh water and chlorine solution or gas is of the specified strength.
2. The liquid chlorine gas-water mixture shall be applied by means of an approved solution feed-chlorinating device and must provide means of preventing the backflow of water into the chlorine cylinder.

3. If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a 1 percent solution (10,000 ppm chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1 percent solution. The following proportions of hypochlorite to water will be required:

Product	Quantity	Water
Calcium hypochlorite* (65 to 70 percent Cl)	1 pound	7.50 gallons
Sodium hypochlorite**	1 pound	4.25 gallons

Notes:
* Comparable to commercial products known as HTH, Perchloron, and Pittchlor.

** Known as liquid laundry bleach, Chlorox, Purex, etc.

C. Point of Application:

1. Inject the chlorine mixture into the pipeline to be treated within 5 pipe diameters of the water line isolation valve at the upstream end of the line and at all extremities of the line through a suitable tap in the top of the pipeline. Water from the existing system or other approved source shall be controlled so as to flow slowly into the newly installed piping during the application of chlorine. The rate of chlorine mixture flow shall be in such proportion to the rate of water entering the pipe that the combined mixture shall contain 40 to 50 ppm of free available chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.
2. Retention Period:
   a. Treated water shall be retained in the pipeline for no less than 24 hours or long enough to destroy all nonspore-forming bacteria whichever is greater. At the end of the retention period, the sterilizing mixture shall have a strength of at least 10 ppm of chlorine.
   b. Operate valves, hydrants, and other appurtenances during sterilization to ensure that the sterilizing mixture is dispersed into all parts of the line, including dead ends, new services, and similar areas that otherwise may not receive the sterilizing solution.
   c. Do not place concentrated quantities of commercial sterilizers in the line before it is filled with water.

d. After chlorination, flush the water from the permanent source of supply until the water through the line is equal chemically and bacteriologically to the permanent source of supply.

3. Disposal of Sterilizing Water: Do not allow sterilizing water to flow into a waterway or storm drainage system as discharge of water into these systems may be in violation of the National Pollutant Discharge Eliminating System (NPDES). Schedule and coordinate rates of flow and locations of discharge of sterilizing and flushing water with the Owner and cognizant state and local regulatory agencies to ensure compliance with applicable rules and regulations.

D. Bacteriologic Tests: Collect two samples. Deliver to a certified laboratory within 6 hours of obtaining the samples and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline after chlorination and refilling. For lines longer than 2 miles, obtain one additional test each mile.

END OF SECTION

SECTION 33 12 16.29
AIR AND VACUUM RELEASE VALVE ASSEMBLIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   b. B36.10M, Welded and Seamless Wrought Steel Pipe.
   c. B36.19M, Stainless Steel Pipe.
   d. Boiler and Pressure Vessel Code.
2. American Water Works Association (AWWA):
   a. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   b. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
   c. C220, Stainless Steel Pipe, 4 In. (100 mm) and Larger.
   d. C500, Metal-Seated Gate Valves for Water Supply Service.
   e. C504, Rubber-Seated Butterfly Valves.
   f. C507, Ball Valves, 6 In. Through 48 In. (150 mm Through 1200 mm).
   g. C509, Resilient-Seated Gate Valves for Water Supply Service.
   h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   i. C550, Protective Interior Coatings for Valves and Hydrants.
   j. C800, Underground Service Line Valves and Fittings.
3. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
   c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   d. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
4. Environmental Protection Agency (EPA): Safe Drinking Water Act.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data sheets for make and model.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Maximum recommended test pressure; maximum and minimum recommended working pressures of air valves, isolation valves, flanges, connecting piping, and fittings.
4. Recommended seating materials for specified operating pressures.

B. Informational Submittals:

1. Manufacturers' Instructions:
   a. Installation and testing of products specified.
   b. Pipeline tapping and service saddle installation.
2. Operation and maintenance data.
3. Affidavit of Compliance in accordance with AWWA C512 stating valve and all materials used conform to applicable requirements of AWWA C512 and these Specifications, and tests specified have been performed and all requirements have been met.
4. Affidavit of Compliance that materials comply with the requirements of the EPA Safe Drinking Water Act and other federal, state, and local requirements.

PART 2 PRODUCTS

2.01 AIR VALVES

A. General:

1. Air release, air/vacuum, and combination air valves shall conform to AWWA C512.
2. Exterior of air valves shall be coated in accordance with Section 09 90 00, Painting and Coating.
3. Interior of air valves shall be coated in accordance with AWWA C550.
4. Air valves shall be factory tested in accordance with AWWA C512 to 150 percent of working pressure.
5. Suitable for operating pressures between 10 and 140 psi.

B. Air and Vacuum Valve, Water Service, 1/2 Inch to 16 Inches:

1. Suitable for water service.
2. Automatically exhausts air during system filling and allows air to re-enter during draining or when vacuum occurs.
3. Air/water Inlet: ASME B16.1 Class 125 flange. 1-inch or 2-inch NPT.
4. Air Outlet: 1-inch or 2-inch NPT. Plain outlet with protective hood. ASME B16.1 Class 125 flanged.
5. Rated 150 psi working pressure, cast iron, ductile iron, or steel body, cover with stainless steel float and trim.
6. Manufacturers and Products:
   a. APCO Valve and Primer Corp.; Series 140 or 150.
   b. Val-Matic Valve; Series 100.
   c. GA Industries; Figure 930.
   d. Netafim USA Guardian (corrosive water service).
   e. A.R.I. Flow Control USA D-040 (corrosive water service).

C. Air Release Valve, Water Service, 1/2 Inch to 6 Inches:

1. Suitable for water service, automatically exhausts small amounts of entrained air under pressure that accumulates in a system.
2. Air/water Inlet: ASME B16.1 Class 125 flange. 1-inch or 2-inch NPT.
3. Air Outlet: 1-inch or 2-inch NPT.
4. Rated 150 psi working pressure; cast iron, ductile iron, or steel body, cover with stainless steel float and trim.
5. Orifice diameter varies, see Drawings.
6. Manufacturers and Products:
   a. APCO Valve and Primer Corp.; Model Series 200A.
   b. Val-Matic Valve; Model 38.
   c. GA Industries; Figure 925.
   d. Plastomatic Valves Inc.; ARV100EPT-PV.
   e. Netafim USA ARIB (corrosive water service).

2.02 CONNECTION TO MAINLINE

A. Flanged Outlet or Fitting: Flange shall be as required to match drilling pattern of adjoining valve and suitable for test pressure and working pressure.

B. Service Saddle:

1. Stainless steel double straps.
2. Body: Ductile iron, nylon, or epoxy coated.
3. Bolts and Nuts: Type 304 stainless steel.

4. Comply with applicable portions of AWWA C800.
5. Manufacturers and Products:
   a. Mueller; Series DR2S.
   b. Romac; Style 202S or 202N.

C. For steel pipe, connection to mainline may be flanged or threaded. Make threaded connections with welded, forged fittings in accordance with ASME Boiler and Pressure Code.

2.03 ISOLATION VALVES

A. Globe Valve 2 Inches and Smaller:

1. All-bronze, screwed ends, union bonnet, inside screw, rising stem.
2. Rated for minimum pressure of 150 psi.

B. Corporation Stop:

1. AWWA C800 type, with ends suitable for adjoining pipe.
2. Rated for minimum pressure of 150 psi.

C. Butterfly Valve:

1. AWWA C504, flanged ends.
2. Rated for minimum pressure of 150 psi.
3. Handwheel operator.

D. Ball Valve:

1. AWWA C507, flanged ends.
2. Rated for minimum pressure of 150 psi.
3. Handwheel operator.

E. Ball Valve:

1. Threaded ends.
2. Rated for minimum pressure of 150 psi.
3. Provide handwheel operator.

2.04 PIPING BETWEEN MAINLINE AND AIR VALVE AND PIPING FOR AIR VENT

A. Steel pipe conforming to ASTM A53/A53M, Schedule 40. Coating shall conform to Section 09 90 00, Painting and Coating. Lining shall conform to Section 09 90 00, Painting and Coating.

B. PVC pipe conforming to ASTM D1785, Schedule 40.

C. Brass pipe conforming to ASTM B43.

D. HDPE pipe conforming to Section 40 50 00, Power Plant Piping Materials.

2.05 VALVE VAULT

A. As specified in Section 03 40 00, Precast Concrete, (concrete vault) and Section 05 50 00, Metal Fabrications (Cover and Access Hatch).

PART 3 EXECUTION

3.01 INSTALLATION

A. Valves:

1. In accordance with manufacturer's printed instructions.
2. Orient valve in vault with easy access to operator.
3. Replace valves that drip or do not function properly.

B. Service Saddle:

1. Tap and install in accordance with manufacturer's printed instructions.
2. Use adapters for size of line being tapped.

C. Valve Vault: Install so finished grade of top of vault is above adjacent ground as shown on Drawings.

D. Insulation:

1. Install within vault, above and around designated valve assemblies as required to protect valve from freezing.
2. Provide space for air passage to allow proper functioning of air valves.
3. Support insulation with clips anchored to manhole or vault wall.

E. Carbon Filter: Install in accordance with manufacturer's recommendations.

F. Pipe Support: Install in accordance with details as shown on Drawings and Section 40 05 15, Piping Support Systems.

3.02 TESTING AND INSPECTION

A. Air Valve:

1. May be either tested while testing pipelines, or as a separate step.
2. Isolation valves shall be in open position during pipeline test.

B. Isolation Valves: Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other.

C. Air and Vacuum Valves: Inspect valves as pipe is being filled to verify venting and seating is fully functional.

D. Verify leak-free performance during testing.

END OF SECTION

SECTION 33 12 19
WATER UTILITY DISTRIBUTION FIRE HYDRANTS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA): C503, Wet-Barrel Fire Hydrants.
2. ASTM International (ASTM): C94, Standard Specification for Ready-Mixed Concrete.
3. NSF International (NSF):
   a. ANSI 61, Drinking Water System Components - Health Effects.
   b. ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals: Catalog cuts of system components.

B. Informational Submittal:

1. Certificate of Compliance: Upon completion of the system installation, verify all fire department hose connections, and check all fire safety devices to ensure their readiness for emergency connection and operation.

PART 2 PRODUCTS

2.01 GENERAL

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

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

2.02 LOW PRESSURE HYDRANTS

A. Hydrant:

1. Break flange or safety top type.
2. Nominal 4-1/2 or 2-1/2-inch main valve opening with 6-inch bottom connections.
3. Conform to AWWA C503.
4. Two 2-1/2-inch hose nozzles.
5. One 4-1/2-inch pumper nozzle.
6. Operating Nuts: 1-1/2-inch National Standard pentagon nut.
7. Mechanical joint inlet connection.
8. Red aboveground line.
9. Manufacturer and Product: James Jones; J3700 Series.

B. Main Valve:

1. Depth of Bury: 3 feet.
2. Equip with O-ring seals.
3. Valve opens on counterclockwise rotation.

2.03 PRECAST CONCRETE PIER BLOCK

A. Nominal dimensions of 8-inch thickness by 16-inch square base.

B. Compressive Strength: 3,000 psi at 28 days.

2.04 GRAVEL FOR DRAINAGE

A. Washed 3/4-inch crushed rock or graded river gravel free of organic matter, sand, loam, clay, and other small particles that will restrict water flow through gravel.

2.05 FOUNDATION STABILIZATION MATERIAL

A. Furnish when existing trench material or imported pipe base material will not support soft or flooded spots in excavated trench.

B. Maximum 3-inch hard rock free from excessive clay material, but enough fines to bind larger fragments.

2.06 CONCRETE FOR THRUST BLOCKING

A. Ready-mix meeting ASTM C94, Alternative 2.

B. Compressive Strength: 3,000 psi at 28 days.

C. Aggregate Size: 1-1/2 inches.

D. Slump: 2 to 4 inches.

2.07 THRUST TIES

A. 3/4-inch diameter steel rods.

B. Duc-Lugs Manufacturer: The Stellar Corp., Columbus, OH.

2.08 MECHANICAL JOINT RESTRAINTS

A. For PVC pipe (AWWA C900), use Tyler Pipe/Utilities Division MJR pipe restraint system on the Uni-Flange Block Buster Pipe Restraint by Ford Meter Box Company.

B. For ductile iron pipe, use either of the above-mentioned pipe restraint systems or U.S. Pipe Field-Lok joint restraint for their Tyton joint pipe and fittings.

C. For HDPE pipe, use Megalug; Series 2000PV.

D. Or approved equivalent.

2.09 RETAINER GLANDS

A. Retainer glands shall be designed for the type of pipe to be restrained.

B. Construction shall be of either gray iron or ductile iron in accordance with applicable requirements of AWWA C111.

C. Device shall be UL listed and Factory Mutual approved.

D. Set screws shall be constructed of corrosion resistant material with torque limiting, twist-off nuts.

E. Retainer glands shall have a working pressure of at least 250 psi with a safety factor of no less than 2:1.

F. Retainer glands shall be as manufactured by EBBA Iron Sales or Standard International.

PART 3 EXECUTION

3.01 GENERAL

A. Install hydrants in accordance with Sections 3.7 and 3.8 of AWWA C600, unless specified otherwise.

3.02 EXCAVATION

A. Excavate to subgrade. Fill over excavated areas with foundation stabilization material. Tamp to provide firm foundation.

3.03 BASE BLOCK

A. Place on firm, level subgrade to ensure uniform support.

3.04 INSTALLATION OF HYDRANTS

A. Locate hydrants to provide accessibility and to minimize potential damage from vehicles.

1. Relocate improperly set hydrants.
2. Hydrant Located behind Curbs: Set barrel so pumper nozzle or hose nozzle caps are a minimum of 18 inches from gutter face of curb.
3. Hydrant Located in Space between Curb and Sidewalk: Not less than 8 inches, clear from sidewalks. See Drawings for actual location.
4. Hydrant Located between Sidewalk and Property Line: Minimum clearance 8 inches from sidewalk. See Drawings for actual location.
5. Set hydrants so safety flange is a minimum of 2 inches above finished ground or sidewalk level.

B. Place hydrant on base block carefully to prevent the base block from breaking.

C. Joints shall conform to Section 3.4 of AWWA C600 when cast or ductile iron pipe is used.

D. Maintain hydrant in a plumb position during subsequent Work.

3.05 GRAVEL FOR DRAINAGE

A. Place gravel around base block and hydrant bottom in accordance with Section 3.7 of AWWA C600.

3.06 CONCRETE THRUST BLOCKING

A. Place blocking after hydrant is set in final position and join to pipe.

B. Concrete thrust block shall have a minimum of 4 square feet of bearing area against undisturbed earth.

3.07 THRUST TIES

A. Install thrust ties in lieu of concrete thrust blocking when ground surface behind hydrant is less than 2 feet above top of hydrant base.

1. Install two tie rods between main valve and hydrant and water main tee and main valve.
2. Install mechanical joint glands with lugs in joints between hydrant, main valve and main line tee.

END OF SECTION

SECTION 33 16 13.14
FRAC TANKS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Design, manufacture, testing, and delivery, and installation of steel frac tanks complete with:

1. Supports.
2. Ground lugs.
3. Lifting lugs.
4. Piping and instrumentation connections.
5. Insulation support: clips; rings.
6. Storage.

B. Equipment and Services Not Provided by this Section:

1. Insulation.
2. Grounding connection.
3. Unloading and storage.
4. Installation.

C. Substitutions/Exceptions/Options:

1. Note exceptions and advise of deviations, additions, deletions, or other changes recommended to meet specified requirements.
2. Deviations are permitted only if outlined in full detail. Written approval of those deviations, and reasons for them, will constitute acceptance.
3. State options in proposal.

D. Compliance: Mechanical design in compliance with this Section is responsibility of manufacturer.

1.02 SUBMITTALS

A. Comply with attached Submittal Data Sheet.

B. Submit detailed list of special tools and devices required to install, adjust, repair, test, or operate equipment. Identify and price separately items which are not provided with equipment.

C. Submit design calculations which demonstrate conformance with requirements of code indicated on Equipment Data Sheets.

D. Submit details and cut sheet of manways with quote.

E. Tank capacity chart indicating gallons (cubic feet of volume) for each inch of depth and cumulative total from bottom.

1.03 QUALITY ASSURANCE

A. Local Codes: Design and fabricate in accordance with state and local codes, ordinances.

B. Conflicting Requirements: If Section requires compliance with two or more industry standards which establish different or conflicting requirements, obtain approval before proceeding with affected operations.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle equipment as follows:

1. Use methods which prevent damage, deterioration, and other loss during shipping and temporary on-site storage.
2. Plug, cap, or cover exposed openings with plywood or other suitable material.
3. Provide instructions for proper unpacking.

B. Deliver loose parts in boxed plywood containers and ship as a unit with equipment.

C. Identify shipping boxes by order number, Project name, Project location, equipment number, and description of contents. Use ink, paint, or other indelible material markings. Securely affix copy of completed packing list to each separate shipping package.

D. Inspect equipment when delivered to ensure equipment is undamaged and complies with specified requirements.

E. Store equipment in manner which facilitates inspection and measurement of quantity. Protect stored products from loss by exposure to rain, wind-driven dust, and other similar phenomena.

1.05 WARRANTY

A. Refer to Terms and Conditions attached to Inquiry (to be done). Warrant supplied equipment for 12 months after shipment against defects in design and manufacturing.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Comply with requirements, tests, inspections, reports, documentation, and approvals specified herein and standards implemented by this Section. Make available on request copy of any part of quality assurance records. Tests, inspections, reports, and documentation are subject to inspection.

B. Provide notification not less than 10 working days prior to start of fabrication.

C. Maintain records of inspections and tests. Indicate nature and number of deficiencies found, quantities approved and rejected, and nature of corrective actions taken. On request, supply copies of inspection and test data prior to or at time of shipment.

D. Provide notification not less than 5 working days prior to conducting inspection or testing required by this Section.

2.02 MATERIALS

A. Fabricate equipment using materials indicated on attached Equipment Data Sheets.

2.03 EQUIPMENT

A. Fabricate vessels in accordance with code indicated on Equipment Data Sheets and requirements of this Section.

B. Comply with specified code requirements, including certification.

C. Furnish vessels complete as shown on approved vessel Shop Drawings and include necessary bolts, nuts, gaskets, and internals and internal piping.

D. Furnish gaskets and external bolting for manholes and other openings which call for blind flange or cover. Use gasket material as specified on attached Equipment Data Sheets.

E. Nozzle flanges to comply with ANSI B16.5, unless specified otherwise on attached Equipment Data Sheets.

F. Trim vessel connections (not connected to internal piping) flush with inside surface of vessel unless specified otherwise on attached Equipment Data Sheets. Round exposed edges of manhole and nozzle necks at inside surface of vessel.

G. Vessel tolerances as required by specified code.

2.04 DESIGN

A. Vessel, General:

1. Choose suitable thickness for vessel shells and heads per code.
2. Equip vessels with lifting lugs per attached Equipment Data Sheets.

B. Corrosion Allowance:

1. Unless otherwise specified, corrosion allowance for carbon steel and low alloy steel is 1/16 inch.
2. Do not use corrosion resistant linings unless otherwise specified.
3. Add corrosion allowance to pressure containing parts, including shell, heads, nozzles, and manways.

C. Nozzles and Manholes:

1. Fabricated plate flanges may be used provided material specification, design calculations, and fabrication details are submitted and approved prior to fabrication.
2. Straddle flange bolt holes over natural vessel centerline.
3. Do not warp or otherwise damage forged flanges on tank nozzles during welding. Flange faces must remain true and flat in accordance with applicable ANSI codes.
4. Provide 6-inch minimum projection for connections, except for instrumentation nozzles.
5. Use lightweight vessel manhole covers. Equip manhole covers with open position stops.
6. Fabricate plate type flanges and manways true and flat so non-resilient gaskets may be used for sealing. Heat-straighten or machine in shop warped flanges.
7. Employ stud and nuts, not machine bolts, for bolting supplied for nozzles and manway covers. Screw each stud into outer nut until three full threads are protruding.

D. Gaskets:

1. Size flat gaskets to fit inside flange bolt holes in accordance with ANSI B16.21.
2. Ship gaskets for blanked connections used in shop testing, where blind flanges are furnished in place.
3. Make test gaskets for shop fabricated flanges and flanges larger than 18 inches same size, material, and type as those specified for operating conditions.

E. Bolting:

1. For special bolting requirements, refer to attached Equipment Data Sheets.
2. Make stud extension for pad mounted flanges 1-1/2 times nut thickness with mating flange installed.
3. Supply attached studs, including bolts and nuts, for major flanged joints, manway covers, and other openings, except piping nozzles.

F. Loadings:

1. Design vessels to withstand effects of wind and earthquake loadings in accordance with requirements of specified code.
2. Comply with seismic and wind design listed in Equipment Data Sheets.
3. Include operating weight as weight due to maximum liquid height plug tank weight.
4. Unless specified otherwise, equate specific gravity of liquids with values specified on Equipment Data Sheets.

2.05 FABRICATION/SHOP ASSEMBLY

A. Painting: Paint exposed carbon steel surfaces per manufacturer's standards.

B. Equipment Tagging: Comply with Tag Data Sheet.

C. Welding:

1. Round interior sharp edges and corners (on pipes and baffles).
2. Comply with specified code for welding.
3. Once vessel has been hydrotested, do not perform further welding without prior notification.
4. Major repairs resulting from material defects or manufacturing efforts must be approved before taking corrective action.

D. External Clips:

1. Furnish platform and ladder clips in accordance with attached Equipment Data Sheets.
2. Drill at least 1/8-inch diameter vent hole in clip reinforcing pad welded to vessel.
3. Continuously weld internal and external clips.

E. Insulation: Insulation not provided by this Section.

2.06 CLEANING

A. Prior to shipping, perform final cleaning of internal and external surfaces after manufacturing and testing operations have been completed.

B. Cleaning procedures are manufacturer's responsibility.

PART 3 EXECUTION

3.01 INSTALLATION

A. Not applicable. Equipment in this Section will not be received, unloaded, and installed by this Section.

3.02 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are part of this Specification.

1. Influent Storage Tank Nos. 1, 2, 3, 4 Equipment Data Sheet.
2. Conditioned Water Storage Tank Nos. 1 and 2.

END OF SECTION

Project No.: 435062	CH2MHILL	By: John Porcella
Owner: PG&E		Date: 09-08-2014
		Equipment No.: TNK-201, TNK-202, TNK-203, TNK-204
	EQUIPMENT DATA SHEET	Equipment Name: Influent Storage Tank # 1, 2, 3, 4

DESCRIPTION

Service:	Groundwater	Working Volume:	*
Capacity:	20,000 gal nominal	Size:	* (Note 1)

DESIGN CRITERIA

	Shell	Jacket	Coil
Type of Tank	Frac/Portable Tank		
Operating Pressure:	ATM psig	N/A psig	N/A psig
Operating Temp.:	86°F	N/A °F	N/A °F
Design Pressure:	<15 psig	N/A psig	N/A psig
Design Temperature:	130°F	N/A °F	N/A °F
Contents:	Groundwater	N/A	N/A
S.G. Contents:	1	N/A	N/A
Seismic Criteria:	See Note 2	N/A	N/A
Corrosion Allowance:	1/16"	N/A	N/A
Cathodic Protection:	No	N/A	N/A
Code:		N/A	N/A
Stamp:	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☐ No

COMPONENT	**MATERIAL**	**GENERAL**	
Shell:	CS	Weight:	*
Top Head:	CS - Flat/Closed		
Bottom Head:	CS - Sloped Bottom		
Jacket:	N/A		
Coil:			*
Baffles:	N/A	Painting, External:	*
Flanges:	See data sheets	Painting, Internal:	*
Internals:	Eductors (Note 1 under nozzle schedule)		
Lining/Coating:	Yes		
Supports:		Tests:	Yes / No
Skirt:	N/A	Hydro	
Bolting:		Stress Relief	
Gaskets:		Rad'Graph	
Insulation:	N/A	Other:	
Insulation Cover:	N/A		
Lifting Lugs:			
Grounding Lugs:			
Handrail/Top Plate:	Yes, Handrail		
Ladders/Platforms:	Yes, for top access		
Rear Wheels:	Fixed Axle		

Project No.: 435062		By: John Porcella
Owner: PG&E		Date: 09-08-2014
		Equipment No.: TNK-201, TNK-202, TNK-203, TNK-204
	EQUIPMENT DATA SHEET	Equipment Name: Influent Storage Tank # 1, 2, 3, 4

REMARKS

* - Manufacturer to provide information

1. Tank width to be 8 feet wide.
2. Use CBC 2010, Site Class D - Seismic Design category: D - Ss = 0.434 - S1=0.135
3. Vendor to provide option for rental and purchase.
4. See Drawings M-11-01, M-11-02 and M-11-03
5. Vendor to provide anchor points at all locations on top of tank where maintenance is required. Anchors to be suitably sized for personnel fall arresting devices per OSHA 1910.166 Appendix C.

NOZZLES

Mark	Req'd	Size	Rating	Type	Face	Service	Note[s]
A1	1	6″	150#	RF	WN	Remedy Water – Main Process Inlet	Top
A2	1	10″/3″	150#	RF	WN	Remedy Water Recirc In	End (1)
A3	1	10″/3″	150#	RF	WN	Remedy Water Recirc In	End (1)
B1	1	6″	150#	RF	WN	Remedy Water – Recirc. Out	Top
B2	1	2″	150#	RF	WN	Remedy Water - Top Tap	End (2)
B3	1	2″	150#	RF	WN	Remedy Water- Bottom Tap	End (2)
B4	1	2″	150#	RF	WN	Slurry	Bottom (3)
B5	1	6″	150#	RF	WN	Remedy Water - Overfill line	Top
DR	1	4″	150#	RF	WN	Drain	End
L	1	3″	150#	RF	WN	Level Element	Top
M	2 min.	22″	-	-	WN	Manway	Side or End
S	1	2″	150#	RF	WN	Spare	Top
V	1	3″	150#	RF	WN	Vent with air/vacuum relief	Top (4)
M	1	22″	-	-	WN	Manway	Top

Project No.: 435062		By: John Porcella
Owner: PG&E		Date: 09-08-2014
		Equipment No.: TNK-201, TNK-202, TNK-203, TNK-204
	EQUIPMENT DATA SHEET	Equipment Name: Influent Storage Tank # 1, 2, 3, 4

NOTE[S]
1. Recirculation inlet with eductor. Double nozzle 3" and outer 10"for outboard eductor access. Eductors installed mid-way between tank top and bottom on end of tank. Nozzle spacing and location per Eductor supplier recommendation. Eductors: (2)-3" Clark-Reliance or Schutte & Koerting TLA PVC Eductors to completely (3 turnovers) mix a 21,000 gal tank in 30 minutes. Minimum. dP of 20 psi.
2. Top tap, B2 located approximately 7' from bottom and bottom tap, B3, located approximately 2.5' from tank bottom.
3. Approximately 0.5' from tank bottom.
4. Air/vacuum relief valve per manufacturer's standard

Project No.: 435062		By: John Porcella
Owner: PG&E		Date: 09-08-2014
		Equipment No.: TNK-201, TNK-202, TNK-203, TNK-204
	EQUIPMENT DATA SHEET	Equipment Name: Influent Storage Tank # 1, 2, 3, 4

Issue:	Date:	Released for:	Approved:	Owner Approved:
IFR	07-18-2012			

Project No.: 435062		By: John Porcella
Owner: PG&E		Date: 09-08-2014
		Equipment No.: TNK-401, TNK-402
	EQUIPMENT DATA SHEET	Equipment Name: Conditioned Water Storage Tank # 1 and 2

DESCRIPTION

Service:	Groundwater	Working Volume:	*
Capacity:	20,000 gal nominal	Size:	* (Note 1)

DESIGN CRITERIA

	Shell	Jacket	Coil
Type of Tank	Frac/Portable Tank		
Operating Pressure:	ATM psig	N/A psig	N/A psig
Operating Temp.:	86°F	N/A °F	N/A °F
Design Pressure:	<15 psig	N/A psig	N/A psig
Design Temperature:	130°F	N/A °F	N/A °F
Contents:	Treated Groundwater	N/A	N/A
S.G. Contents:	1	N/A	N/A
Seismic Criteria:	See Note 2	N/A	N/A
Corrosion Allowance:	1/16"	N/A	N/A
Cathodic Protection:	No	N/A	N/A
Code:		N/A	N/A
Stamp:	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☐ No

COMPONENT	**MATERIAL**	**GENERAL**				
Shell:	CS	Weight:	*			
Top Head:	CS - Flat/Closed					
Bottom Head:	CS - Sloped Bottom					
Jacket:	N/A					
Coil:						*
Baffles:	N/A	Painting, External:	*			
Flanges:		Painting, Internal:	*			
Internals:						
Lining/Coating:	Yes					
Supports:			Tests:	Yes	No	
Skirt:	N/A		Hydro			
Bolting:			Stress Relief			
Gaskets:			Rad'Graph			
Insulation:	N/A		Other:			
Insulation Cover:	N/A					
Lifting Lugs:						
Grounding Lugs:						
Handrail/Top Plate:	Yes, Handrail					
Ladders/Platforms:	Yes, for top access					
Rear Wheels:	Fixed Axle					

Project No.: 435062		By: John Porcella
Owner: PG&E		Date: 09-08-2014
		Equipment No.: TNK-401, TNK-402
	EQUIPMENT DATA SHEET	Equipment Name: Conditioned Water Storage Tank # 1 and 2

REMARKS

* - Manufacturer to provide information

1. Tank width to be 8 feet wide.
2. Use CBC 2010, Site Class D - Seismic Design category: D - Ss = 0.434 - S1=0.135
3. Vendor to provide option for rental and purpose.
4. See Drawings M-14-01, M-14-02 and M-14-03
5. Vendor to provide anchor points at all locations on top of tank where maintenance is required. Anchors to be suitably sized for personnel fall arresting devices per OSHA 1910.166 Appendix C.

NOZZLES

Mark	Req'd	Size	Rating	Type	Face	Service	Note[s]
A1	1	2″	150#	RF	WN	Treated Water – Main Process Inlet	Top
A2	1	3″/10″	150#	RF	WN	Future	End (1)
A3	1	3″/10″	150#	RF	WN	Future	End (1)
B1	1	2″	150#	RF	WN	Outlet	End
B3	1	4″	150#	RF	WN	Remedy Water - Overfill line	Top
DR	1	4″	150#	RF	WN	Drain	Bottom
L	1	3″	150#	RF	WN	Level Element	Top
M	2 min	22″	150#	RF	WN	Manway	Side or End
S	1	2″	150#	RF	WN	Spare	Top
V	1	3″	150#	RF	WN	Vent with air/vacuum relief	Top (2)
M	1	22″	-	-	WN	Manway	Top

NOTE[S]

1. Recirculation inlet with eductor. Double nozzle 3″ and outer 10″for outboard eductor access. Nozzles installed mid-way between tank top and bottom on end of tank. Nozzle spacing and location per Eductor supplier recommendation. Eductors will be future installation.
2. Air/vacuum relief valve per manufacturer's standard

Project No.: 435062		By: John Porcella
Owner: PG&E		Date: 09-08-2014
		Equipment No.: TNK-401, TNK-402
	EQUIPMENT DATA SHEET	Equipment Name: Conditioned Water Storage Tank # 1 and 2

Project No.: 435062		By: John Porcella
Owner: PG&E		Date: 09-08-2014
		Equipment No.: TNK-401, TNK-402
	EQUIPMENT DATA SHEET	Equipment Name: Conditioned Water Storage Tank # 1 and 2

Issue:	Date:	Released for:	Approved:	Owner Approved:
IFR	07-18-2012			

SECTION 33 21 13.01
WATER WELL MOBILIZATION/DEMOBILIZATION

PART 1 GENERAL

1.01 SCOPE

A. This section includes the Work necessary to mobilize, demobilize, set up, move equipment, and clean drill sites related to the drilling, construction, development, and testing of wells (to be completed).

1.02 SUBMITTALS

A. Informational Submittals (submit before mobilization):

1. Applicable permits.
2. Stormwater pollution prevention plan.
3. Proposed schedule.
4. Structural calculations for sound walls or curtains, in accordance with requirements of locally adopted building code (if needed).

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Temporary Facilities and Controls: Refer to Section 01 50 00, Temporary Facilities and Controls (to be completed).

B. Equipment: Refer to Section 33 21 13.03, Water Well Drilling.

C. Superintendent shall be at the Site full time.

D. Equipment needed for the first 30 days of Work shall be onsite at start of the Work.

3.02 WORK LAYOUT

A. Set up well drilling rigs, drilling waste solid and liquid containment, storage and treatment systems, pump service rigs, and other related equipment in designated areas specified and shown. Coordinate exact layouts and locations with Owner before equipment or material arrive on site.

B. Set up work facilities in a neat and orderly manner within designated areas.

3.03 NOISE CONTROL (TO BE COMPLETED)

A. Be prepared to monitor noise levels at least once daily during a time when onsite equipment is in use and noise levels are expected to be the highest. Measure noise levels approximately 50 feet from drill site.

B. Night time drilling operations shall be permitted only with Owner's prior approval. To the extent possible, conduct night time drilling operations while limiting the following activities: hammering on pipe, racking or making-up of pipe, rapid acceleration and deceleration of diesel engines, and picking up or laying down drill pipe.

C. Monitor noise levels. If, at any time, the noise limits are exceeded, take immediate corrective action through drilling equipment modifications, addition of supplemental noise abatement equipment, or changes in operating procedures. Noise levels may also be monitored by Owner to assess compliance.

D. Be prepared to provide noise barrier equipment to limit noise and to allow drilling to proceed on next well while pumping and aquifer testing proceeds simultaneously on previous well.

3.04 EQUIPMENT CLEANING

A. Downhole tools and equipment that may come in contact with tools or equipment that may be positioned directly above borehole or completed well shall arrive onsite free of surface deposits of friable solids; for example, mud, sand, grout, caked on cuttings and cleaned of grease, oils, and other petroleum products. Except that normal amounts of thread joint compound on drill pipe and tool joints, and normal amounts of lubricating grease on mechanical equipment is allowed.

B. Clean downhole equipment, tools, and equipment that may come in contact with downhole equipment that becomes soiled with petroleum products to satisfaction of Engineer before resuming work on well.

C. Remove trackable mud, cuttings, sand, grout and other materials from undercarriage, tires and other surfaces of equipment prior to moving equipment on or across public roads and pathways.

D. Do not empty, spill, splash, or slosh containerized drilling mud and fluids onto ground surface while moving containers, pipes and equipment.

E. Cleanup drilling mud, settled solids, and other semi-liquids and solids that spill from, or are emptied from, equipment as it is being moved.

3.05 DEMOBILIZATION

A. Remove temporary above grade or buried utilities, equipment, facilities, materials.

B. Clean and repair damage caused by installation or removal of temporary facilities and equipment.

C. Stabilize disturbed ground in accordance with Section 31 32 00, Soil Stabilization. Coordinate exact stabilization locations and requirements with Owner prior to stabilization.

END OF SECTION

SECTION 33 21 13.03
WATER WELL DRILLING

PART 1 GENERAL

1.01 SCOPE

A. This section includes the Work necessary to drill, construction, develop, and test wells (to be completed).

1.02 REFERENCES

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

1. American Petroleum Institute (API):
   a. 13A, Specification for Drilling-Fluid Materials.
   b. 13B-1, Recommended Practice Standard Procedure for Field Testing Water-Based Drilling Fluids.
2. ASTM International (ASTM): D422, Standard Test Method for Particle-Size Analysis of Soils.
3. International Association of Drilling Contractors (IADC): API-Approved Official Daily Drilling Report Form.
4. National Pollutant Discharge Elimination System (NPDES).
5. NSF International (NSF): 61, Drinking Water System Components—Health Effects.

1.03 SUBMITTALS

A. Action Submittals (submit before mobilization):

1. Copy of well driller license and experience/qualifications.
2. List of equipment proposed for use on project.
3. Manufacturer’s product data for all drilling and fluid handling equipment proposed for use on project, to include drill rigs.
4. Manufacturer’s product data for all materials proposed for use on project, to include drilling fluids, muds and additives.

B. Informational Submittals:

1. Drilling fluid specialist qualifications (submit before drilling).
2. Detailed description of drilling fluid program including details on mud tanks, pits, circulation system (submit before drilling).
3. Description of proposed methods (submit before drilling).

4. Daily Drilling Log to include alignment and plumbness results (submit daily).
5. Geolograph (or equal) logs for each 8-hour drilling period (to be completed).
6. Sieve analyses test results (to be completed).
7. Calibration test of mechanical drift indicator tool.
8. Water quality analysis test results.
9. If applicable, approved chain-of-custody form(s) related to disposing of materials generated during well drilling.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Driller: Licensed to drill and install wells in the applicable state (to be completed).
2. Drilling Fluid Specialist: Mud specialist shall be approved by Owner prior to drilling (to be completed).

B. Regulatory Requirements:

1. Comply with applicable permits, laws, and regulations in disposing of drilling fluids, drill cuttings, and water generated during drilling and well construction. Permits, laws and regulations shall include, but not be limited to, the following:
   a. Federal, state, and local laws, regulations, and ordinances related to disposing of materials generated in constructing wells.
   b. Site-specific requirements (to be completed).
2. Demonstrate compliance with the applicable permits, laws, regulations and requirements described above
3. If applicable, use approved chain-of-custody form(s) demonstrating compliance with disposal of materials generated during well drilling (to be completed).

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Notify Owner at least 5 working days before drilling begins.

B. Notify Owner of anticipated delays whenever they become apparent.

C. Excavation of mud pits will not be allowed unless approved by Owner (to be completed).

D. The minimum equipment required consists of the following (to be completed):

1. Drilling rig, drilling equipment, and associated self-contained fluid circulation equipment.
2. Temporary test pump, pump service rig, and equipment capable of setting and operating pumps as specified in these Specifications.
3. Tanks and storage bins to contain drilling fluid, drill cuttings, and high solids displacement water from each well for a minimum of 40 days.
4. A water treatment and disposal system including tanks, temporary pipelines, pumps, and associated equipment to treat and dispose of development water and aquifer test discharge water.
5. High pressure washer and miscellaneous associated equipment for removing mud and trackable debris from drilling equipment.

3.02 DRILLING EQUIPMENT (TO BE COMPLETED)

A. Provide direct circulation rotary, reverse circulation rotary, down-hole hammer, auger, and/or other drilling equipment and accessories required to complete well as specified.

B. Be prepared to equip drilling rig with a geolograph capable of recording rate of penetration and depth of hole as drilling progresses. Geolograph shall be approved by Owner prior to mobilizing equipment to field.

3.03 DRILLING FLUIDS (TO BE COMPLETED)

A. Drilling fluid program may be prepared by a certified drilling fluid specialist.

B. Use new materials in the formulation of drilling fluid at each well site. Used drilling fluid materials shall not be reused at subsequent well sites.

C. Tentative Properties:

1. Comprised of a polymer-based “mud” or a bentonite “gel”-based mud.
   a. “Gel”-based mud shall be a high-yield, 200-mesh sodium bentonite.
   b. A bentonite viscosifier only meeting requirements of API 13A will be considered insufficient for applications required in this Project.
2. NSF 61 Certified.

3. Possess characteristics that are required to:
   a. Adequately clean drill cuttings off drill bit and bottom of hole.
   b. Transport ("float") cuttings to the surface and remove them from the fluid.
   c. Provide borehole stability to prevent caving of the walls as drilling progresses.
   d. Control subsurface pressures.
   e. Cool drill bit and lubricate drill string.
   f. Prevent excessive fluid loss into permeable zones.
   g. Permit recovery of representative samples of drill cuttings.
4. Maintain to deposit only a thin, maximum of approximately 1/16 of an inch, easily removable filter cake on face of borehole. Maintain as follows:
   a. Weight: Not to exceed approximately 9.2 pounds per gallon.
   b. Viscosity: Not to exceed approximately 32 seconds per quart.
   c. Sand Content: Not to exceed approximately 1 to 5 percent.
   d. Total Solids Content: Not to exceed approximately 5 to 10 percent.
   e. 30-Minute Water Loss: Not to exceed approximately 15 milliliters.
5. Manufacturers and Products:
   a. Baroid Industrial Drilling Products; Quik-Gel.
   b. CETCO; Super Gel-X.
   c. Or Owner-approved equal.

D. Water:

1. Use potable water, with a minimum chlorine residual of approximately 0.5 mg/L, in formulating drilling fluids whether employed alone or in combination with drilling additives.
2. Contains specific conductance of less than approximately 2,000 micromhos/cm and gross alpha of less than approximately 15 picocuries/liter.
3. Soda ash is permitted for use to increase pH of the water used to mix drilling fluids.

E. Additives, if required, shall be approved by Owner. Organic drilling additives shall not be used without Owner's prior approval.

F. Use of salt or brine as a method of increasing mud weight during drilling will not be permitted during construction of well without Owner prior approval. Materials proposed for controlling the artesian flow shall be reviewed and approved by Owner, prior to use.

3.04 CIRCULATION SYSTEM (TO BE COMPLETED)

A. General:

1. System shall minimize recirculation of drill cuttings.
2. Design to facilitate retrieval of representative samples from the discharge with a minimum of recirculation of material.

B. Include settling tanks of adequate size, a sampling trough, a shaker table, and a desanding/desilting system.

1. Equip with shaker table and desander/desilter system with a minimum of four cones, capable of handling capacity of system.
2. Desander/desilter system shall have pump capable of supplying a minimum of approximately 40 psi at 80 gallons per minute per cone minimum.

C. Settling Tanks:

1. Vessels used for mixing drilling fluids shall be clean and free of contaminants and extraneous materials prior to their use in drilling operations.
2. Use above ground tanks for mixing, circulation and inclusion of approved additives.
3. Use proper controls to prevent spillage of mud or additives onto ground.

3.05 TEST EQUIPMENT (TO BE COMPLETED)

A. Drilling fluid test equipment and test procedures shall generally conform to API 13B-1.

B. Equipment for measuring fluid properties shall be made immediately available at drill site.

1. Mechanical Drift Indicator: Furnish and employ self-checking type to measure borehole deflection.
1. Manufacturer: Eastman Oil Well Survey Company.
2. Or Owner-approved equal.

3.06 BOREHOLE DRILLING (TO BE COMPLETED)

A. Before drilling, install temporary or permanent surface or pit casing needed to stabilize surface material.

B. Drill wells by direct circulation rotary, reverse circulation rotary, down-hole hammer , auger and/or other methods.

C. Drill boreholes to dimensions and depth shown and specified.

D. Borehole Deflection:

1. Drill boreholes sufficiently straight and plumb to permit installation of casing and screen.
2. Use mechanical drift indicator to measure borehole deflection.
    a. Provide Owner results of calibration test of mechanical drift indicator tool showing tool is operating properly and accurately.
    b. Calibration test shall be performed by tool manufacturer prior to use of tool on Project.
3. Conduct mechanical drift indicators at approximately 50 to 200-foot intervals.
4. Deflection:
    a. If less than approximately 1 degree, well shall be deemed in proper plumbness and alignment.
    b. If section of borehole exceeds approximately 1 degree, correct deviation or plug and abandon borehole at Contractor’s own expense.
5. Periodically conduct analysis of drift indicator record and make part of drilling log record.

E. If geophysical logging is to be done, condition borehole to allow free passage of logging tools to bottom.

F. Drilling Fluids and Additives:

1. Check drilling fluid properties, including fluid weight, marsh funnel viscosity, water loss, additions of water, sand content, and total solids content, at a minimum of:
    a. Approximately every 100 feet of depth drilled.
    b. Approximately every 12 hours of circulation when not drilling.
    c. As directed by Owner.
2. Maintenance:
    a. Maintain complete control over drilling fluid characteristics during operation of well construction.
    b. If proper control of drilling fluid is not maintained, retain or employ an experienced, qualified mud engineer onsite to supervise and maintain drilling fluid characteristics, at Contractor’s expense.

3. Determine and maintain the quantities and type of commercial drilling mud necessary for the Work, to secure and store those materials at Site, and use them in accordance with accepted practice compliance with water well drilling operations.

G. Use of additional bentonite, clay, mud, or other foreign matter that has a tendency to build a mud cake on the walls of the hole and clog or seal up water-bearing stratum will not be permitted without prior approval of Engineer.

3.07 TEST HOLE DRILLING AND SAMPLING (TO BE COMPLETED)

A. Drill holes to diameters and depths shown and specified. Test hole diameters outside of this range are not authorized and no payment will be made for test hole drilling if this drill bit size range is exceeded.

B. Owner will have representative onsite during drilling to determine exact depth of test hole based on cuttings.

C. Rate of penetration of test hole shall be limited to approximately 20 to 40 feet per hour so Contractor can obtain, and Owner can log, geological samples.

D. As test holes are advanced, collect representative formation samples at approximately 5-foot intervals to 10-foot intervals and as shown.

E. Collect samples from circulation fluid, by split-spoon, by coring, by push-tube method, by auger method, by bailing, and/or by other methods.

3.08 BOREHOLE REAMING (TO BE COMPLETED)

A. Ream borehole for production well to the shown or specified diameter from bottom of conductor casing, if applicable, to the total depth shown or specified.

B. In order to maintain full borehole diameter, maintain well borehole full of drilling fluid until screen, casing, and gravel pack, if applicable, are installed.

C. Maintain circulation of drilling fluid until casing is set, unless Owner, in consultation with Contractor, judges circulation to be unnecessary.

D. Maintain a free, uncollapsed, open borehole. If borehole collapses, ream borehole at Contractor’s sole expense.

3.09 DAILY LOG

A. General:

1. Keep driller's log of borehole which carefully and accurately describes the materials penetrated.
2. Drilling log shall be available for inspection at Site at all times.

B. Utilize the IADC, API-approved official Daily Drilling Report Form, or equivalent, as approved by Owner.

1. Submit legible forms covering the previous day suitable for photocopying to the Owner on a daily basis.
2. Daily log shall be signed daily by Contractor and Owner to represent their agreement of the included data.

C. Data:

1. Include the following:
   a. Formations encountered from surface to total depth, indicating the depth of each change in formation and including difficulties and unusual conditions met during drilling.
   b. Drilling rate.
   c. Depth at which water is first encountered.
   d. Other pertinent phenomena observed.
   e. Record of variations in the addition and amount of approved clays or chemical products or water required.
   f. Properties of drilling fluids as described in Article Drilling Fluids and depth at which changes were required.

3.10 SAMPLE COLLECTION (TO BE COMPLETED)

A. Approximately every 5 to 10 feet and at each change in the strata, collect a large, representative sample of the interval or new strata in accordance with procedures approved by Owner.

B. Storage:

1. Store each sample in a suitable gallon-sized, waterproof container and label each "SAMPLE".
2. Label shall include well number, date, time, and depth interval.
3. Sample containers shall be stored in a manner to prevent breakage or loss.
4. Furnish containers approved by Owner.

3.11 SIEVE ANALYSIS (TO BE COMPLETED)

A. The grain size distribution of approximately 5 to 10 cutting samples shall be determined by sieve analysis. Samples selected shall be approved by Owner.

B. Perform sieve analysis in accordance with ASTM D422 and include a table and plot of the cumulative percent of particles retained by each sieve versus particle size.

C. Provide a recommendation for well screen slot size, interval screened, and gravel pack gradation. Obtain Engineer's approval prior to ordering materials.

D. Provide sieve analysis results within approximately 24 to 48 hours of completion of borehole.

3.12 DRILL CUTTINGS AND DRILL FLUIDS DISPOSAL (TO BE COMPLETED)

A. Separate drill cuttings and drill fluids generated during borehole drilling using appropriate equipment.

B. Contain drill cuttings while onsite in roll-off bins or equivalent, and ultimately disposed of as shown and specified.

C. Separate suspended solids from drill fluids using appropriate equipment, including temporary tankage to allow sufficient settling time to meet discharge requirements for suspended solids and turbidity, if applicable.

1. Solids separated from drill fluids shall be contained while onsite in roll-off bins or equivalent, and ultimately disposed of as shown or specified.
2. Discharge water remaining from drill fluids after solids separation as shown and specified.

D. Upon completion of drilling, remove and dispose of drilling mud and cuttings from well from Site in accordance with Owner's direction and State and Local regulations.

E. Restore ground surface to its original condition and stabilize as specified in Section 31 32 00, Soil Stabilization.

END OF SECTION

SECTION 33 41 01
STORM DRAIN, SANITARY SEWER AND DRAINAGE PIPING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M36M, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
   b. M190M, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
   c. M196M, Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.
2. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm through 1200 mm) for Water and Other Liquids.
   d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.
3. ASTM International (ASTM):
   a. A746, Standard Specification for Ductile Iron Gravity Sewer Pipe.
   b. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   d. C150, Standard Specification for Portland Cement.
   e. C311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
   f. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   g. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.

h. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
i. C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
j. C507, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
k. C595, Standard Specification for Blended Hydraulic Cements.
l. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
m. C655, Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe.
n. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
o. C1012, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
p. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
q. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
r. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
s. D3034, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
t. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
u. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
v. F679, Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
w. F794, Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
x. F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.

1.02 SUBMITTALS

A. Informational Submittals: Manufacturer’s Certification of Compliance.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

A. As specified in Article Pipe and Pipe Joints of this section.

2.02 SERVICE AND DRAIN CONNECTIONS

A. Pipe and fittings for individual service connection shall be of one type of material throughout.

2.03 PIPE AND PIPE JOINTS

A. Polyvinylchloride Pipe (PVC):

1. Pipe and Fittings:
   a. 15-Inch Diameter and Under: ASTM D3034.
   b. Standard Dimension Ratio (SDR): Not to exceed 35.
2. Joints: ASTM D3212.
3. Rubber Gaskets: ASTM F477.
4. Adapter for Connecting Pipe to Manholes: Provide seal between pipe and concrete as recommended by pipe manufacturer.

B. Ductile Iron Pipe (DIP):

1. Pipe and Fittings:
   a. Meet requirements of ANSI/AWWA C151/A21.51, Grade 60-42-10 iron.
   b. Thickness Class: 52.
   c. Lining: Cement-mortar lined and seal coated in accordance with ANSI/AWWA C104/ A21.4.
2. Fittings: ANSI/AWWA C110/A21.10.
3. Joints: ANSI/AWWA C111/A21.11 as shown or optional if not shown.

C. High-Density Polyethylene Pipe (HDPE):

1. Pipe: Profile wall, 10 inches and larger, conforming to ASTM F894.
2. Strength: Minimum wall thickness shall have a ring stiffness class (RSC) of 63.
3. Joints: Bell and spigot with rubber gasket meeting the requirements of ASTM F477.
4. Joint Lubricant: Furnished by pipe manufacturer.

2.04 SERVICE CONNECTION MARKERS

A. New 2 by 4 lumber construction grade or better.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES

A. General:

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.
2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.
3. Pipe invert may deviate from line or grade up to 1/2 inch for line and 1/4 inch for grade, provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.
4. Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.
5. Prevent entry of foreign material into gasketed joints.
6. Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

B. PVC and HDPE Pipe:

1. Deflection of PVC and HDPE pipe shall be kept to a minimum and in no case shall it exceed 7-1/2 percent of the pipe inside diameter. All PVC and HDPE sanitary sewer pipe shall be tested for deflection after installation and backfill by pulling a round plug equal to 92-1/2 percent of pipe diameter through the completed pipeline. The plugs shall be a minimum of 1-1/2 times longer than the inside diameter of the pipe being tested.
2. Where PVC and HDPE pipe is connected to manholes or concrete structures, an adapter shall be provided at each point of connection. Adapters shall be suitable for jointing with the PVC and HPDE pipe furnished and shall provide a watertight seal.

C. Ductile Iron Pipe Corrosion Protection:

1. Remove foreign material from the exterior of the pipe.
2. Wrap pipe with polyethylene encasement tube 2 feet longer than the pipe section prior to laying pipe section.
3. After assembling the pipe joint, overlap encasement tube with adjacent tube and seal joints with securing tape.
4. Provide additional securing tape at 3-foot intervals along the pipe.
5. Repair rips, punctures, or other damage to the polyethylene with securing tape.
6. Fittings may be wrapped with a flat sheet or split tube provided all seams are securely taped.

D. Concrete Closure Collars: Only use concrete closure collars where shown or authorized by Engineer.

E. Service Connections:

1. Minimum Slope: 1/4 inch per foot.
2. Markers:
   a. Paint the top portion of the marker immediately after its installation with first-quality white, quick-drying enamel. After the paint has dried, use black, quick-drying enamel and neatly indicate the distance from the natural ground surface to the top of the service connection pipe in feet and inches.
   b. If marker is broken or knocked out of vertical alignment during backfilling operation, reopen trench and place marker in accordance with Sewer Service Connection Details shown on Drawings.
3. Disconnecting and Reconnecting Existing Service Connections:
   a. Locate the existing service connections prior to constructing the tee in the new sewerline.
   b. Disconnect existing service connections from existing sewers to be abandoned and reconnect them to the new sewers.

F. Square-End Underdrains: Cover top and sides of the joints with a strip of asphalt-saturated 30-pound roofing felt.

G. Perforated Underdrain: Lay with open joints and with perforations down and at 5 o'clock and 7 o'clock.

3.02 TESTING

A. Visual Inspection: When inspected with reflected light, sewer lines shall show a clear, unobstructed view between manholes. A practically full circle of light shall be seen when viewed from the adjoining end of the line. Defects as a result of this test shall be corrected at Contractor's expense.

B. Pressure: After installation of pipe and manholes and backfill, pressure test the sewer line with one of the following methods:

1. Hydrostatic Test:
    a. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under specified conditions.
    b. Maximum Allowable Leakage: 0.16-gallon-per-hour-per-inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
    c. Exfiltration Test:
        1) Hydrostatic Head:
            a) At least 6 feet above maximum estimated groundwater level in section being tested or the top of the barrel or cone section, whichever is less.
            b) No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
        2) Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.
    d. Infiltration Test - Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Pneumatic Test:
    a. Equipment:
        1) Calibrate gauges with standardized test gauge provided by Owner at start of each testing day. Owner will witness calibration.
        2) Install gauges, air piping manifolds, and valves at ground surface.
        3) Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 9 psi or less.
        4) Restrain plugs used to close sewer lines to prevent blowoff.
    b. Procedure:
        1) Clean the pipe section (manhole to manhole reach of sewer) being tested by propelling a snug fitting inflated ball or

other adequate method through the pipe with water. It is important that the pipe be thoroughly wetted if consistent results are to be expected.

2) Plug pipe outlets with pneumatic plugs. The pneumatic plugs shall be able to resist internal testing pressures without requiring external bracing. Inflate plugs from above-ground control panel. Plug upstream end of tested sections first. Give special attention to house laterals.
3) Determine the groundwater level surrounding the section of sewer under test.
    a) Pipe Nipple Installation:
        (1) Use 1/2-inch diameter noncorrosive threaded pipe nipple.
        (2) Install pipe directly over the sewer pipe entering the manhole (maintain 6 to 12 inches clear).
        (3) Threaded end shall extend no more than 2 inches on the inside of the manhole. Total length of the nipple shall exceed the manhole wall thickness by no less than 4 inches.
        (4) Install pipe through manhole using watertight seal and cap pipe with threaded 1/2-inch cap.
        (5) Install test pipes at sufficient intervals along sanitary route to give adequate data on ground water levels.
    b) Ground Water Level:
        (1) Remove threaded cap.
        (2) Blow air through pipe nipple to clear any obstructions.
        (3) Connect clear plastic tube to pipe nipple.
        (4) Hold plastic tube vertically to allow ground water to rise in tube.
        (5) Measure from invert of sewer pipe to water level in tube.
        (6) After ground water level has been determined, remove plastic tubing and recap and seal pipe nipple to prevent any future infiltration.
4) If the groundwater level is above the crown of the pipe, the test pressures shall be increased by 0.43 psig for each foot of water above the average elevation of the invert of the pipe. Test pressures shall not exceed 9 psig.

5) Introduce air slowly to the section of pipe under evaluation until the internal air pressure is raised to 4 psig, plus any increase required by a high groundwater level.
6) Allow the air pressure to stabilize. Air may be added slowly to maintain a pressure of 4 psig (plus groundwater allowance) for 2 minutes. While temperature is stabilizing, spray plugs, pipes, and hoses with soap solution to detect air leaks.
7) After the stabilization period when the pressure decreases to no less than 3.5 psig (plus groundwater allowance), the stopwatch is started, and when the pressure reaches 2.5 psig (plus groundwater allowance), the stopwatch is stopped.
8) The leak test shall be considered successful if the time required for a 1-pound pressure drop is greater than the allowable time for the pipe section under test to lose air.
9) In all cases where an air test is conducted, the manholes shall be hydrostatically tested separately as previously specified.
10) Persons conducting an air test must be made aware of the fact that an air test may be dangerous if improperly conducted.
11) Air Testing Tables: Tables 1 and 2 will be used to determine the required test duration for the section of line being tested.

3.03 REPAIR AND RETESTING

A. Sections of pipe not meeting the pressure test requirements shall be replaced.

B. Following repairs, sections shall be retested as specified.

3.04 SEWER CLEANING

A. Prior to final acceptance and final manhole-to-manhole inspection of the sewer system by Construction Manager, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the sewer system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment.

B. Upon Engineer’s final manhole-to-manhole inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

3.05 EXPLANATION AND USE OF TABLES

A. Explanation of Tables:

1. Column A: Nominal diameter of pipe (any pipe material).
2. Column B: Minimum duration of air test regardless of length of line segment being tested (e.g., 8-inch PVC equals test duration of 7 minutes 34 seconds, Table 1).
3. Column C: Length of line associated with minimum duration of air test (Column B).
4. Column D: L = Length of line in feet; product of computations yields duration of air test (e.g., 250 feet of 12-inch PVC where groundwater is present (test duration = 3.418 by (250 feet) equals 854.50 seconds = 14 minutes 15 seconds [Table 1]).
5. Column E: Duration of air test for given incremental lengths of line.

B. Use of Tables:

1. Table 1 is based on an air loss rate of 0.0015 cfm per square foot of internal surface area. Use for line installations where groundwater (and subsequent infiltration) is present.
2. Table 2 is based on an air loss rate of 0.0015 cfm per square foot of internal surface area. Use for line installations where groundwater (and subsequent infiltration) is not present.

Table 1

Specification Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated for Q = 0.0015

Pipe Diameter (Inches) (A)	Minimum Time (Min: Sec) (B)	Length For Minimum Time (Feet) (C)	Time For Longer Length (Seconds) (D)	Specification Time for Length (L) Shown (Min: Sec) (E)				
				100 Feet	150 Feet	200 Feet	250 Feet	300 Feet
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42

Pipe Diameter (Inches) (A)	Minimum Time (Min: Sec) (B)	Length For Minimum Time (Feet) (C)	Time For Longer Length (Seconds) (D)	Specification Time for Length (L) Shown (Min: Sec) (E)				
				100 Feet	150 Feet	200 Feet	250 Feet	300 Feet
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50

Table from UNI-B-6-98, Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe, Uni-Bell Plastic Pipe Association.

Table 2

Specification Time Required for a 0.5-psig Pressure Drop for Size and Length of Pipe Indicated for Q = 0.0015

Pipe Diameter (Inches) (A)	Minimum Time (Min: Sec) (B)	Length For Minimum Time (Feet) (C)	Time For Longer Length (Seconds) (D)	Specification Time for Length (L) Shown (Min: Sec) (E)				
				100 Feet	150 Feet	200 Feet	250 Feet	300 Feet
4	1:53	597	0.190 L	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427 L	2:50	2:50	2:50	2:50	2:50
8	3:47	298	0.760 L	3:47	3:47	3:47	3:47	3:48
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38

Pipe Diameter (Inches) (A)	Minimum Time (Min: Sec) (B)	Length For Minimum Time (Feet) (C)	Time For Longer Length (Seconds) (D)	Specification Time for Length (L) Shown (Min: Sec) (E)				
				100 Feet	150 Feet	200 Feet	250 Feet	300 Feet
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55
39	18:25	61	18.054 L	30:57	45:09	60:11	75:14	90:16
42	19:50	57	20.039 L	34:54	52:21	69:48	87:15	104:42

Table from UNI-B-6-98, Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe, Uni-Bell Plastic Pipe Association.

END OF SECTION

SECTION 33 46 00
SUBSURFACE DRAINAGE

PART 1 GENERAL

1.01 GENERAL

A. This section covers requirements for subsurface drainage piping and cleanouts, used within the Project area. This includes leach field laterals for septic tank systems.

1.02 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M252, Standard Specification for Corrugated Polyethylene Drainage Pipe.
   b. M294, Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter.
2. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   d. D75, Standard Practice for Sampling Aggregates.
   e. D422, Standard Test Method for Particle-Size Analysis of Soils.
   f. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75-µm) Sieve.
   g. D6707 , Standard Specification for Circular-Knit Geotextile for use in Subsurface Drainage Applications
   h. F405, Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.
   i. F449, Standard Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control.
   j. F667, Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings.
3. Natural Resources Conservation Service (NRCS): Conservation Practice Standard 606, Subsurface Drain.

1.03 DEFINITIONS

A. Cleanouts: Surface access ports used to access drain lines and constructed of solid corrugated piping.

B. Granular Drain Material: Granular (sand or gravel) material used as an envelope around drain lines and leach field laterals to provide pipe bedding, a permeable drainage zone, and stabilization of base soils to prevent migration of fines into drain lines and leach field laterals.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Drain line pipe and fittings.
      2) Drain line installation equipment.
      3) High-pressure water jet cleaning equipment.
      4) Drain line sock; include manufacturer's recommendation for length of time UV-resistant sock may be left exposed.
   b. Precast Base, Cone, and Top Slab Manhole Sections: Details of construction.

B. Informational Submittals:

1. Granular Drain Material:
   a. Manufacturer's Certificate of Compliance, in accordance with Section
   b. Test results from approved commercial testing laboratory before delivering material to Site and at least 10 days before material is required for use.
2. Surveys:
   a. Survey plan to collect drain line grade QA/QC information, including methods and schedule.
   b. Field Survey:
      1) Information consisting of stationing and ground surface elevation for each drain line prior to installation.
      2) Information consisting of stationing and installed invert elevation of drain pipe for drain line grade QA/QC.
3. Final drain line inspection and cleaning certification of compliance.

1.05 QUALITY ASSURANCE

A. Granular Drain Material Source:

1. Sampling:
   a. Conduct sampling of granular drain material source under supervision of Engineer in accordance with ASTM D75.
   b. Samples shall be representative and be clearly marked to show source of the material.
   c. Testing:
      1) In accordance with ASTM D1140 to determine percentage of fines.
      2) In accordance with ASTM D422 to determine gradation of particles larger than No. 200 sieve.
   d. Acceptance:
      1) Based on inspection of source by Engineer.
      2) Certified test results.
   e. Provide additional sampling, testing, and certification for every 500 cubic yards of material and when there is a change in granular drain material.
   f. Upon Engineer's request, supply supplemental samples of granular drain material to a testing laboratory designated by Owner during installation of drain lines. Owner will bear costs of testing.

1.06 DOCUMENTATION

A. Survey Plan:

1. Submit prior to beginning Work.
2. Update on a weekly basis through final drain line inspection and cleaning.

B. Surveying:

1. At least 10 days prior to installation, provide Engineer with the following information for each drain line:
   a. Field survey ground surface elevations at 250-foot increments.
   b. Calculated cut depth from ground surface to drain line invert elevation.
2. Provide surveyed drain line grades to Engineer no more than 5 days following installation of drain line section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Drain Sock:

1. Free of tears or other damage. Replace damaged sock.
2. Protect polyethylene drain lines with geotextile sock from UV light while stored onsite, unless geotextile sock is certified UV resistant.
3. UV-resistant Sock Stored Onsite Uncovered:
   a. Mark date of first sunlight exposure for each roll at factory.
   b. Do not allow UV-resistant sock to remain uncovered for more time than recommended by manufacturer.

PART 2 PRODUCTS

2.01 DRAIN LINES

A. Drain lines shall be perforated, unless otherwise noted on Drawings.

B. Perforated Drain Lines:

1. Heavy-duty corrugated polyethylene pipe meeting NRCS Conservation Practice Specification 606.
2. Conforming to ASTM F405 for 3-inch to 6-inch diameter pipe.
3. Conforming to ASTM F667 for 8-inch to 15-inch diameter pipe.
4. Water Inlet:
   a. Area of at least 1 square inch per foot of length.
   b. Dimensions of water inlet area shall be measured on a straight specimen with no external forces applied. Make measurements with instruments accurate to 0.01 inch.
   c. Perforations:
      1) Locate at least one perforation in the middle of corrugation so there is a shoulder on each side of perforation.
      2) Pipe 4 Inches to 12 Inches in Diameter:
         a) Slotted perforations shall be no wider than 1/8 inch or no longer than 1-1/4 inches.
         b) Slotted perforations equally spaced along length and circumference of tubing in not less than three rows.
      3) Pipe 15 inches in Diameter: Circular perforations will be accepted.

C. Nonperforated Drain Lines:

1. Heavy-duty corrugated polyethylene pipe with smooth interior walls.
2. Conforming to AASHTO M252 for 3-inch to 10-inch pipe.

3. Conforming to AASHTO M294 for 12-inch to 15-inch pipe, Type S.

D. Drain Sock:

Provide geotextile fabric material (sock) surrounding perforated drain lines.

1. Drain Sock shall be geotextile shall be a knit fabric of polymeric filaments or yarns such as polypropylene, polyethylene, polyester, or polyamide formed into a stable network such that the filaments/yarns retain their relative position to each other.
2. Geotextile shall be uniform in texture, thickness and appearance, and be free of defects, flaws or tears that would significantly alter its strength or filtering properties.
3. Drain Sock fabric shall confirm to the properties listed below:

Property	Value	Test Method
Weight	3.5 – 3.9 oz./yd2.	ASTM D3776
Thickness	0.040 in.	
Burst Strength (min)	120 psi	ASTM D3887
Puncture Resistance (min)	180 lbs.	ASTM D6241
Air Permeability	700 ft.3/ft.2/min.	ASTM D737
Apparent Opening Size	30, U.S. Standard Sieve	ASTM D4751
Permittivity (min)	2.4 sec.-1	ASTM D4491
Water Flow Rate	300 gal/min/ft.2 (2"Constant Head)	ASTM D4491

E. Drain Line Fittings:

1. Includes cleanouts, elbows, tees, branch connections, snap end caps, and reducing couplers.
2. Conforming to ASTM F405 and ASTM F667 as appropriate.
3. Cleanout snap end cap shall have a metal locating plate attached as shown in Drawings.
4. Diameter of cleanout fittings shall be as shown on Drawings.
5. Fittings installed as part of a continuous operation shall be clamp type rather than snap type. Fittings installed after pipe is in place may be either type.

F. Leach Field Laterals.

2.02 GRANULAR DRAIN MATERIAL

A. In accordance with Section 31 23 23.15, Trench Backfill.

B. Composed of hard, durable, natural mineral particles free from organic matter, clay balls, soft particles, or other impurities or foreign matter.

C. Material shall conform to the following grading requirements:

Size or U.S. Standard Sieve	Percent Passing by Dry Weight
2 inch	100
1/2 inch	90-100
1/4 inch	40-70
#4	10-50
#200	0-15

2.03 TRENCH BACKFILL

A. Above pipe zone shall be in accordance with Section 31 23 23.15, Trench Backfill.

B. Within pipe zone shall be in accordance with Section 31 23 23.15, Trench Backfill.

C. Native backfill free from organic matter and other impurities or foreign matter and free from rocks larger than 3 inches in diameter.

2.04 BASE ROCK

A. In accordance with Section 31 23 23.15, Trench Backfill.

B. Base rock shall be clean 3/4-inch minus crushed granular or crushed rock uniformly graded from coarse to fine and with sufficient fines for proper compaction.

2.05 DRAIN ROCK

A. In accordance with Section 31 23 23.15, Trench Backfill.

B. Drain rock shall be washed gravel or crushed stone, 3/4 inch to 1-1/2 inch diameter.

2.06 DIVERTER VALVE

A. A noncorrosive alternating valve shall be provided with 4 inch Schedule 40 female connections. The valve plug shall be non-removable, water-tight, and externally operate. The valve shall be provided with an internal stop mechanism for positioning the plug, and the plug shall be non-jamming when turning from stop to stop. There shall be no metal parts in contact with the drainage. The inlet and outlet ports shall be clearly labeled for easy installation and the position of the valve shall be clearly indicated on top of the valve. The valve shall be installed in such a manner as to be easily accessible from the ground surface and operated with a standard water key provided.

PART 3 EXECUTION

3.01 TRENCH EXCAVATION

A. In accordance with Section 31 23 23.15, Trench Excavation.

B. Excavate to lines and grades shown on Drawings allowing required thickness of granular fill to be placed around drain lines as shown on Drawings.

C. Installation of Drain Lines below Water Table: Install with trenching machine specifically designed for fluid soil conditions.

3.02 DRAIN LINE INSTALLATION

A. Pipe Installation:

1. Handle and install in conformance with ASTM F449.
2. Lay drain lines and appurtenances to lines and grades shown on Drawings.
3. Take special precautions on hot days to ensure stretch limit is not exceeded and excessive deflection is not caused by premature backfilling.

B. Fitting Installation:

1. Standard connections shall be in conformance with ASTM F449.
2. For nonstandard connections, join drain lines using manufacturer’s printed recommended methods to complete connection.

3. Drain lines that are exposed to make a connection after trench backfilling shall have 4 inches of granular drain material replaced around drain line and connection.
4. Wrap connections and fittings with geotextile sock.

3.03 GRANULAR DRAIN MATERIAL INSTALLATION

A. Place granular drain material around perforated drain lines as shown on Drawings.

B. Place granular drain material around perforated drain lines in a continuous operation during placement of drain lines.

C. Place granular drain material with spreader boxes or other equipment in a manner to minimize segregation.

3.04 TRENCH BACKFILL

A. Trench shall not be left open overnight; plug end of drain lines and backfill trench to prevent animals, sediment, or debris from entering pipe.

B. Perform in a manner that shall minimize settlement.

C. Backfill may be placed automatically by trencher.

D. Where backfill material is placed in drain line trenches mechanically, backfill material shall be pushed onto slope of backfill previously placed and allowed to slide down into trench. Backfill shall not be pushed into trench in such a way as to permit free fall of material until at least 2 feet of cover has been provided over the top of drain line.

E. Place in such a manner to prevent displacement of drain line and granular fill after backfilling.

F. Trench Compaction:

1. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor.
2. Additional mechanical backfilling shall be done to leave trench with 4-inch to 6-inch elevated mound on trench.

G. Unless otherwise directed by Engineer, procedures for compaction of trench backfill material shall be accomplished by close of each day's work.

3.05 CLEANING ACCESS INSTALLATION

A. Install inline cleanout in drain lines longer than 1,000 feet and place cleanouts no further than 1,000 feet apart in drain lines longer than 2,000 feet. Install end-of-line caps at upstream end of drain lines.

B. Placing Precast Manhole Sections:

1. Make joints between precast manhole sections of cement mortar.
2. Place mortar in groove of the lower section of pipe prior to placing next section.
3. Set sections plumb.
4. Fill joints between sections completely with mortar and trowel to a smooth finish.
5. Joints between precast sections shall be watertight.
6. Cut openings in precast manhole sections as required to accommodate inlet and discharge pipes.
7. Cut holes with care and patch with nonshrinking mortar. Bend reinforcement out from the hole insofar as possible so as to reinforce patching.

3.06 FIELD QUALITY CONTROL

A. Drain Line Grade:

1. Measure by field survey a minimum of every 250 linear feet after line placement and prior to covering pipeline with backfill. Measure drain invert elevation with a survey method accurate to 0.01 foot vertical.
2. Measure for grade at the top of pipe.
3. Drain lines with grades less than 1 percent shall be placed to the design grade within a tolerance of plus or minus 0.1 foot of design invert elevation.
4. Grades of 1 percent or steeper shall be placed to the design grade within a tolerance of plus or minus 0.2 foot of design invert elevation.
5. No reversal in grade of the drain lines shall be permitted.

B. Drain Line Stretching:

1. Drain lines shall not be stretched more than 5 percent during installation.

2. Measure stretch by measuring the distance across a minimum of 10 corrugations and comparing to manufacturer's standard corrugation dimensions.

3.07 FINAL INSPECTION AND CLEANING

A. Preparation:

1. Do not begin jet washing until subsurface drainage work is complete.
2. Stage the Work to provide adequate supply of water for jet washing to allow inspection and cleaning of each section of drain line in one continuous operation.
3. Access to drain lines shall be through drain line cleanouts, or outfall.

B. High Pressure Jet Washing Equipment:

1. Suitable type and size to perform cleaning specified herein.
2. Cleaning nozzle capable of jet washing 6-inch diameter to 15-inch diameter drain lines in sections up to 1,000 feet long.
3. Capable of negotiating 4-inch diameter cleaning access point.
4. Jet mechanism shall have a forward-piercing jet with trailing side jets that propel mechanism forward.
5. Operating pressures at pump shall not exceed a maximum of 2,300 psi.
6. Operate in accordance with manufacturer's printed instructions, recommendations, and best practice of the trade.

C. Pass high-pressure water jet cleaner through entire length of each drain line no sooner than 10 calendar days after installation of drain line.

D. When drain lines must be jet washed in sections, upstream sections shall be jet washed before connecting section downstream.

E. If tailwater produced is not clear, run jet cleaner through drain line section up to two more passes.

F. Obstructions within drain lines, collapsed drain line sections, or sections outside allowable tolerances for grade that are identified during final inspection and cleaning shall be repaired and corrected to meet Specification.

G. Complete final drain line inspection and cleaning certification of compliance addressing the following items:

1. Dates of work, equipment, and personnel performing work.

2. Locations and descriptions of obstructions, collapsed sections, out-of-grade sections, and actions taken to repair problems.
3. Locations of sections where tailwater did not run clear after three passes.

H. After completing jet washing for a drain line, restore area to a neat and finished appearance.

END OF SECTION

PG&E

TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

PRE-FINAL (90%)
TECHNICAL SPECIFICATION

VOLUME 3

for the construction of the

TOPOCK GROUNDWATER REMEDIATION PROJECT

****

****

CH2M HILL

Oakland, CA

September 8, 2014

Project No. 435062 Copy No. _____

TABLE OF CONTENTS

VOLUME 1

DIVISION 23—HEATING, VENTILATING, AND AIR-CONDITIONING

DIVISIONS 24 THROUGH 25—NOT USED

DIVISION 26—ELECTRICAL

DIVISIONS 27 THROUGH 30—NOT USED

VOLUME 3

Submersible Well Pump PMP-*541, *542 Data Sheet
Submersible Well Pump PMP-*544, *545, *543 Data Sheet
Submersible Well Pump PMP-*546, *547, *548, *549 Data Sheet
Submersible Well Pump PMP-*641A, *641B Data Sheet
Submersible Well Pump PMP-441 Data Sheet
Submersible Well Pump PMP-*540 Data Sheet
Submersible Well Pump PMP-*640 Data Sheet

44 42 56.09 Non-Clog Dry-Pit Centrifugal Pumps
Supplements:
Influent Tank Farm, Decon Pad, Remedy Produced Water Conditioning Plant Sump Pumps Submersible Centrifugal Pump Data Sheet
Conditioning Water Tank Farm Sump Pump Submersible Centrifugal Pump Data Sheet

44 42 56.10 Horizontal End Suction Centrifugal Pumps
Supplements:
Influent Storage Tank Recirculation Pump #1, 2, 3, 4 Pump Data Sheet
Filter Feed Pump 1 – A Side, Filter Feed Pump 2 – A Side Data Sheet
Filter Feed Pump 1 – B Side, Filter Feed Pump 2 – B Side Data Sheet
Conditioned Water Transfer Pump 1 & 2 Data Sheet
Truck Loading Pump Data Sheet
Electric Motor Data Sheet

44 42 56.15 Air Operated Diaphragm Pumps
Supplement:
Solids Pump Air-Operated Diaphragm Pump Data Sheet

44 43 13.16 Cartridge Filters

44 44 13.01 Chemical Metering Pumps
Supplement:
Caustic Feed Pump 1 and 2 Data Sheet
Coagulant Feed Pump 1 and 2 Data Sheet
Acid Feed Pump 1 and 2 Data Sheet
Carbon Substrate Pumps, Well Maintenance Reagent Pumps Data Sheet

DIVISIONS 45 THROUGH 49—NOT USED

VOLUME 4

DRAWINGS

END OF SECTION

SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
5. California Building Code (CBC).
6. California Mechanical Code (CMC).
7. Manufacturers' Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
   b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and

anchor for piping 6 inches and larger and 4 inches and smaller. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

2. Calculations for each type of pipe support, attachment and anchor.
3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing (to be completed).

B. Informational Submittals:

1. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing (to be completed).
2. Maintenance information on piping support system.

1.04 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes and as shown on Structural General Drawings.
3. Wind loads in accordance with governing codes and as shown on Structural General Drawings.
4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
   a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
   b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

E. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.02 HANGERS

A. Clevis: MSS SP 58, Type 1:

1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.

B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:

1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.

C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:

1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.

2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.

D. Pipe Rollers and Supports: MSS SP 58, Type 44:

1. Anvil; Figure 175, sizes 2 inches through 30 inches.
2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):

1. Anvil; Figure 199, 3,000-pound rating.
2. B-Line; Figure B3067, 3,000-pound rating.

B. Adjustable “J” hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.

C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.

D. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches though 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP , Type 37 with U-bolt.
   a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.

b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.

3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
   a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
   b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. B-Line; Strut System.
2. Unistrut.
3. Anvil; Power-Strut.
4. Aickinstrut (FRP System).
5. Enduro-Durostrut (FRP Systems).

2.06 FRP PIPE SUPPORTS SYSTEMS

A. General:

1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
2. Fire Retardant: ASTM E84.
3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers:

1. Factor of Safety: 3 to 1.
2. Minimum Design Load: 200 pounds.

C. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.
2. Identify and highlight non-FRP fasteners or components in Shop Drawing.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.

2.07 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

2.08 ELBOW AND FLANGE SUPPORTS

A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.09 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. Anvil; Figure 137 and Figure 137S.
2. B-Line; Figure B3188 and Figure B3188NS.

2.10 PIPE ALIGNMENT GUIDES

A. Type: Spider.

B. Manufacturers and Products:

1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

2.11 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.12 SEISMIC RESTRAINTS

A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.

B. Manufacturers:

1. Mason Industries.
2. B-Line.
3. Anvil.

2.13 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.
2. Bolt Length (Extension Above Top of Nut):
   a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
   b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.
2. Manufacturer and Products:
   a. B-Line; B1999 Vibra Cushion.

b. B-Line; Iso Pipe, Isolation Tape.

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
2. Manufacturers and Products:
   a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
   b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers and Products:
   a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
   b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
3. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
5. Concrete Attachment Plates:
   a. Anvil; Figure 47, Figure 49, or Figure 52.
   b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for seismic loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3-inch.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
3. Horizontal Piping Supported from Floors:
   a. Saddle Supports:

1) Pedestal Type, elbow and flange.
2) Provide minimum 1-1/2-inch grout beneath baseplate.

b. Floor Mounted Channel Supports:
1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
3) Attach pipe to channel with clips or pipe clamps.

c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

4. Insulated Pipe:
a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
c. Wall-mounted pipe clips not acceptable for insulated piping.

5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
1) These lines include air operated diagram

2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
b. Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

3. Steel Beams: I-beam clamp or welded attachments.

4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
6. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to 120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:
   a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
   b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Table 1: Nonchemical Areas.
2. Table 2: Chemical Areas.

END OF SECTION

Table 1
Nonchemical Areas

Exposure Conditions	Support Material
Office Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Shops and Warehouse Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Pipe Galleries	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Process Areas: Wetted or Submerged	Stainless steel or FRP
Pipes conveying chemicals listed in Table 2	Provide with corresponding support per Table 2

Notes:

1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
2. Stainless steel to be Type 304.
3. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
4. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

Table 2
Chemical Areas

Exposure Conditions	Support for Direct Exposure	Support for Remote Exposure
Alum	FRP	Precoated steel
Aqua Ammonia	Stainless steel	Precoated steel
Coagulants	FRP	Precoated steel or galvanized steel
Ferric Chloride	FRP	Precoated steel
Ferric Sulfate	FRP	Precoated steel
Hydrochloric Acid	FRP	Precoated steel
Hydrofluorosilic Acid	FRP	Precoated steel
Lime	Stainless steel, FRP, precoated steel	Stainless steel, FRP, precoated steel
Methanol	Galvanized steel	Galvanized steel
Polymers	FRP	Precoated steel
Potassium Permanganate	Precoated steel	Precoated steel
Powdered Activated Carbon	Precoated steel	Precoated steel
Sodium Carbonate	Stainless steel	Precoated steel
Sodium Hydroxide	Stainless steel	Precoated steel
Sodium Hypochlorite	FRP	Precoated steel
Sulfuric Acid	Stainless steel	Precoated steel

Table 2
Chemical Areas

Exposure Conditions	Support for Direct Exposure	Support for Remote Exposure

Notes:

1. Direct exposure includes entire area within containment area; area within 20 feet horizontal and 10 feet vertical of chemical pumps or chemical mixing stations; or as specified.
2. Remote exposure is area beyond area defined as direct exposure, but within designated building.
3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
4. Stainless steel to be Type 304.
5. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
6. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME): B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
3. American Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C500, Metal-Seated Gate Valves for Water Supply Service.
   c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
   d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
   e. C509, Resilient-Seated Gate Valves for Water Supply Service.
   f. C510, Double Check Valve Backflow Prevention Assembly.
   g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
   j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   k. C542, Electric Motor Actuators for Valves and Slide Gates.
   l. C550, Protective Interior Coatings for Valves and Hydrants.
   m. C606, Grooved and Shouldered Joints.
   n. C800, Underground Service Line Valves and Fittings.
4. ASTM International (ASTM):
   a. A276, Standard Specification for Stainless Steel Bars and Shapes.
   b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

e. B61, Standard Specification for Steam or Valve Bronze Castings.
f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
m. D429, Standard Test Methods for Rubber Property—Adhesion to Rigid Substrates.
n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

5. FM Global (FM).
6. Food and Drug Administration (FDA).
7. International Association of Plumbing and Mechanical Officials (IAPMO).
8. Manufacturers Standardization Society (MSS):
   a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
   b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
   c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
   d. SP-88, Diaphragm Valves.
   e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
9. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
10. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
11. Underwriters Laboratories, Inc. (UL).
12. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Power and control wiring diagrams, including terminals and numbers.
   d. For each power actuator provided, manufacturer's standard data sheet, with application specific features and options clearly identified.
   e. Sizing calculations for open-close/throttle and modulating valves.
   f. Seismic anchorage and bracing drawings and cut sheets.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance for:
   a. Electric actuators; full compliance with AWWA C542.
   b. Butterfly valves; full compliance with AWWA C504.
   c. Provide in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).
2. Tests and inspection data.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data (to be completed).
4. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).

PART 2 PRODUCTS

2.01 GENERAL

A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.

D. Valve ends to suit adjacent piping.

E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Size operators and actuators to operate valve for full range of pressures and velocities.

G. Valve to open by turning counterclockwise, unless otherwise specified.

H. Factory mount operator, actuator, and accessories.

2.02 SCHEDULE

A. Additional requirements relative to this section are shown on Electric Motor Actuated Valve Schedule, Pneumatic Actuated Valve Schedule, Self-Regulated Valve Schedule, Solenoid Valve Schedule, and Miscellaneous Schedule located at the end of this section.

2.03 MATERIALS

A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
2. Stainless steel Alloy 18-8 may be substituted for bronze.

B. Valve materials in contact with or intended for drinking water service to meet the following requirements:

1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
2. Coatings materials to be formulated from materials deemed acceptable to NSF 61.

2.04 FACTORY FINISHING

A. General:

1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
3. Material in contact with potable water shall conform to NSF 61.
4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”

B. Where epoxy lining and coating are specified, factory finishing shall be as follows:

1. In accordance with AWWA C550.
2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.05 VALVES

A. Gate Valves:

1. General:
   a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
      1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
      2) Mark AWWA gate valves with manufacturer’s name or mark, year of valve casting, valve size, and working water pressure.
      3) Repaired AWWA gate valves shall not be submitted or supplied.
      4) Supply AWWA gate valves with stainless steel bolting.
      5) AWWA C509 and AWWA C515 valves may be substituted for each other.
2. Type V100 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, single solid wedge gate, nonrising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Figure 438, NPT threaded ends.

2) Stockham; Figure B103, NPT threaded ends.
3) Crane; Figure 1324, soldered ends.
4) Stockham; Figure B104, soldered ends.

3. Type V101 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, single solid wedge gate, rising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Crane; Figure 428, NPT threaded ends.
      2) Stockham; Figure B-100, NPT threaded ends.
      3) Crane; Figure 1334, soldered ends.
      4) Stockham; Figure B-108, soldered ends.
4. Type V102 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, nonrising stem, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Figure 437.
      2) Stockham; Figure B-128.
5. Type V103 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, rising stem, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Crane; Figure 431.
      2) Stockham; Figure B122.
6. Type V104 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, nonrising stem, stainless steel seat rings, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Figure 426.
      2) Stockham; Figure B-140.
7. Type V105 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, rising stem, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Crane; Figure 424.
      2) Stockham; Figure B-132.
8. Type V106 Gate Valve 2 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, nonrising stem, stainless steel seat rings, Class 300

rated 300 psi SWP/1,000 psi CWP, complies with MSS SP-80 Type 1.

b. Manufacturers and Products:
   1) Crane; Figure 636E.
   2) Stockham; Figure B-147.

9. Type V107 Gate Valve 2 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, rising stem, stainless steel seat rings, Class 300 rated 300 psi SWP/1,000 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Crane; Figure 634E.
      2) Stockham; Figure B-145.
10. Type V108 Gate Valve 2 Inches to 24 Inches:
   a. Iron body, bronze mounted, flanged ends, solid wedge gate, nonrising bronze stem, Class 125 rated 125 psi SWP, 200 psi CWP for 2 inches through 12 inches and 100 psi SWP, 150 psi CWP for 14 inches through 24 inches.
   b. Manufacturers and Products:
      1) Crane; Figure 461.
      2) Stockham; Figure G612.
11. Type V110 Gate Valve 2 Inches to 24 Inches:
   a. Iron body, bronze mounted, flanged ends, solid wedge gate, outside screw and yoke, Class 125 rated 125 psi SWP, 200 psi CWP for 2 inches through 12 inches and 100 psi SWP, 150 psi CWP for 14 inches through 24 inches.
   b. Manufacturers and Products:
      1) Crane; Figure 465-1/2.
      2) Stockham; Figure G623.
12. Type V120 Gate Valve 3 Inches to 48 Inches for Water Service:
   a. AWWA C500, iron body, bronze mounted, flanged ends, double-disc gate, nonrising bronze stem, working water pressure 200 psi for 3 inches through 12 inches and 150 psi for 14 inches through 48 inches.
   b. Manufacturers and Products:
      1) M&H Valve Company; Style 67.
      2) Clow Valve Company; AWWA C500.
13. Type V122 Gate Valve 3 Inches to 48 Inches for Buried Water Service:
   a. AWWA C500, iron body, bronze mounted, mechanical joint ends, double-disc gate, nonrising bronze stem, 2-inch operating nut, and O-ring sealed stuffing box, working water pressure of 200 psi for 3 inches through 12 inches and 150 psi for 14 inches through 48 inches.

b. Manufacturers and Products:
   1) M&H Valve Company; Style 67.
   2) Clow Valve Company; AWWA C500.

14. Type V124 Gate Valve 16 Inches and Larger for Low Pressure Water Service:
    a. Iron body, bronze mounted, flanged ends, double disc gate, nonrising bronze stem, rated for 50 psi, working water pressure, 125 psi ASME B16.1 drilling.
    b. Manufacturer and Product: Ludlow-Rensselaer Valve Division of Patterson Industries, Inc.; List 11.
15. Type V132 Resilient Seated Gate Valve 3 Inches to 12 Inches, for Buried Service:
    a. Iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, nonrising stem, in accordance with AWWA C509, 2-inch operating nut, minimum design working water pressure 200 psig, full port, fusion epoxy coated inside and outside per AWWA C550.
    b. Manufacturers and Products:
       1) M&H Valve; AWWA C509.
       2) U.S. Pipe; A-USPO.
16. Type V134 Resilient Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
    a. Ductile iron body, resilient seat, bronze stem and stem nut, ASME B16.1 Class 125 flanged ends, nonrising stem or outside screw and yoke, in accordance with AWWA C515, minimum design working water pressure 200 psig, full port, fusion epoxy coated inside and outside per AWWA C550, NSF 61 certified.
    b. Manufacturers and Products:
       1) American Flow Control; Series 2500.
       2) M&H; Style 7000 and C515 Large RW Valves.
17. Type V137 Resilient Seated Gate Valve 4 Inches to 12 Inches:
    a. UL Listed and FM Approved for fire protection, iron body, resilient seat, bronze mounted, ASME B16.1 Class 125 flanged ends, nonrising stem, 2-inch operating nut, in accordance with AWWA C509, design working water pressure 200 psig, full port, fusion-epoxy coated inside and outside per AWWA C550, NSF 61 certified , indicator post flange and indicator post assembly with lockable handle.
    b. Manufacturers and Products:
       1) Kennedy Valve; Ken-Seal II.
       2) M&H Valve; Style 4067.
       3) Mueller; P-2360.

18. Type V142 Gate Valve 3 Inches to 12 Inches:
    a. UL Listed, iron body, bronze-mounted, designed for fire protection service, rising stem, outside screw and yoke, ASME B16.1 flanged ends, rated 175 pound WOG.
    b. Double disc type gate, bronze wedge pins, parallel seat, gate stem in bronze bushing through stuffing box.
19. Type V144 Indicator Post Valve 3 Inches to 14 Inches:
    a. UL Listed, iron body, bronze mounted, nonrising stem, rated 175 pound WOG, AWWA C111/A21.11 mechanical joint ends.
    b. Double disc type gate, bronze wedge pins, parallel seat, gate stem sealed with double O-ring pressure and dirt seal.
    c. Bolted flanged bonnet for mounting indicator post, indicator post to be locking type with an adjustable barrel and weather-sealed indicator window to display OPEN and SHUT positions.
    d. Manufacturers:
        1) Mueller.
        2) Nibco.
        3) United Water Products.
20. Type 156 Gate Valve 3 Inches and Smaller:
    a. PVC body and stem, single solid wedge gate, nonrising stem, Viton O-rings. Union bonnet style.
    b. Manufacturers and Products:
        1) Spears; NPT threaded ends for 2 inch diameter and smaller.
        2) Spears; flanged ends for 3 inch diameter.
21. Type 157 Gate Valve 4 and 6 Inches:
    a. Stainless steel body and stem, bolted bonnet, integral seat flexible wedge disc, rising stem, Viton seal.
    b. Manufacturer and Product: Aloyco; flanged ends.

B. Globe Valves:

1. Type V200 Globe Valve 3 Inches and Smaller:
    a. All-bronze, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.
    b. Manufacturers and Products:
        1) Stockham; Figure B-22T, NPT threaded end.
        2) Crane Co.; Figure 7TF, NPT threaded end.
        3) Milwaukee; Model 1590T, soldered ends.
        4) NIBCO; Figure S-235-Y, soldered ends.

2. Type V201 Angle Pattern Valve 2 Inches and Smaller:
   a. All-bronze, NPT threaded ends, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Stockham; Figure B-222T.
      2) Crane Co.; Figure 17TF.
3. Type V202 Globe Valve 3 Inches and Smaller:
   a. All-bronze, union bonnet, packed gland, inside screw, rising stem, replaceable stainless steel tapered plug type disc and seat ring, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80 Type 3.
   b. Manufacturers and Products:
      1) Stockham; Figure B-62, NPT threaded end.
      2) Crane Co.; Figure 212P, NPT threaded end.
4. Type V204 Globe Valve 2 Inches and Smaller:
   a. All-bronze, NPT threaded ends, union bonnet, packed gland, inside screw, rising stem, replaceable stainless steel tapered plug type disc and seat ring, Class 300 rated 300 psi SWP/1,000 psi CWP, complies with MSS SP-80 Type 3.
   b. Manufacturers and Products:
      1) Crane; Figure 382P.
      2) Stockham; Figure B-74.
5. Type V205 Angle Pattern Valve 2 Inches and Smaller:
   a. All-bronze, NPT threaded ends, union bonnet, packed gland, inside screw, rising stem, replaceable stainless steel tapered plug type disc and seat ring, Class 300 rated 300 psi SWP/1,000 psi CWP, complies with MSS SP-80 Type 3.
   b. Manufacturers and Products:
      1) Stockham; Figure B-274.
      2) Crane; Figure 384P.
6. Type V208 Needle Disc Type Globe Valve 1/8 Inch to 3/4 Inch:
   a. All-bronze, threaded bonnet, packed gland, rising stem, bronze body and stem, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80.
   b. Manufacturers and Products:
      1) Crane Cat.; No. 88.
      2) Stockham; B-64.
7. Type V209 Needle Disc Type Globe Valve 1/8 Inch to 3/4 Inch:
   a. All-bronze, threaded bonnet, packed gland, rising stem, bronze body and stem, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80.

b. Manufacturers and Products:
   1) Crane Cat.; No. 89.
   2) Stockham; B-264.

8. Type V210 Globe Valve 2 Inches to 10 Inches:
   a. Iron body, bronze mounted, flanged ends, bronze seat, outside screw and yoke, bolted bonnet, Class 125 rated 125 psi SWP/200 psi CWP, complies with MSS SP-85 Type 1.
   b. Manufacturers and Products:
      1) Stockham; G-512.
      2) Crane; Figure 351.
9. Type V234 Angle Type Hose Valve 1/2 Inch to 3/4 Inch:
   a. Bronze or manufacturer's standard brass, angle sillcock type body, threaded or solder inlet as applicable, pressure rating 125 psi cold water.
   b. Manufacturer and Product: Nibco; QTX Series.
10. Type V235 Angle Type Hose Valve 3/4 Inch:
   a. 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmospheric vacuum breaker conforming to ASSE 1011 and IAPMO code.
   b. Manufacturers and Products:
      1) Acorn; 8126, surface pipe mount valve, bent nose without flange.
      2) Acorn; 8121, surface mount through wall valve, bent nose with flange.
      3) Acorn; 8131, pipe and pedestal mounted valve located above 6 inches, straightnose.
      4) Acorn; 8136, pedestal mounted valve located lower than 6 inches, inverted nose.
11. Type V236 Globe Style Hose Valve 1 Inch to 3 Inches:
   a. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, cast brass male NPT by male NHT adapter with hexagonal center wrench nut, brass cap with chain, complies with MSS SP-80, rated 300 WOG.
   b. Manufacturers and Products:
      1) Stockham; Figure B-22T.
      2) Crane Co.; Cat. No. 7TF.
      3) Nibco; Figure T-235-Y.
12. Type V237 Angle Pattern Hose Valve 1 Inch to 2 Inches:
   a. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, cast brass male NPT by male NHT adapter with hexagonal center wrench nut, complies with MSS SP-80, rated 300 WOG.

b. Manufacturers and Products:
1) Stockham; Figure B-222T.
2) Crane Co.; Cat. No. 17TF.
3) Nibco; Figure T-335-Y.

13. Type V238 Globe Valve 3 Inches:
a. PVC body, outside stem and yoke design, Teflon seal. PVC shall conform to ASTM D1784 Cell Classification 12454-A.
b. Manufacturer and Product: Asahi, flanged end.

14. Type V239 Globe Valve 1 and 2 Inches:
a. PVC body, union bonnet design, Teflon seal. PVC shall conform to ASTM D1784 Cell Classification 12454-A.
b. Manufacturer and Product: Asahi, threaded end.

15. Type V240 Globe Valve 2 and 6 Inches:
a. Stainless steel body, bolted bonnet design, Viton seal. Stainless steel shall be CF8M.
b. Manufacturers and Products:
1) 2 Inch: Aloyco, threaded end.
2) 6 Inch: Aloyco, flanged end.

C. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
b. Manufacturers and Products:
1) Threaded:
a) Conbraco Apollo; 70-100.
b) Nibco; T-580-70.
2) Soldered:
a) Conbraco Apollo; 70-200.
b) Nibco; S-580-70.

2. Type V301 Ball Valve 2 Inches and Smaller for General Water and Air Service:
a. Two-piece, full port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.

b. Manufacturers and Products:
   1) Threaded:
      a) Conbraco Apollo; 77-100.
      b) Nibco; T-585-70.
   2) Soldered:
      a) Conbraco Apollo; 77-200.
      b) Nibco; S-585-70.

3. Type V302 Actuator Ready Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, actuator mounting pad, Type 316 stainless steel ball and stem, vented ball, reinforced PTFE seats and seals, adjustable packing nut, blowout-proof stem, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 71-140.
      2) Milwaukee; 20BSOR-02.
4. Type V303 Ball Valve 2 Inches and Smaller for Equipment Air System Shutoff:
   a. Two-piece, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, 125 psig rated, safety exhaust port to exhaust downstream side when valve is in closed position, zinc-coated steel locking handle with vinyl grip.
   b. Meets OSHA Regulation 29 CFR Part 1910.147 requirements.
   c. Manufacturers and Products:
      1) Conbraco Apollo; 75-100-41.
      2) Nibco; T-580-70-SV/T-585-70-SV.
5. Type V304 Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Three-piece, full port, NPT threaded ends, bronze body and end pieces, hard chrome plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150 psi SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Threaded Ends:
         a) Conbraco Apollo; 82-100.
         b) Nibco; T-595-Y.
         c) Stockham; T-395 Series.
      2) Solder Ends:
         a) Conbraco Apollo; 82-200.
         b) Nibco; S-595-Y.

c) Stockham; S-395 Series.

6. Type V306 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Two-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end piece, NPT threaded ends, ASTM A276 Type 316 stainless steel ball, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 1,000 psig CWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76F-100 Series.
      2) Nibco; T-585-S6-R-66-LL.
7. Type V307 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, NPT threaded ends, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 800 psig to 1,000 psig CWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 86R-100/86-500 Series.
      2) Nibco; T-595-S6-R-66-LL.
8. Type V308 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Two-piece, standard port, NPT threaded ends, ASTM A351/A351M GR CF8M stainless steel body and end pieces, actuator mounting pad, Type 316 stainless steel ball and stem, vented ball, reinforced PTFE seats and seals, adjustable packing nut, blowout-proof stem, rated 1,500 psig WOG minimum, 150 psi SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76-100.
      2) Nibco; T-580-S6-R-66-LL.
      3) Milwaukee; 20SSOR-02.
9. Type V309 Instrument Air Shutoff Valve 1/8 Inch to 3/4 Inch:
   a. Stainless steel body ball valve, nylon handle, tube fitting ends, PTFE seats and seals, panel nut, rated 1,500 psi minimum.
   b. Manufacturers and Products:
      1) Swagelok; 40 Series.
      2) Parker Hannifin; B Series.
10. Type V330 PVC Ball Valve 2 Inches and Smaller:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.

b. Manufacturers and Products:
   1) Nibco; Chemtrol Tru-Bloc.
   2) ASAHI/America; Type 21.
   3) Spears; True Union.

11. Type V331 PVC Ball Valve 3 Inches and 4 Inches:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.
12. Type V335 CPVC Ball Valve 2 Inches and Smaller:
   a. Rated 150 psi at 100 degrees F, 80 psi at 140 degrees, with ASTM D1784, Type IV, Grade 1 chlorinated polyvinyl chloride (CPVC) body, ball, and stem, end entry, double union design, with solvent-weld socket ends or single union ball with flanged ends drilled to ASME B16.1, replaceable Teflon seat, Viton or Teflon O-ring stem seals, to block flow in both directions.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.
      3) Spears; True Union.
13. Type V340 Ball Valve 1/2 to 2 Inches for General Water and Air Service:
   a. True union, full port, NPT threaded ends, PVC body and ball, Viton O-ring seal and socket.
   b. Manufacturer and Product: Spears, threaded ends.
14. Type V341 Ball Valve 1/4 Inch for General Water and Air Service:
   a. One-piece, full port, NPT threaded ends, PVC body and ball, Viton O-ring seal and socket,
   b. Manufacturer and Product: Spears, threaded ends.
15. Type V342 Ball Valve 3 Inches for General Water and Air Service:
   a. True union, full port, flanged ends, PVC body and ball, Viton O-ring seal and socket,
   b. Manufacturer and Product: Spears, flanged ends.
16. Type V343 Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Three-piece, full port, NPT threaded ends, blowout proof stem design, adjustable packing gland, stainless steel body and end pieces, lever and nut, Teflon seats, MSS SP-110 compliant.
   b. Manufacturer and Product: Apollo, Threaded Ends.

17. Type V344 Electrically Actuated Stainless Steel Ball Valve 2 Inches and Smaller:
    a. Stainless steel body, ball and stem, Viton O-ring stem and seals.
    b. Manufacturer: Triac.
18. Type V345 Solenoid Ball Valve 2 Inches or Smaller:
    a. Stainless steel body, ball and stem, Viton or Teflon disc, O-ring stem and seals.
    b. Manufacturer and Product: ASCO; HT8210G015E.

D. Plug Valves:

1. Type V462 Gauge Cock 1/8 Inch to 1/4 Inch:
    a. 1/4-inch bronze body, hexagon end pattern, tee head, male ends, rated 125-pound SWP.
    b. Manufacturer and Product: United Brass Works; Figure 973.
2. Type V464 Corporation Stop 1/2 Inch to 2 Inches:
    a. AWWA C800 type, tapered threaded inlet, except when connecting to tapped fittings which require IPS tapered threads, outlet compression connection or IPS threads to suit connecting pipe, stops 1 inch and smaller rated 100 psi, larger stops rated 80 psi.
    b. Manufacturers:
        1) Ford Meter Box Co.
        2) Mueller Co.

E. Butterfly Valves:

1. General:
    a. In full compliance with AWWA C504 and following requirements:
        1) Suitable for throttling operations and infrequent operation after periods of inactivity.
        2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
        3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
        4) No travel stops for disc on interior of body.
        5) Self-adjusting V-type or O-ring shaft seals.
        6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
        7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
        8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.

9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
10) Valves to be in full compliance with NSF 61. Provide NSF 61 certificate for each valve in potable water service.

b. Non-AWWA butterfly valves to meet the following actuator requirements:
1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.

2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
a. AWWA C504, Class 150B.
b. Short body type, flanged ends.
c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N rubber seat bonded or molded in body only, and stainless steel seating surface.
d. Manufacturers and Products:
1) Pratt; Model 2FII or Triton XR-70.
2) DeZurik; AWWA Valve.

3. Type V502 Butterfly Valve General Service 3 Inches to 20 Inches:
a. AWWA C504, Class 150B.
b. Wafer style type.
c. Buna-N rubber seat.

4. Type V504 Butterfly Valve General Service 4 Inches to 48 Inches:
a. AWWA C504, Class 150B.
b. Mechanical joint end type.
c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N rubber seat bonded or molded in body only, and stainless steel seating surface.
d. Manufacturers and Products:
1) Pratt; Groundhog.
2) DeZurik; Buried AWWA Valve.

5. Type V506 Butterfly Valve High Pressure Service 4 Inches to 48 Inches:
a. AWWA C504, Class 250B.
b. Short body type, Class 250 flanged ends.
c. Cast or ductile iron body, cast or ductile iron disc with Type 316 stainless steel disc edge, ASTM A564/A564M Type 630 Condition H-1100/1150 or Type 316 stainless steel shaft, Buna-N rubber seat bonded or molded in body only, self-adjusting V-type multi-ring seals.
d. Manufacturers and Products:
1) Pratt; Triton HP-250.

2) DeZurik; AWWA Flanged Class 250.
3) Mueller; Lineseal XP Class 250.

6. Type V513 Butterfly Valve 2 Inches to 20 Inches:
   a. Lug style, cast-iron or ductile iron body, aluminum bronze or ductile iron disc, Type 316 or Type 18-8 stainless steel one-piece stem, Buna-N replaceable resilient seat, heavy-duty self-lubricating sleeve type bushings, NBR stem seal, 150 psi working pressure rating, valve body to fit between ASME B16.1 Class 125/150 flanges.
   b. Manufacturers and Products:
      1) Bray Controls; Series 30/31.
      2) Tyco/Keystone; Model AR1/AR2.
      3) Crane/Centerline; Series 200.
7. Type V514 High Performance Butterfly Valve 2 Inches to 36 Inches:
   a. ASME B16.1 Class 150 lug style, high performance type, body as specified, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, Buna-N seat, PTFE stem packing, stainless steel with RTFE thrust washer.
   b. Manufacturers and Products:
      1) Tyco/Keystone; K-Lok Series.
      2) DeZurik; BHP Series.
8. Type V520 Solid Polyvinyl Chloride Butterfly Valve 1-1/2 Inches to 8 Inches:
   a. Wafer body type, pressure rated 150 psi at 70 degrees F CWP, solid ASTM D1784, Type I, Grade 1, PVC body and contoured PVC or polypropylene valve disc, stainless steel valve stem, Viton seat, lever operator.
   b. Manufacturers and Products:
      1) ASAHI/America; Type 57.
      2) Spears.
9. Type 521 CPVC Butterfly Valve 1-1/2 Inches to 12 Inches:
   a. Lug Body Type; pressure rated 150 psi at 73 degrees F CWP; solid D1784 (CPVC cell classification 23447); Type 1; CPVC body and disc; Type 316 stainless steel stem; Buna-N or FKM seats; lever or gear operator
   b. Manufacturers and Products:
      1) Spears.
      2) Georg Fischer; Type 567.
10. Type V530 Butterfly Valve 4 Inches to 20 Inches for Fire Protection Service:
   a. UL Listed and FM Approved, flanged style, AWWA C504 Class 150B valve with cast-iron body, aluminum-bronze disc, stainless steel stem, EPDM seat, geared operator with highly visible position indicator and detachable crank handle.

b. For buried service, provide post indicating assembly with detachable crank handle.
c. Manufacturer and Product: Pratt; IBV PIVA.

11. Type V540 Butterfly Valve General Service 4 Inches:
    a. A351 CF8M Stainless Steel.
    b. Resilient seated, lug type.
    c. Stainless steel body, disc and shaft, Viton seat bonded or molded in body only, and stainless steel seating surface.
    d. Manufacturer: Bray.
12. Type V541 Electrically Actuated Stainless Steel Butterfly Valve 2 and 3 Inches:
    a. Stainless steel body, ball and stem, Viton O-ring stem and seals.
    b. Manufacturer: Triac.

F. Check and Flap Valves:

1. Type V600 Check Valve 2 Inches and Smaller:
    a. All bronze, threaded cap, threaded or soldered ends, swing type replaceable bronze disc, rated 125-pound SWP, 200-pound WOG.
    b. Manufacturers and Products:
        1) Stockham; Figure B-319, threaded ends.
        2) Milwaukee; Figure 509, threaded ends.
        3) Stockham; Figure B-309, soldered ends.
        4) Milwaukee; Figure 1509, soldered ends.
2. Type V602 Check Valve 2 Inches and Smaller:
    a. All bronze, threaded cap, threaded ends, swing type replaceable Teflon disc and bronze disc holder, rated 150-pound SWP, 300-pound WOG.
    b. Manufacturers and Products:
        1) Walworth; Figure 3412.
        2) Milwaukee; Figure 510.
3. Type V604 Check Valve 2-1/2 Inches to 12 Inches:
    a. Flanged end, cast-iron body, bronze mounted swing type, solid bronze or cast-iron disc, bronze seat ring, rated 125-pound SWG, 200-pound WOG.
    b. Manufacturers and Products:
        1) Stockham G-931; List 37, Clearway check valve.
        2) Crane Co.; Cat. No. 373.
4. Type V606 Check Valve 2 Inches to 12 Inches:
    a. Flanged end, cast-iron body, bronze mounted swing type, solid bronze or cast-iron disc, bronze seat ring, outside lever and weight, rated 125-pound SWP, 200-pound WOG.

b. Manufacturers and Products:
   1) Stockham; G-931.
   2) Crane Co.; Cat. No. 383.

5. Type V608 Swing Check Valve 2 Inches to 24 Inches:
   a. AWWA C508, 125-pound flanged ends, cast-iron body, bronze body seat, bronze mounted cast-iron clapper with bronze seat and rubber facing, stainless steel hinge shaft.
   b. Valves, 2 inches through 12 inches rated 175-pound WWP . Valves to be plain fitted. Increasing-pattern body valve may be used where increased outlet piping size is shown.
   c. Manufacturers and Products:
      1) M&H Valve; Style 59, 159, or 259.
      2) Mueller Co.; No. A-2600 Series.
6. Type V610 Swing Check Valve 2-1/2 Inches to 12 Inches for Fire Protection Service:
   a. UL Listed, FM Approved, iron body, bronze-mounted, rated 175 pounds WOG, self-adjusting bronze disc, ends ASME B16.1 flanged, with a 1-inch NPT tapped and plugged boss.
   b. Manufacturers and Products:
      1) Kennedy; Figure 126.
      2) Mueller; A-2120-6.
7. Type V612 Double Disc Swing Check Valve 2 Inches to 48 Inches:
   a. Wafer style, spring loaded, cast-iron body, aluminum-bronze or ductile iron discs, Buna-N resilient seats, and Type 316 stainless steel spring, hinge pin, and stop pin.
   b. Valves 2 inches through 12 inches rated 200 psi nonshock working pressure.
   c. Manufacturers and Products:
      1) APCO; Series 9000.
      2) Val-Matic; Dual Disc.
      3) Crane/Stockham; WG-970.
      4) Tyco; Gulf MB Series.
8. Type V614 Slanting Disc Check Valve 2 Inches to 60 Inches:
   a. Slanting or tilting disc design, off-center pivot, body ductile iron two-piece design, bronze seat on 55 degree angle, disc bronze or ductile iron, pivot pin and bushing Type 304 stainless steel, Class 125, 150 psi rating, Class 125 flange drilling, valve disc position indicator.
   b. Manufacturers and Products:
      1) APCO; Series 800.
      2) Val-Matic; Series 9800.
9. Type V615 Slanting Disc Check Valve 2 Inches to 60 Inches:
   a. Slanting or tilting disc design, off-center pivot, body ductile iron two-piece design, bronze seat on 55 degree angle, disc bronze or ductile

iron, pivot pin and bushing Type 304 stainless steel, Class 250, 300 psi rating, Class 250 flange drilling, flat face.

b. Manufacturers and Products:
   1) APCO; Series 800.
   2) Val-Matic; Series 9700.

10. Type V616 Slanting Disc Check Valve 2 Inches to 36 Inches:
    a. Off-center pivoting disc design, wafer style, cast-iron body, ductile iron discs, Type 316 stainless steel pivot pin, spring pin, and bushing, Buna-N disc seal, Type 316 stainless steel or Monel spring, Class 125.
    b. Manufacturer and Product: Daniel Flow Products; Chexter 1600 Series, Type D.
11. Type V617 Wafer Style Check Valve 2 Inches to 36 Inches:
    a. Wafer style, swing check, one-piece body design, full resilient seal in machined body groove. Cast-iron body, ASME B16.1 Class 125 or 150 rating, Type 316 stainless steel disc, Type 316 stainless steel spring and other internals, Buna-N seal.
    b. Manufacturers and Products:
       1) Tyco; Prince Figure 800 Series.
       2) Crane; Uni-Chek II.
12. Type V620 Silent Check Valve 2 Inches to 10 Inches:
    a. Wafer style, iron body, center guided valve, bronze trim, Buna-N seat, stainless steel springs, rated 150-pound WOG.
    b. Manufacturers and Products:
       1) Mueller; Steam Specialty 91AP.
       2) APCO; Series 300.
13. Type V622 Silent Check Valve 3 Inches to 24 Inches:
    a. Globe style, center guided, 125-pound flanges, cast-iron body, bronze trim, Buna-N seat, stainless steel spring. Valves to be FM Approved in sizes up to and including 12 inches.
    b. Manufacturers and Products:
       1) APCO; Series 600.
       2) Val-Matic; 1800 Series.
       3) Cla-Val; Series 581.
14. Type V624 Silent Check Valve 4 Inches to 12 Inches for Fire Protection Service:
    a. UL Listed or FM Approved, center-guided wafer style valve, iron body, bronze trim, stainless steel spring, rated 175-pound nonshock, CWP.
    b. Manufacturers and Products:
       1) Mueller; Steam Specialty.
       2) APCO.

15. Type V630 PVC Ball Check Valve 4 Inches and Smaller:
    a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 150 psi at 73 degrees F, and Viton seat and seal.
    b. Manufacturers and Products:
        1) Nibco; Chemtrol Tru Union.
        2) ASAHI/America.
        3) Spears; True Union.
16. Type V631 CPVC Ball Check Valve 4 Inches and Smaller:
    a. ASTM D1784 Cell Class 23477B CPVC body, single or dual union socket weld ends, rated 150 psi at 73 degrees F, 110 psi at 140 degrees F, Viton seat and seal.
    b. Manufacturers and Products:
        1) Nibco; Chemtrol Tru Union.
        2) ASAHI/America.
        3) Spears; True Union.
17. Type V634 Rubber Flapper Check Valve 2 Inches to 24 Inches:
    a. Iron body, ASME B16.1, Class 125 flanges, steel-reinforced Buna-N flapper raised seating ring, rated 150-pound CWP.
    b. Manufacturers and Products:
        1) APCO; Series 100.
        2) Val-Matic; “Swingflex.”
18. Type V640 Double Check Valve Backflow Prevention Assembly 3/4 Inch to 10 Inches:
    a. Two resilient seated check valves, two outside screw and yoke resilient-seated isolation valves, test cocks, in accordance with AWWA C510, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
    b. Manufacturers and Products:
        1) FEBCO; Model 8540.
        2) Danfoss Flomatic; Model DCVE/DCV.
        3) Watts; Series 007/709.
19. Type V642 Reduced-Pressure Principle Backflow Prevention Assembly 3/4 Inch to 10 Inches:
    a. Two resilient seated check valves with an independent relief valve between the valves, two outside screw and yoke resilient-seated isolation valves, test cocks, in accordance with AWWA C511, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
    b. Manufacturers and Products:
        1) FEBCO; Model 860.
        2) Danfoss Flomatic; Model RPZE/RPZ.

3) Watts; Series 009/909.

20. Type V654 Check Valve 2 Inches and Smaller for Heating, Chilled, and Cooling Service:
    a. All-bronze type silent check valve, screwed ends, rated 200-pound WOG.
    b. Manufacturers and Products:
        1) Mueller; Steam Specialty No. 203-BP.
        2) Metraflex.
21. Type V690 Flap Gate 6 Inches to 96 Inches:
    a. Cast-iron body and cover, bronze-mounted, flanged frame type, dual pivot-point hinge arms, hinge arms bronze, hinge pins Type 304 stainless steel, seat bronze and impacted into grooves in body and cover flap, lubrication fittings for each pivot, upper and lower pivot adjustment.
    b. Manufacturers and Products:
        1) Rodney Hunt Co.; Series FV-AC or FV-AR.
        2) Hydro Gate; Model 50C or 50.
22. Type V692 Flap Valve 4 Inches to 30 Inches:
    a. Flange style frame, cast-iron body, bronze seats on body and cover, bronze hinge pins.
    b. Manufacturers and Products:
        1) M&H Valve; Style 47-02.
        2) Clow Valve; No. F-3012.
23. Type V694 Check Valve 1 Inch to 48 Inches: Elastomer type flanged or slip-on as shown on Drawings, round entry area to match pipe, contoured duckbilled shaped exit, flat bottom and off-set bill design, curved bill for 18 inches and larger, valve open with approximately 2 inches of line pressure and return to CLOSED position under zero flow condition, rated for 50 psi minimum operating pressure; flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced Buna-N.
24. Type V1692 CPVC Check Valve 3 Inches to 12 Inches:
    a. Wafer body type, pressure rated 90 psi at 130 degrees F CWP, solid ASTM D1784, Type 1, Grade 1, CPVC body and CPVC valve disc, stainless steel valve stem, Viton seat, flanged ends to fit between Class 150 RF flanges.
    b. Manufacturer: Cameron.
25. Type V720 PVC Pressure Relief, By-Pass Relief, Back-Pressure Regulator, Back-Pressure, Anti-Siphon Valve 1/2 Inch to 2 Inches:
    a. Direct acting diaphragm, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.

b. PVC body, Teflon or Viton diaphragm, PVC or Teflon piston, high-density polyethylene or stainless steel adjusting bolt and locknut, stainless steel or coated steel spring, stainless steel fasteners.
c. Designed to open when upstream pressure reaches setpoint; set pressure adjustable from 10 psi to 100 psi, minimum.
d. Manufacturers and Products:
1) Plast-O-Matic; Series RVDT.
2) Griffco; Series BPV.
3) Primary Fluid Systems; TOP Valve.

26. Type V722 PVC Pressure Regulating Valve, 1/2 Inch to 1-1/2 Inches:
a. Diaphragm operated assembly, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
b. PVC body, Viton seals and diaphragm, coated stainless steel spring, stainless steel adjusting bolt, locknut, and fasteners.
c. Designed to regulate downstream pressure closing when pressure reaches setpoint; set pressure adjustable from 5 psi to 50 psi.
d. Manufacturers and Products:
1) Plast-O-Matic, Series PR.
2) Hayward; Pressure Regulator.

27. Type V725 Automatic Degassing Valve, 1/2 Inch to 3/4 Inch:
a. PVC or CPVC construction with Viton seals, NPT threaded inlet and outlet, float designed to automatically vent gases, 150 psi design pressure.
b. Manufacturers and Products:
1) Plast-O-Matic; Series DGV.
2) Primary Fluid Systems, Inc.; Accu-Vent.

28. Type V780 Check Valve 3 Inches:
a. Swing check style.
b. PVC body and swing arm, Viton seals.
c. PVC conforms to Type I, ASTM D1784 Cell Classification 12454.
d. Manufacturer: Spears, flanged ends.

29. Type V781 Check Valve 2 Inches:
a. Y-pattern style.
b. PVC body and spring, Viton seals.
c. Manufacturer: Hayward, threaded ends.

30. Type V782 Check Valve 4 and 6 Inches:
a. Swing check style.
b. Stainless steel conforms to ASTM A351 CF3M.
c. Stainless steel body and swing arm, Viton seals.
d. Manufacturer: Aloyco, flanged ends.

31. Type V783 Check Valve 3/4, 1 and 1-1/2 Inches:
a. Y-pattern, low pressure style.
b. Stainless steel body and spring, Viton seals.

c. Manufacturer: Check-all, threaded ends.

32. Type V784 Check Valve 1-1/2 and 2 Inches:
    a. Y-pattern style.
    b. Stainless steel conforms to ASTM A351 CF3M.
    c. Stainless steel body and spring, Teflon seals.
    d. Manufacturer: Flomatic, threaded ends.
33. Type V785 PVC Pressure Relief, Valve 1-1/2 Inch and 2 Inches:
    a. Stainless steel body, Viton diaphragm.
    b. Design pressure TBD.
    c. Manufacturer: Kunkle, threaded connection.

G. Miscellaneous Valves:

1. Type V900 Diaphragm Valve 1/2 Inch to 12 Inches:
    a. Weir type, polypropylene-lined cast-iron body, ASME B16.1 flanged ends, manual operator indicating, rising stem type with handwheel, diaphragm in accordance with MSS SP-88 Category B.
    b. Manufacturers:
        1) ITT Engineered Valves.
        2) Saunders Valve, Inc.
2. Type V901 Diaphragm Valve 1/2 Inch to 12 Inches:
    a. Straight-through type, polypropylene-lined cast-iron body, ASME B16.1 flanged ends, manual operator indicating, rising stem type with handwheel, diaphragm in accordance with MSS SP-88, Category B.
    b. Manufacturers:
        1) ITT Engineered Valves.
        2) Saunders Valve, Inc.
3. Type V903 Diaphragm Valve, 1/2 Inch to 4 Inches:
    a. Weir type with PVC Type 1, Grade 1 or CPVC Type 4, Grade 1 as shown body, Viton (FKM) diaphragm double union design, handwheel operator, position indicator, adjustable travel stop, clear molded acrylic stem cap.
    b. Manufacturers and Products:
        1) ASAHI/AMERICA; Diaphragm Valve Type 14.
        2) ITT Engineered Valves; Dia-Flo.
        3) Saunders Valve; Diaphragm Valve.
4. Type V905 Pinch Valve 1 Inch to 12 Inches:
    a. Cast-iron fully enclosed body, epoxy lined and coated, ASME B16.1 Class 125 flanged ends, one-piece molded Buna-N elastomer tube, full-port design, 90 psi minimum working pressure, double-acting upper and lower pinch bars that close on centerline, stainless steel

stem, handwheel operator, position indicator, geared operator for valves 6 inches and larger.

b. Manufacturers and Products:
   1) Red Valve Co.; Series 75.
   2) RF Technologies, Inc.; RF Valve.

5. Type V925 Sampling Valve:
   a. Type 316 stainless steel wetted parts, hand operated iron crank, piston to extend to inner surface of vessel or pipe, sealed by two compressible replaceable Teflon rings, one above discharge port and other below discharge port, 3/4-inch NPT inlet and 3/4-inch NPT outlet.
   b. Manufacturers and Products:
      1) Strahman Valves, Inc.; Piston Type Sampling Valve.
      2) Fetterolf Corporation; Rod-Seal Sampling Valve.
6. Type V940 Solenoid Valve 1/4 Inch to 2 Inches:
   a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (OPEN or CLOSED when de-energized as indicated.
   b. Minimum operating pressure differential no greater than 5 psig, maximum operating pressure differential not less than 125 psig.
   c. Manufacturers:
      1) ASCO.
      2) Skinner.
7. Type V941 Solenoid Valve 1/4 Inch to 2 Inches:
   a. Four-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (OPEN or CLOSED when de-energized as indicated).
   b. Minimum operating pressure differential no greater than 5 psig, maximum operating pressure differential not less than 125 psig.
   c. Manufacturers:
      1) Numatics Series 2005.
      2) SNC Pneumatics.
8. Type V960 Diaphragm Valve 1-1/2 Inch:
   a. Weir type, polypropylene-lined cast-iron body, ASME B16.1 flanged ends, manual operator indicating, rising stem type with handwheel, diaphragm in accordance with MSS SP-88 Category B.
   b. Manufacturer: Saunders Valve, Inc.

9. Type V961 Float Valve:
   a. Stainless steel body and rod.
   b. Manufacturer: Gadren Machine Company.
10. Type V962 Air Relief Valve:
   a. Stainless steel body, Viton seal.
   b. Manufacturer: Flomatic.
11. Type V963 Foot Valve 1-1/2 Inches:
   a. Bronze body, Stainless Steel screen.
   b. Manufacturer: Flomatic.
12. Type V964 V-Smart Down Hole Control Valve 4 Inches:
   a. Stainless steel body.
   b. Manufacturer: ASR, flanged ends.

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
   a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
   b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
   c. Operator self-locking type or equipped with self-locking device.
   d. Position indicator on quarter-turn valves.
   e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator’s threaded steel reach rod with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
   a. Galvanized and painted handwheel.
   b. Cranks on gear type operator.
   c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
   d. Valve handles to take a padlock, and wheels a chain and padlock.
3. Buried Operator:
   a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.

b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
c. Buried valves shall have extension stems, bonnets, and valve boxes.

B. Electric Motor Actuators:

1. General:
   a. Comply with latest version of AWWA C542.
   b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve.
   c. Controls integral with actuator and fully equipped as specified in AWWA C542.
   d. Stem protection for rising stem valves.
2. Actuator Operation—General:
   a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multiturn valves, as applicable.
   b. Manual override handwheel.
   c. Valve position indication.
   d. Operate from FULL CLOSED to FULL OPEN positions or the reverse in the number of seconds given in Electric Motor Actuator Schedule.
3. Open-Close(O/C)/Throttling(T) Service:
   a. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
   b. Actuator suitable for throttling operation of valve at intermediate positions.
   c. LOCAL-OFF-REMOTE Selector Switch, padlockable in each position:
      1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in LOCAL position.
      2) Remote OPEN-STOP-CLOSE momentary control dry contact inputs in REMOTE position. Integral seal-in circuits for remote OPEN and CLOSE commands; valve travel stops when remote STOP contact opens.
      3) Auxiliary contact that closes in REMOTE position.
   d. OPEN and CLOSED indicating lights.
   e. Integral reversing motor starter with built-in overload protection.
   f. Valve shall remain in last position on loss of operator power.
4. Modulating (M) Service:
   a. Size motors for continuous duty.
   b. Feedback potentiometer, or equivalent, and integral electronic positioner/comparator circuit to maintain valve position.

c. HAND-OFF-AUTO (Local-Off-Remote) Selector Switch, padlockable in each position:
   1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in HAND (Local) position.
   2) 4 to 20 mA dc input signal to control valve in AUTO (Remote) position.
   3) Auxiliary contact that closes in AUTO (Remote) position.
d. Valve shall close upon loss of signal, unless otherwise indicated.
e. OPEN and CLOSED indicating lights.
f. Ac motor with solid state reversing starter or dc motor with solid state reversing controller, and built-in overload protection. Controller capable of 1,200 starts per hour.
g. Duty cycle limit timer and adjustable band width, or equivalent, to prevent actuator hunting.
h. Valve position output converter that generates isolated 4 mA to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24V dc.

5. Actuator Power Supply:
   a. 480 volts, three-phase, unless otherwise indicated.
   b. Control power transformer, 120-volt secondary.
   c. Externally operable power disconnect switch.
6. Enclosure:
   a. As defined in NEMA 250, Type 4, unless otherwise indicated.
   b. Contain 120-volt space heaters, if required to prevent condensation.
7. Limit Switch:
   a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120 volts ac.
   b. Each valve actuator to have a minimum of two auxiliary transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
   c. Housed in actuator control enclosure.
8. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Motor Actuator Schedule.
9. Manufacturers:
   a. Rotork Controls.
   b. Flowserve Limitorque.

C. Pneumatic Actuators:

1. General:
   a. Actuator complete with air sets, exhaust mufflers, speed controls, pilot solenoids, safety vented isolation valves, and accessories.

b. Suitable for full operation range of valve at air supply pressure indicated.
c. Position indication and stop limiting devices on all actuators.

2. Vane Style Actuator:
   a. In compliance with AWWA C541.
   b. Air supply of 80 psig.
   c. Pressure die-cast aluminum housing with corrosion resistant fusion bonded epoxy finish, stainless steel bolting, stainless steel adjustable end stops.
   d. Electroless nickel-plated steel shaft and vane, single-component machined or cast part.
   e. Dual-opposed polyurethane lip seals with stainless steel expander.
   f. Double Acting:
      1) Complete with mounting hardware.
      2) Suitable for non-lubrication air.
   g. Spring Return:
      1) Wound stainless steel spring type in separate housing.
      2) Attached to pneumatic actuator housing.
3. Geared Manual Override: Geared type with de-clutchable handwheel, torque rated for application.
   a. Visual Indicator: High visibility, OPEN-CLOSED indication, color coded, chemical resistant, clear polycarbonate cover.
   b. Manufacturers:
      1) Kinetrol.
      2) K-Tork.
4. Cylinder Actuator:
   a. In compliance with AWWA C541.
   b. Air supply pressure of 80 psig.
   c. Nonswivel type totally enclosed:
      1) Travel stops and position indicator.
      2) Factory lubricated and sealed requiring no additional lubrication.
   d. Double Acting:
      1) Nonmetallic for operation on nonlubricated air.
      2) Handwheel override independent of cylinder.
   e. Spring Return:
      1) Open, closed, or throttling, steel cylinder with air line lubricators. Nonlubricated air may be used if certified by manufacturer.
      2) Modulating: Nonmetallic for operation on nonlubricated air.
      3) Manual override manufacturer’s standard.

f. Actuators used on quarter-turn valves to include a totally enclosed valve actuating mechanism. Actuating mechanism to be factory lubricated and sealed.
g. Manufacturers:
    1) Rotork.
    2) DeZurik.

5. Diaphragm Actuator:
    a. Spring return with steel or aluminum diaphragm case and spring barrel, steel spring and actuator stem, and fabric-reinforced neoprene diaphragm.
    b. Actuators used on quarter-turn valves to include a totally enclosed valve actuating mechanism. Actuating mechanism to be factory lubricated and sealed.
    c. Diaphragm actuators sized and configured for service indicated and air supply pressure of 35 psig.
    d. Manufacturers and Products:
        1) Fisher Controls; Type 1051.
        2) Keystone Valve; Figure 723.
    e. Accessories:
        1) Air Set: Pressure regulator with internal relief, filter, outlet pressure gauge, and adjustable reduced pressure range as required by valve actuator.
        2) Aluminum body and handwheel.
        3) Safety vented lockout isolation valve.
        4) Gauge range 1-1/3 to 2 times maximum operating pressure.
        5) Manufacturers and Products:
            a) Fisher Controls; Type 67 AFR.
            b) Masoneilan; No. 77-4.
    f. Air Exhaust Muffler:
        1) In the exhaust port of actuator pilot solenoid valves.
        2) Manufacturers:
            a) Barry Wright Corp.
            b) Allied Witan Co.
    g. Limit Switch:
        1) Single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac.
        2) Housed in NEMA 4X enclosure.
        3) Adjustable for OPEN and CLOSED valve positions.
    h. Positioner:
        1) For modulating actuators, shall be pneumatic force balance instruments to control valve position as a function of input signal. Accomplish positive positioning of valve by a mechanical feedback connection from valve actuating

mechanism. Position feedback through a characterized linear cam to allow adjustment of valve positioning and input signal. Positioner suitable for double acting or spring return actuator.

2) Positioner to have zero and span adjustment and be field reversible for direct or reverse action.
3) Gauges for supply and output pressure and for input signal pressure.
4) Positioner for 3 psig to 15 psig pneumatic input signal or 4 mA to 20 mA dc input signal as indicated.
5) Positioner for dc input signal with transducers shall convert electrical signal to appropriate pneumatic signal. Transducer integral with positioner or separate component. If separate, factory mount transducer on pneumatic operator. Line electric power not required for transducer.
6) Corrosion-resistant enclosures for positioners and transducers to be splash-proof and moisture-proof with gasketed covers.

i. Pilot Solenoid Valve:
1) Solenoid valve shall pilot control actuator in appropriate configuration for type of open-close actuator being controlled. Double acting actuator shall have four-way solenoid valve, and spring return actuator shall have three-way solenoid valve. Dual coil valve shall not change position unless one coil is energized while the other is de-energized.
2) Pilot operated diaphragm type solenoid valve with brass body and resilient seat. Valve with minimum operating pressure differential no greater than 10 psig and maximum operating pressure differential no less than 150 psig. Internal parts corrosion-resistant. Solenoid valve to have Class F molded coils for operation on 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure as defined in NEMA 250, Type 4X.
3) Manufacturers:
a) Asco Red Hat.
b) Norgren USA.

j. Open-Close and Throttling Valve:
1) Double Acting Cylinders: Four-way solenoid with dual coils.
2) Spring Return Cylinders: Three-way solenoids, spring return.

6. Modulating Valve: Positioner with 4 to 20 mA input signal, unless otherwise indicated.
7. Control Features: Pneumatic actuators with features noted in the Pneumatic Actuator Schedule.

2.07 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve operator valve 2 inch and larger, bearing valve tag number shown on Electric Motor Actuator Schedule, Pneumatic Actuator Schedule, Self-Regulated Valve Schedule, or Drawings.

B. Limit Switch:

1. Factory installed NEMA 4X limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120V ac.

C. T-Handled Operating Wrench:

1. Two each galvanized operating wrenches, 4 feet long.
2. Manufacturers and Products:
   a. Mueller; No. A-24610.
   b. Clow No.; F-2520.
3. Two each galvanized operating keys for cross handled valves.

D. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.

1. Manufacturers:
   a. Pratt.
   b. DeZurik.

E. Floor Stand:

1. Nonrising, heavy pattern, indicating type.
2. Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment. Stem length as required to connect valve operating nut and floor stand.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 stainless steel.
5. Manufacturers and Products:
   a. Clow; Figure F-5515.
   b. Mueller, Figure A-26426.

F. Floor Box:

1. Plain type, for support of nonrising type stem.

2. Complete with solid extension stem, operating nut, and stem guide brackets. Stem length as required to extend valve operating nut to within 3 inches of finish floor.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 stainless steel.
5. Manufacturers and Products:
    a. Neenah Foundry; R 7506.
    b. Clow; No. F5690.

G. Chain Wheel and Guide:

1. Handwheel direct-mount type.
2. Complete with chain.
3. Galvanized or cadmium-plated.
4. Manufacturers and Products:
    a. Clow Corp.; Figure F-5680.
    b. Walworth Co.; Figure 804.
    c. DeZurik Corp.; Series W or LWG.

H. Cast-Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 5-1/4-inch ID shaft.

1. Box: Cast iron with minimum depth of 9 inches.
2. Lid: Cast iron, minimum depth 3 inches, locking typemarked as shown.
3. Extensions: PVC pipe.
4. Two-piece box and lid for valves 4 inches through 12 inches, three-piece box and lid for valves larger than 12 inches with base sized for valve.
5. Valve extension stem for valves with operating nuts 3 feet or greater below finish grade.
6. Manufacturers and Products:
    a. East Jordan Iron Works; Cast-Iron Valve Boxes.
    b. Bingham & Taylor; Cast-Iron Valve Boxes.

I. Concrete Valve Box: Designed for traffic loads, sliding type, with minimum of 10-inch ID shaft.

1. Box: High-density, reinforced concrete, minimum depth 12 inches, cast-iron ring seat.
2. Lid: Cast iron, minimum depth 3 inches, marked as shown.
3. Extensions: Concrete.
4. Manufacturers and Products:
    a. Christy Concrete Products; G Series.
    b. BES Concrete Products; G Series.

J. Indicator Post Assembly:

1. Cast or ductile iron post head, bell, and wrench with cast or ductile iron or steel barrel.
2. Plexiglas or equal protected window to indicate OPEN and CLOSED position.
3. Padlockable eye bolt for wrench.
4. Adjustable bury depth. Bury depth as required for valve installation.
5. UL Listed and FM Approved.
6. Manufacturers and Products:
   a. Clow; Style 2945.
   b. Mueller; A-20806.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

D. Valve Installation and Orientation:

1. General:
   a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
   b. Install valves in location for easy access for routine operation and maintenance.
   c. Install valves per manufacturer’s recommendations.
2. Gate, Globe, and Ball Valves:
   a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.

b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.

3. Eccentric Plug Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve as follows:
      1) Liquids with suspended solids service with horizontal flow: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
      2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).
      3) Clean Liquids and Gas Service: Install valve with seat end downstream of higher pressure when valve is closed (higher pressure forces plug into seat).
4. Butterfly Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
   b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
   c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
   d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
   e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.
5. Check Valves:
   a. Install valve in horizontal or vertical flow (up) flow piping only for liquid services.
   b. Install valve in vertical flow (up) piping only for gas services.
   c. Install swing check valve with shaft in horizontal position.

E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

F. Install safety isolation valves on compressed air.

G. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

H. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

I. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

J. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

K. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate “L” type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

3.02 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer’s data.

E. Set, verify, and record set pressures for relief and regulating valves.

F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.

G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 MANUFACTURER'S SERVICES

A. See Section 01 43 33, Manufacturers' Field Services (to be completed), and Section 01 91 14, Equipment Testing and Facility Startup (to be completed).

3.04 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are part of this Specification.

1. Manual Valve Schedule.
2. Self-Contained Automated Valve Schedule.
3. Solenoid Valve Schedule.
4. Electric Power Automated Valve Schedule.
5. Pneumatic Automated Valve Schedule.
6. Miscellaneous Schedules.
7. Control Valve Data Sheets – FCV-FW-01012 and FCV-FW-02-012.
8. Specialty Items Schedule.

END OF SECTION

CH2MHILL

CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
FRESHWATER SUPPLY, STORAGE, AND INJECTION EQUIPMENT VALVES															
A	V-010A	I-01-01	HNWR1A	PMP-010	6"-FW-LCLF-010101	40 50 00	SWING CHECK	6	FW	40 27 02	V608	A	900	180	
A	V-010B	I-01-01	HNWR1A	PMP-010	6"-FW-LCLF-010101	40 50 00	BUTTERFLY	6	FW	40 27 02	V500	A	900	180	
A	V-010E	I-01-01	HNWR1A	STR-010	STR-010	40 50 00	BALL	1 1/2	FW	40 27 02	V335	A	900	180	STR-010 manual purge valve
A	V-071A	I-01-01	HNWR1A	FM-071	6"-FW-LCLF-010101	40 50 00	BUTTERFLY	6	FW	40 27 02	V500	A	900	180	
A	V-072A	I-01-01	HNWR1A	FM-072	6"-FW-LCLF-010112	40 50 00	BUTTERFLY	6	FW	40 27 02	V500	A	900	180	
A	V-061A	I-01-01	HNWR1A	PIT-061	6"-FW'-LCLF-010101	40 50 00	BUTTERFLY	6	FW	40 27 02	V500	A	900	180	
A	SP-061B	I-01-01	HNWR1A	PIT-061	6"-FW-LCLF-010101	40 50 00	GATE	1/2*	FW	40 27 02	V101 or V925	A	900	180	Sample Port Valve
A	V-061D	I-01-01	HNWR1A	PIT-061	PIT-061	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	180	Pressure indicator valve*, NC
A	V-061C	I-01-01	HNWR1A	PIT-061	PIT-061	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	180	Pressure indicator valve*
A	V-020A	I-01-01	HNWR1A		12"-FW-HALE-010101	40 50 00	BUTTERFLY	12	FW	40 27 02	V500	A	900	180	
A	V-020B	I-01-01	HNWR1A		12"-FW-HALE-0203	40 50 00	BUTTERFLY	12	FW	40 27 02	V500	A	900	180	
A	V-020C	I-01-01	HNWR1A		12"-FW-HALE-0203	40 50 00	BUTTERFLY	12	FW	40 27 02	V500	A	900	180	
A	V-010C	I-01-01	SITEB	PMP-010	6"-FW-LCLF-010103	40 50 00	SWING CHECK	6	FW	40 27 02	V608	A	900	245	Note 3
A	V-010D	I-01-01	SITEB	PMP-010	6"-FW-LCLF-010103	40 50 00	BUTTERFLY	6	FW	40 27 02	V500	A	900	245	Note 3
A	V-010F	I-01-01	SITEB	STR-010	STR-010	40 50 00	BALL	1 1/2	FW	40 27 02	V335	A	900	245	Note 3; STR-010 manual purge valve
A	V-061A	I-01-01	SITEB	PIT-061	6"-FW-LCLF-010103	40 50 00	BUTTERFLY	6	FW	40 27 02	V500	A	900	245	Note 3
A	V-071A	I-01-01	SITEB	FM-071	6"-FW-LCLF-010103	40 50 00	BUTTERFLY	6	FW	40 27 02	V500	A	900	245	Note 3
A	SP-061B	I-01-01	SITEB	PIT-061	6"-FW-LCLF-010103	40 50 00	BALL	1/2*	FW	40 27 02	V335	A	900	245	Note 3; Sample Port Valve
A	V-061C	I-01-01	SITEB	PIT-061	PIT-061	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	245	Note 3; Pressure indicator valve*
A	V-061D	I-01-01	SITEB	PIT-061	PIT-061	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	245	Note 3; Pressure indicator valve*, NC
A	V-103A	I-02-01	FWST	TNK-103	12"-FW-HALE-020204	40 50 00	BUTTERFLY	12	FW	40 27 02	V513	A	900	75	
A	V-103B	I-02-01	FWST	TNK-103	12"-FW-HALE-020103	40 50 00	BUTTERFLY	12	FW	40 27 02	V513	A	900	75	
A	V-103C	I-02-01	FWST	TNK-103	10"-FW-PULK-020204	40 50 00	BUTTERFLY	10	FW	40 27 02	V513	A	900	25	
A	V-103D	I-02-01	FWST	TNK-103	14"-FW-PULK-020203	40 50 00		10	FW	40 27 02	V513	A	900	25	
A	V-103E	I-02-01	FWST	TNK-103	2"-FW-HALE-0206	40 50 00	BALL	2	FW	40 27 02	V335	A	900	25	
A	V-001A	I-02-02	FW01	PIT-061	4"-FW-PULK-020201	40 50 00	BUTTERFLY	4	FW	40 27 02	V521	A	900	25	
A	SP-01A	I-02-02	FW01	PIT-061	4"-FW-PULK-020201	40 50 00	BALL	3/4*	FW	40 27 02	V335	A	900	25	Sample Port Valve
A	V-001B	I-02-02	FW01	FM-071	2"-FW-PULK-020202	40 50 00	BUTTERFLY	4	FW	40 27 02	V521	A	900	25	
A	V-001C	I-02-02	FW01	PMP-001	2"-FW-PULK-020202	40 50 00	BUTTERFLY	4	FW	40 27 02	V521	A	900	25	
A	V-061A	I-02-02	FW01	PIT-061	PIT-061	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	25	Pressure indicator valve*
A	V-061B	I-02-02	FW01	PIT-061	PIT-061	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	25	Pressure indicator valve*
A	V-062B	I-02-02	FW01	PIT-062	PIT-062	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	25	Pressure indicator valve*
A	V-062A	I-02-02	FW01	PIT-062	PIT-062	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	25	Pressure indicator valve*
A	V-014A	I-02-02	FW01	ARV-014	4"-FW-PULK-020203	40 50 00	BALL	1	FW	40 27 02	V335	A	900	5	Upstream of ARV
A	V-001D	I-02-02	FW01	PMP-001	6'-RW-PULK-020204	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	400	135	
A	V-001E	I-02-02	FW01	FM-072	6'-RW-PULK-020204	40 50 00	SWING CHECK	3/4	RW	40 27 02	V612	A	400	135	Split Disk Type
A	SP-01B	I-02-02	FW01	FM-072	6'-RW-PULK-020204	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	400	135	Sample Port Valve
A	V-001F	I-02-02	FW01	FM-072	6'-RW-PULK-020204	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	400	135	
A	V-001A	I-02-02	FW02	PIT-061	4"-FW-PULK-020201	40 50 00	BUTTERFLY	4	FW	40 27 02	V521	A	900	25	
A	SP-01A	I-02-02	FW02	PIT-061	4"-FW-PULK-020201	40 50 00	BALL	3/4*	FW	40 27 02	V335	A	900	25	Sample Port Valve
A	V-001B	I-02-02	FW02	FM-071	2"-FW-PULK-020202	40 50 00	BUTTERFLY	4	FW	40 27 02	V521	A	900	25	
A	V-001C	I-02-02	FW02	PMP-001	4"-FW-PULK-020203	40 50 00	BUTTERFLY	4	FW	40 27 02	V521	A	900	25	
A	V-061A	I-02-02	FW02	PIT-061	PIT-061	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	25	Pressure indicator valve*
A	V-061B	I-02-02	FW02	PIT-061	PIT-061	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	25	Pressure indicator valve*

CH2MHILL

CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	V-062B	I-02-02	FW02	PIT-062	PIT-062	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	25	Pressure indicator valve*
A	V-062A	I-02-02	FW02	PIT-062	PIT-062	40 50 00	BALL	1/2	FW	40 27 02	V335	A	900	25	Pressure indicator valve*
A	V-014A	I-02-02	FW02	ARV-014	2"-FW-PULK-020210	40 50 00	BALL	1*	FW	40 27 02	V335	A	900	5	Upstream of ARV
A	V-001D	I-02-02	FW02	PMP-001	4"-RW-PULK-020215	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	200	75	
A	V-001E	I-02-02	FW02	FM-072	4"-RW-PULK-020215	40 50 00	SWING CHECK	3/4	RW	40 27 02	V612	A	200	75	Split Disk Type
A	SP-01B	I-02-02	FW02	FM-072	4"-RW-PULK-020215	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	200	75	Sample Port Valve
A	V-001F	I-02-02	FW02	FM-072	4"-RW-PULK-020215	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	200	75	
A	V-101A	I-02-02	FW02	PMP-101	4"-RW-PULK-020202	40 50 00	SWING CHECK	4	RW	40 27 02	V608	A	250	65	
A	V-101B	I-02-02	FW02	PMP-101	4"-RW-PULK-020202	40 50 00	BUTTERFLY	4	RW	40 27 02	V521	A	250	65	
A	V-102A	I-02-02	FW02	PMP-102	4"-RW-PULK-020203	40 50 00	SWING CHECK	4	RW	40 27 02	V608	A	250	65	
A	V-102B	I-02-02	FW02	PMP-102	4"-RW-PULK-020203	40 50 00	BUTTERFLY	4	RW	40 27 02	V521	A	250	65	
REMEDY-PRODUCED WATER CONDITIONING PLANT VALVES															
A	SP-071A	I-11-01	RTP01	TNK-201	6"-RW-PULK-110101	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	35	48	Sample Port Valve
A	V-201A	I-11-01	RTP01	TNK-201	6"-RW-PULK-110107	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	35	48	
A	V-201B	I-11-01	RTP01	TNK-201	6"-RW-PULK-110105	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	SP-201C	I-11-01	RTP01	TNK-201	6"-RW-PULK-110105	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-201D	I-11-01	RTP01	TNK-201	6"-RW-PULK-110106	40 50 00	SWING CHECK	6	RW	40 27 02	V1692	A	492	46	
A	V-201E	I-11-01	RTP01	TNK-201	6"-RW-PULK-110106	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	V-201F	I-11-01	RTP01	TNK-201	6"-RW-PULK-110106	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	V-201G	I-11-01	RTP01	TNK-201	2"-RW-PULK-110102	40 50 00	BALL	2	RW	40 27 02	V335	A	492	46	
A	SP-201H	I-11-01	RTP01	TNK-201	2"-RW-PULK-110102	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-201I	I-11-01	RTP01	TNK-201	2"-RW-PULK-110103	40 50 00	BALL	2	RW	40 27 02	V335	A	492	46	
A	SP-201J	I-11-01	RTP01	TNK-201	2"-RW-PULK-110103	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-201K	I-11-01	RTP01	TNK-201	2"-SL-PULK-110104	40 50 00	BALL	2	SL	40 27 02	V335	A	492	46	
A	SP-201L	I-11-01	RTP01	TNK-201	2"-SL-PULK-110104	40 50 00	BALL	3/4*	SL	40 27 02	V335	A	492	46	Sample Port Valve
A	V-201M	I-11-01	RTP01	TNK-201	4"-DR-PULK-110108	40 50 00	BUTTERFLY	4	DR	40 27 02	V521	A	492	46	Drainage Valve, NC
A	V-261A	I-11-01	RTP01	PI-261	PI-261	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	492	46	Pressure indicator valve*
A	V-261B	I-11-01	RTP01	PI-261	PI-261	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	492	46	Pressure indicator valve*, NC
A	V-213A	I-11-01	RTP01	TNK-201	1/2" IN 2"-CAU-110110-H	40 50 00	BALL	1/2	CAU	40 27 02	V335	A	0.17	80	
A	V-213B	I-11-01	RTP01	TNK-201	1/2" IN 2"-CAU-110110-H	40 50 00	BALL	1/2	CAU	40 27 02	V335	A	0.17	80	
A	V-213C	I-11-01	RTP01	TNK-201	1/2" IN 2"-CAU-110110-H	40 50 00	BALL CHECK	1/2	CAU	40 27 02	V631	A	0.17	80	
A	V-214A	I-11-01	RTP01	TNK-201	1/2" IN 2"-ACD-110109	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.17	80	
A	V-214B	I-11-01	RTP01	TNK-201	1/2" IN 2"-ACD-110109	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.17	80	
A	V-214C	I-11-01	RTP01	TNK-201	1/2" IN 2"-ACD-110109	40 50 00	BALL CHECK	1/2	ACD	40 27 02	V631	A	0.17	80	
A	V-215A	I-11-01	RTP01	TNK-201	1/2" IN 2"-COG-110111	40 50 00	BALL	1/2	COG	40 27 02	V335	A	0.17	80	
A	V-215B	I-11-01	RTP01	TNK-201	1/2" IN 2"-COG-110111	40 50 00	BALL	1/2	COG	40 27 02	V335	A	0.17	80	
A	V-215C	I-11-01	RTP01	TNK-201	1/2" IN 2"-COG-110111	40 50 00	BALL CHECK	1/2	COG	40 27 02	V631	A	0.17	80	
A	V-202A	I-11-02	RTP01	TNK-202	6"-RW-PULK-110207	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	35	48	
A	V-202B	I-11-02	RTP01	TNK-202	6"-RW-PULK-110205	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	SP-202C	I-11-02	RTP01	TNK-202	6"-RW-PULK-110205	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-202D	I-11-02	RTP01	TNK-202	6"-RW-PULK-110206	40 50 00	WAFER CHECK	6	RW	40 27 02	V1692	A	492	46	
A	V-202E	I-11-02	RTP01	TNK-202	6"-RW-PULK-110206	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	V-202F	I-11-02	RTP01	TNK-202	6"-RW-PULK-110206	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	V-202G	I-11-02	RTP01	TNK-202	2"-RW-PULK-110202	40 50 00	BALL	2	RW	40 27 02	V335	A	492	46	
A	SP-202H	I-11-02	RTP01	TNK-202	2"-RW-PULK-110202	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-202I	I-11-02	RTP01	TNK-202	2"-RW-PULK-110203	40 50 00	BALL	2	RW	40 27 02	V335	A	492	46	

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CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	SP-202J	I-11-02	RTP01	TNK-202	2"-RW-PULK-110203	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-202K	I-11-02	RTP01	TNK-202	2"-SL-PULK-110204	40 50 00	BALL	2	SL	40 27 02	V335	A	492	46	
A	SP-202L	I-11-02	RTP01	TNK-202	2"-SL-PULK-110204	40 50 00	BALL	3/4*	SL	40 27 02	V335	A	492	46	Sample Port Valve
A	V-202M	I-11-02	RTP01	TNK-202	4"-DR-PULK-110208	40 50 00	BUTTERFLY	4	DR	40 27 02	V521	A	492	46	Drainage Valve, NC
A	V-262A	I-11-02	RTP01	PI-262	PI-262	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	492	46	Pressure indicator valve*
A	V-262B	I-11-02	RTP01	PI-262	PI-262	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	492	46	Pressure indicator valve*, NC
A	V-223A	I-11-02	RTP01	TNK-202	1/2" IN 2"-CAU-110211-H	40 50 00	BALL	1/2	CAU	40 27 02	V335	A	0.17	80	
A	V-223B	I-11-02	RTP01	TNK-202	1/2" IN 2"-CAU-110211-H	40 50 00	BALL	1/2	CAU	40 27 02	V335	A	0.17	80	
A	V-223C	I-11-02	RTP01	TNK-202	1/2" IN 2"-CAU-110211-H	40 50 00	BALL CHECK	1/2	CAU	40 27 02	V631	A	0.17	80	
A	V-224A	I-11-02	RTP01	TNK-202	1/2" IN 2"-ACD-110209	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.17	80	
A	V-224B	I-11-02	RTP01	TNK-202	1/2" IN 2"-ACD-110209	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.17	80	
A	V-224C	I-11-02	RTP01	TNK-202	1/2" IN 2"-ACD-110209	40 50 00	BALL CHECK	1/2	ACD	40 27 02	V631	A	0.17	80	
A	V-225A	I-11-02	RTP01	TNK-202	1/2" IN 2"-COG-110211	40 50 00	BALL	1/2	COG	40 27 02	V335	A	0.17	80	
A	V-225B	I-11-02	RTP01	TNK-202	1/2" IN 2"-COG-110211	40 50 00	BALL	1/2	COG	40 27 02	V335	A	0.17	80	
A	V-225C	I-11-02	RTP01	TNK-202	1/2" IN 2"-COG-110211	40 50 00	BALL CHECK	1/2	COG	40 27 02	V631	A	0.17	80	
A	V-203A	I-11-03	RTP01	TNK-203	6"-RW-PULK-110307	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	35	48	
A	V-203B	I-11-03	RTP01	TNK-203	6"-RW-PULK-110305	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	SP-203C	I-11-03	RTP01	TNK-203	6"-RW-PULK-110305	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-203D	I-11-03	RTP01	TNK-203	6"-RW-PULK-110306	40 50 00	WAFER CHECK	6	RW	40 27 02	V1692	A	492	46	
A	V-203E	I-11-03	RTP01	TNK-203	6"-RW-PULK-110306	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	V-203F	I-11-03	RTP01	TNK-203	6"-RW-PULK-110306	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	V-203G	I-11-03	RTP01	TNK-203	2"-RW-PULK-110302	40 50 00	BALL	2	RW	40 27 02	V335	A	492	46	
A	SP-203H	I-11-03	RTP01	TNK-203	2"-RW-PULK-110302	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-203I	I-11-03	RTP01	TNK-203	2"-RW-PULK-110303	40 50 00	BALL	2	RW	40 27 02	V335	A	492	46	
A	SP-203J	I-11-03	RTP01	TNK-203	2"-RW-PULK-110303	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-203K	I-11-03	RTP01	TNK-203	2"-SL-PULK-110304	40 50 00	BALL	2	SL	40 27 02	V335	A	492	46	
A	SP-203L	I-11-03	RTP01	TNK-203	2"-SL-PULK-110304	40 50 00	BALL	3/4*	SL	40 27 02	V335	A	492	46	Sample Port Valve
A	V-203M	I-11-03	RTP01	TNK-203	4"-DR-PULK-110308	40 50 00	BUTTERFLY	4	DR	40 27 02	V521	A	492	46	Drainage Valve, NC
A	V-263A	I-11-03	RTP01	PI-263	PI-263	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	492	46	Pressure indicator valve*
A	V-263B	I-11-03	RTP01	PI-263	PI-263	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	492	46	Pressure indicator valve*, NC
A	V-233A	I-11-03	RTP01	TNK-203	1/2" IN 2"-CAU-110310-H	40 50 00	BALL	1/2	CAU	40 27 02	V335	A	0.17	80	
A	V-233B	I-11-03	RTP01	TNK-203	1/2" IN 2"-CAU-110310-H	40 50 00	BALL	1/2	CAU	40 27 02	V335	A	0.17	80	
A	V-233C	I-11-03	RTP01	TNK-203	1/2" IN 2"-CAU-110310-H	40 50 00	BALL CHECK	1/2	CAU	40 27 02	V631	A	0.17	80	
A	V-234A	I-11-03	RTP01	TNK-203	1/2" IN 2"-ACD-110309	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.17	80	
A	V-234B	I-11-03	RTP01	TNK-203	1/2" IN 2"-ACD-110309	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.17	80	
A	V-234C	I-11-03	RTP01	TNK-203	1/2" IN 2"-ACD-110309	40 50 00	BALL CHECK	1/2	ACD	40 27 02	V631	A	0.17	80	
A	V-235A	I-11-03	RTP01	TNK-203	1/2" IN 2"-COG-110311	40 50 00	BALL	1/2	COG	40 27 02	V335	A	0.17	80	
A	V-235B	I-11-03	RTP01	TNK-203	1/2" IN 2"-COG-110311	40 50 00	BALL	1/2	COG	40 27 02	V335	A	0.17	80	
A	V-235C	I-11-03	RTP01	TNK-203	1/2" IN 2"-COG-110311	40 50 00	BALL CHECK	1/2	COG	40 27 02	V631	A	0.17	80	
A	V-204A	I-11-04	RTP01	TNK-204	6"-RW-PULK-110407	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	35	48	
A	V-204B	I-11-04	RTP01	TNK-204	6"-RW-PULK-110405	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	SP-204C	I-11-04	RTP01	TNK-204	6"-RW-PULK-110405	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-204D	I-11-04	RTP01	TNK-204	6"-RW-PULK-110406	40 50 00	WAFER CHECK	6	RW	40 27 02	V1692	A	492	46	
A	V-204E	I-11-04	RTP01	TNK-204	6"-RW-PULK-110406	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	V-204F	I-11-04	RTP01	TNK-204	6"-RW-PULK-110406	40 50 00	BUTTERFLY	6	RW	40 27 02	V521	A	492	46	
A	V-204G	I-11-04	RTP01	TNK-204	2"-RW-PULK-110402	40 50 00	BALL	2	RW	40 27 02	V335	A	492	46	

CH2MHILL

CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	SP-204H	I-11-04	RTP01	TNK-204	2"-RW-PULK-110402	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-204I	I-11-04	RTP01	TNK-204	2"-RW-PULK-110408	40 50 00	BALL	2	RW	40 27 02	V335	A	492	46	
A	SP-204J	I-11-04	RTP01	TNK-204	2"-RW-PULK-110408	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	Sample Port Valve
A	V-204K	I-11-04	RTP01	TNK-204	2"-SL-PULK-110404	40 50 00	BALL	2	SL	40 27 02	V335	A	492	46	
A	SP-204L	I-11-04	RTP01	TNK-204	2"-SL-PULK-110404	40 50 00	BALL	3/4*	SL	40 27 02	V335	A	492	46	Sample Port Valve
A	V-204M	I-11-04	RTP01	TNK-204	4"-DR-PULK-110408	40 50 00	BUTTERFLY	4	DR	40 27 02	V521	A	492	46	Drainage Valve, NC
A	V-289A	I-11-04	RTP01	AE/AIT-289	AE/AIT-289	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	492	46	turbidity analyzer*
A	V-264A	I-11-04	RTP01	PI-264	PI-264	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	492	46	Pressure indicator valve*
A	V-264B	I-11-04	RTP01	PI-264	PI-264	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	492	46	Pressure indicator valve*, NC
A	V-243A	I-11-04	RTP01	TNK-204	1/2" IN 2"-CAU-110410-H	40 50 00	BALL	1/2	CAU	40 27 02	V335	A	0.17	80	
A	V-243B	I-11-04	RTP01	TNK-204	1/2" IN 2"-CAU-110410-H	40 50 00	BALL	1/2	CAU	40 27 02	V335	A	0.17	80	
A	V-243C	I-11-04	RTP01	TNK-204	1/2" IN 2"-CAU-110410-H	40 50 00	BALL CHECK	1/2	CAU	40 27 02	V631	A	0.17	80	
A	V-244A	I-11-04	RTP01	TNK-204	1/2" IN 2"-ACD-110404	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.17	80	
A	V-244B	I-11-04	RTP01	TNK-204	1/2" IN 2"-ACD-110404	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.17	80	
A	V-244C	I-11-04	RTP01	TNK-204	1/2" IN 2"-ACD-110404	40 50 00	BALL CHECK	1/2	ACD	40 27 02	V631	A	0.17	80	
A	V-245A	I-11-04	RTP01	TNK-204	1/2" IN 2"-COG-110408	40 50 00	BALL	1/2	COG	40 27 02	V335	A	0.17	80	
A	V-245B	I-11-04	RTP01	TNK-204	1/2" IN 2"-COG-110408	40 50 00	BALL	1/2	COG	40 27 02	V335	A	0.17	80	
A	V-245C	I-11-04	RTP01	TNK-204	1/2" IN 2"-COG-110408	40 50 00	BALL CHECK	1/2	COG	40 27 02	V631	A	0.17	80	
A	V-265A	I-11-04	RTP01	PI-265	PI-265	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	30	Pressure indicator valve*
A	V-265B	I-11-04	RTP01	PI-265	PI-265	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	30	Pressure indicator valve*, NC
A	V-205A	I-11-04	RTP01	PMP-205	2"-WS-PULK-110409	40 50 00	BALL	2	WS	40 27 02	V335	A	35	30	
A	V-205B	I-11-04	RTP01	PMP-205	2"-WS-PULK-110409	40 50 00	WAFER CHECK	2	WS	40 27 02	V1692	A	35	30	
A	V-205C	I-11-04	RTP01	PMP-205	2"-WS-PULK-110410	40 50 00	BALL	2	WS	40 27 02	V335	A	35	30	
A	V-310A	I-12-01	RTP01	PMP-310	2"-RW-PULK-110403	40 50 00	BALL	2	RW	40 27 02	V335	A	35	46	
A	V-310B	I-12-01	RTP01	PMP-310	2"-RW-PULK-120103	40 50 00	WAFER CHECK	2	RW	40 27 02	V1692	A	35	23	
A	V-310C	I-12-01	RTP01	PMP-310	2"-RW-PULK-120103	40 50 00	BALL	2	RW	40 27 02	V335	A	35	23	
A	SP-310D	I-12-01	RTP01	PMP-310	2"-RW-PULK-120103	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	35	23	Sample Port Valve
A	V-310E	I-12-01	RTP01	PMP-310	2"-RW-PULK-120111	40 50 00	BALL	2	RW	40 27 02	V335	A	35	23	NC
A	V-361A	I-12-01	RTP01	PI-361	PI-361	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	35	23	Pressure indicator valve*
A	V-361B	I-12-01	RTP01	PI-361	PI-361	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	35	23	Pressure indicator valve*, NC
A	V-320A	I-12-01	RTP01	PMP-320	2"-RW-PULK-120101	40 50 00	BALL	2	RW	40 27 02	V335	A	35	46	
A	V-320B	I-12-01	RTP01	PMP-320	2"-RW-PULK-120103	40 50 00	WAFER CHECK	2	RW	40 27 02	V1692	A	35	23	
A	V-320C	I-12-01	RTP01	PMP-320	2"-RW-PULK-120103	40 50 00	BALL	2	RW	40 27 02	V335	A	35	23	
A	SP-320D	I-12-01	RTP01	PMP-320	2"-RW-PULK-120103	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	35	23	Sample Port Valve
A	V-320E	I-12-01	RTP01	PMP-320	2"-RW-PULK-120103	40 50 00	BALL	2	RW	40 27 02	V335	A	35	23	NC
A	V-362A	I-12-01	RTP01	PI-362	PI-362	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	35	23	Pressure indicator valve*
A	V-362B	I-12-01	RTP01	PI-362	PI-362	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	35	23	Pressure indicator valve*, NC
A	SP-311C	I-12-01	RTP01	FIL-311	2"-RW-PULK-120104	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	35	23	Sample Port Valve
A	SP-321C	I-12-01	RTP01	FIL-321	2"-RW-PULK-120105	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	35	23	Sample Port Valve
A	V-361C	I-12-01	RTP01	DPIT-361	DPIT-361	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	23	DPIT valve*, part of filter package
A	V-361D	I-12-01	RTP01	DPIT-361	DPIT-361	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	23	DPIT valve*, part of filter package
A	V-362C	I-12-01	RTP01	DPIT-362	DPIT-362	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	23	DPIT valve*, part of filter package
A	V-362D	I-12-01	RTP01	DPIT-362	DPIT-362	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	23	DPIT valve*, part of filter package
A	V-363A	I-12-01	RTP01	DPIT-363	DPIT-363	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	23	DPIT valve*, part of filter package
A	V-363B	I-12-01	RTP01	DPIT-363	DPIT-363	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	23	DPIT valve*, part of filter package
A	V-364A	I-12-01	RTP01	DPIT-364	DPIT-364	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	23	DPIT valve*, part of filter package

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CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	V-364B	I-12-01	RTP01	DPIT-364	DPIT-364	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	23	DPIT valve*, part of filter package
A	V-311	I-12-01	RTP01	FIL-311/321	?"-RW-PULK-120109	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	23	Part of filter package
A	SP-371A	I-12-01	RTP01	FIL-312/322	2"-TW-PULK-120107	40 50 00	BALL	3/4*	TW	40 27 02	V335	A	35	23	Sample Port Valve
A	V-330A	I-12-02	RTP01	PMP-330	2"-RW-PULK-110414	40 50 00	BALL	2	RW	40 27 02	V335	A	35	46	
A	V-330B	I-12-02	RTP01	PMP-330	2"-RW-PULK-120202	40 50 00	WAFER CHECK	2	RW	40 27 02	V1692	A	35	43	
A	V-330C	I-12-02	RTP01	PMP-330	2"-RW-PULK-120202	40 50 00	BALL	2	RW	40 27 02	V335	A	35	43	
A	SP-330D	I-12-02	RTP01	PMP-330	2"-RW-PULK-120202	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	35	43	Sample Port Valve
A	V-363C	I-12-02	RTP01	PI-363	PI-363	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	35	43	Pressure indicator valve*
A	V-363D	I-12-02	RTP01	PI-363	PI-363	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	35	43	Pressure indicator valve*. NC
A	V-340A	I-12-02	RTP01	PMP-340	2"-RW-PULK-120201	40 50 00	BALL	2	RW	40 27 02	V335	A	35	46	
A	V-340B	I-12-02	RTP01	PMP-340	2"-RW-PULK-120203	40 50 00	WAFER CHECK	2	RW	40 27 02	V1692	A	35	43	
A	V-340C	I-12-02	RTP01	PMP-340	2"-RW-PULK-120203	40 50 00	BALL	2	RW	40 27 02	V335	A	35	43	
A	SP-340D	I-12-02	RTP01	PMP-340	2"-RW-PULK-120203	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	35	43	Sample Port Valve
A	V-364C	I-12-02	RTP01	PI-364	PI-364	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	35	43	Pressure indicator valve*
A	V-364D	I-12-02	RTP01	PI-364	PI-364	40 50 00	BALL	1/2*	RW	40 27 02	V335	A	35	43	Pressure indicator valve*, NC
A	SP-331C	I-12-02	RTP01	FIL-331	2"-RW-PULK-120204	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	35	43	Sample Port Valve
A	SP-341C	I-12-02	RTP01	FIL-341	2"-RW-PULK-120205	40 50 00	BALL	3/4*	RW	40 27 02	V335	A	35	43	Sample Port Valve
A	V-365A	I-12-02	RTP01	DPIT-365	DPIT-365	40 50 00	BALL	1/2	RW	Vendor supplied	Vendor supplied	A	35	43	DPIT valve*, part of filter package
A	V-365B	I-12-02	RTP01	DPIT-365	DPIT-365	40 50 00	BALL	1/2	RW	Vendor supplied	Vendor supplied	A	35	43	DPIT valve*, part of filter package
A	V-366A	I-12-02	RTP01	DPIT-366	DPIT-366	40 50 00	BALL	1/2	RW	Vendor supplied	Vendor supplied	A	35	43	DPIT valve*, part of filter package
A	V-366B	I-12-02	RTP01	DPIT-366	DPIT-366	40 50 00	BALL	1/2	RW	Vendor supplied	Vendor supplied	A	35	43	DPIT valve*, part of filter package
A	V-367A	I-12-02	RTP01	DPIT-367	DPIT-367	40 50 00	BALL	1/2	RW	Vendor supplied	Vendor supplied	A	35	43	DPIT valve*, part of filter package
A	V-367B	I-12-02	RTP01	DPIT-367	DPIT-367	40 50 00	BALL	1/2	RW	Vendor supplied	Vendor supplied	A	35	43	DPIT valve*, part of filter package
A	V-368A	I-12-02	RTP01	DPIT-368	DPIT-368	40 50 00	BALL	1/2	RW	Vendor supplied	Vendor supplied	A	35	43	DPIT valve*, part of filter package
A	V-368B	I-12-02	RTP01	DPIT-368	DPIT-368	40 50 00	BALL	1/2	RW	Vendor supplied	Vendor supplied	A	35	43	DPIT valve*, part of filter package
A	V-331	I-12-02	RTP01	FIL-331/341	'-RW-PULK-120209	40 50 00	BALL	Supplier	RW	Vendor supplied	Vendor supplied	A	35	43	Part of filter package
A	SP-372A	I-12-02	RTP01	FIL-332/342	2"-TW-PULK-120207	40 50 00	BALL	3/4*	TW	40 27 02	V335	A	35	43	Sample Port Valve
A	V-910A	I-12-03	RTP01	TNK-910	TNK-910	40 50 00	BALL	2*	CAU	40 27 02	V335	A	75	150	NC
A	V-910B	I-12-03	RTP01	TNK-910	1/2" IN 2"-CAU-PULK-120301-H	40 50 00	BALL	1/2	CAU	40 27 02	V335	A	0.017	80	
A	V-910C	I-12-03	RTP01	PMP-911/912	CCOL-0910	40 50 00	BALL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Calibration column valve*, part of caustic feed pump package
A	V-911A	I-12-03	RTP01	PMP-911	1/2" IN 2"-CAU-PULK-120307-H	40 50 00	BALL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-911B	I-12-03	RTP01	PMP-911	1/2" IN 2"-CAU-PULK-120302-H	40 50 00	PRESSURE RELIEF	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-911C	I-12-03	RTP01	PMP-911	1/2" IN 2"-CAU-PULK-120308-H	40 50 00	PRESSURE CONTROL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-911D	I-12-03	RTP01	PMP-911	1/2" IN 2"-CAU-PULK-120302-H	40 50 00	BALL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	NC; Part of caustic feed pump package; spec'd per vendor quote
A	V-911E	I-12-03	RTP01	PMP-911	1/2" IN 2"-CAU-PULK-120302-H	40 50 00	SWING CHECK	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote

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CLIENT: *PG&E*

PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062

REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	V-911F	I-12-03	RTP01	PMP-911	1/2" IN 2"-CAU-PULK-120302-H	40 50 00	BALL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-911G	I-12-03	RTP01	PMP-911	1/2" IN 2"-CAU-PULK-120313-H	40 50 00	BALL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-912A	I-12-03	RTP01	PMP-912	1/2" IN 2"-CAU-PULK-120301-H	40 50 00	BALL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-912B	I-12-03	RTP01	PMP-912	1/2" IN 2"-CAU-PULK-120303-H	40 50 00	PRESSURE RELIEF	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-912C	I-12-03	RTP01	PMP-912	1/2" IN 2"-CAU-PULK-120309-H	40 50 00	PRESSURE CONTROL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-912D	I-12-03	RTP01	PMP-912	1/2" IN 2"-CAU-PULK-120303-H	40 50 00	BALL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	NC; Part of caustic feed pump package; spec'd per vendor quote
A	V-912E	I-12-03	RTP01	PMP-912	1/2" IN 2"-CAU-PULK-120303-H	40 50 00	SWING CHECK	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-912F	I-12-03	RTP01	PMP-912	1/2" IN 2"-CAU-PULK-120303-H	40 50 00	BALL	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Part of caustic feed pump package; spec'd per vendor quote
A	V-961A	I-12-03	RTP01	PI-961	PI-961	40 50 00	Vendor supplied	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Pressure indicator valve; Part of caustic feed pump package; spec'd per vendor quote
A	V-962A	I-12-03	RTP01	PI-962	PI-962	40 50 00	Vendor supplied	1/2	CAU	Vendor supplied	Vendor supplied	A	0.017	80	Pressure indicator valve; Part of caustic feed pump package; spec'd per vendor quote
A	V-920A	I-12-03	RTP01	TNK-920	1/2" IN 2"-COG-PULK-120304	40 50 00	BALL	1/2	COG	40 27 02	V335	A	0.017	80	
A	V-920B	I-12-03	RTP01	PMP-921/922	CCOL-0920	40 50 00	BALL	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Calibration column valve*, part of coagulant feed pump package
A	V-921A	I-12-03	RTP01	PMP-921	1/2" IN 2"-COG-PULK-120310	40 50 00	BALL	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Part of coagulant feed pump package; spec'd per vendor quote
A	V-921B	I-12-03	RTP01	PMP-921	1/2" IN 2"-COG-PULK-120310	40 50 00	PRESSURE RELIEF	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Part of coagulant feed pump package; spec'd per vendor quote
A	V-921C	I-12-03	RTP01	PMP-921	1/2" IN 2"-COG-PULK-120311	40 50 00	PRESSURE CONTROL	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Part of coagulant feed pump package; spec'd per vendor quote
A	V-921D	I-12-03	RTP01	PMP-921	1/2" IN 2"-COG-PULK-120305	40 50 00	BALL	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	NC; Part of coagulant feed pump package; spec'd per vendor quote
A	V-921E	I-12-03	RTP01	PMP-921	1/2" IN 2"-COG-PULK-120305	40 50 00	BALL	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Part of coagulant feed pump package; spec'd per vendor quote

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CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	V-922A	I-12-03	RTP01	PMP-922	1/2" IN 2"-COG-PULK-120304	40 50 00	BALL	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Part of coagulant feed pump package; spec'd per vendor quote
A	V-922B	I-12-03	RTP01	PMP-922	1/2" IN 2"-COG-PULK-120314	40 50 00	PRESSURE RELIEF	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Part of coagulant feed pump package; spec'd per vendor quote
A	V-922C	I-12-03	RTP01	PMP-922	1/2" IN 2"-COG-PULK-120312	40 50 00	PRESSURE CONTROL	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Part of coagulant feed pump package; spec'd per vendor quote
A	V-922D	I-12-03	RTP01	PMP-922	1/2" IN 2"-COG-PULK-120314	40 50 00	BALL	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	NC; Part of coagulant feed pump package; spec'd per vendor quote
A	V-922E	I-12-03	RTP01	PMP-922	1/2" IN 2"-COG-PULK-120314	40 50 00	BALL	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Part of coagulant feed pump package; spec'd per vendor quote
A	V-963A	I-12-03	RTP01	PI-963	PI-963	40 50 00	Vendor supplied	1/2	COG	Vendor supplied	Vendor supplied	A	0.017	80	Pressure indicator valve; Part of coagulant feed pump package; spec'd per vendor quote
A	V-930A	I-12-04	RTP01	TNK-930	TNK-930	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.017	80	
A	V-930B	I-12-04	RTP01	TNK-930	1/2" IN 2"-ACD-PULK-120401	40 50 00	BALL	1/2	ACD	40 27 02	V335	A	0.017	80	
A	V-930C	I-12-04	RTP01	PMP-931/932	CCOL-0930	40 50 00	BALL	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Calibration column valve*, part of acid feed pump package
A	V-931A	I-12-04	RTP01	PMP-931	1/2" IN 2"-ACD-PULK-120404	40 50 00	BALL	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-931B	I-12-04	RTP01	PMP-931	1/2" IN 2"-ACD-PULK-120402	40 50 00	PRESSURE RELIEF	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-931C	I-12-04	RTP01	PMP-931	1/2" IN 2"-ACD-PULK-120405	40 50 00	PRESSURE CONTROL	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-931D	I-12-04	RTP01	PMP-931	1/2" IN 2"-ACD-PULK-120402	40 50 00	BALL	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	NC; Part of acid feed pump package; spec'd per vendor quote
A	V-931E	I-12-04	RTP01	PMP-931	1/2" IN 2"-ACD-PULK-120402	40 50 00	SWING CHECK	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-931F	I-12-04	RTP01	PMP-931	1/2" IN 2"-ACD-PULK-120402	40 50 00	BALL	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-931G	I-12-04	RTP01	PMP-931/932	1/2" IN 2"-ACD-PULK-120407	40 50 00	BALL	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-932A	I-12-04	RTP01	PMP-932	1/2" IN 2"-ACD-PULK-120401	40 50 00	BACK PRESSURE	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-932B	I-12-04	RTP01	PMP-932	1/2" IN 2"-ACD-PULK-120401	40 50 00	PRESSURE RELIEF	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-932C	I-12-04	RTP01	PMP-932	1/2" IN 2"-ACD-PULK-120406	40 50 00	PRESSURE RELIEF	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-932D	I-12-04	RTP01	PMP-932	1/2" IN 2"-ACD-PULK-120403	40 50 00	BALL	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	NC; Part of acid feed pump package; spec'd per vendor quote
A	V-932E	I-12-04	RTP01	PMP-932	1/2" IN 2"-ACD-PULK-120403	40 50 00	SWING CHECK	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote

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CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	V-932F	I-12-04	RTP01	PMP-932	1/2" IN 2"-ACD-PULK-120403	40 50 00	BALL	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Part of acid feed pump package; spec'd per vendor quote
A	V-964A	I-12-04	RTP01	PI-964	PI-964	40 50 00	Vendor supplied	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Pressure indicator valve; Part of acid feed pump package; spec'd per vendor quote
A	V-965A	I-12-04	RTP01	PI-965	PI-965	40 50 00	Vendor supplied	1/2	ACD	Vendor supplied	Vendor supplied	A	0.017	80	Pressure indicator valve; Part of acid feed pump package; spec'd per vendor quote
A	V-940A	I-12-04	RTP01	TNK-944		40 50 00	BALL		DEW	Vendor supplied	Vendor supplied	A			Note 3
A	V-940C	I-12-04	RTP01	PMP-945	CCOL-0940	40 50 00	BALL		DEW	Vendor supplied	Vendor supplied	A			Note 3; Calibration column valve*, part of dewatering aid pump package
A	V-941A	I-12-04	RTP01	DRM-941		40 50 00	BALL		DEW	Vendor supplied	Vendor supplied	A			Note 3
A	V-942A	I-12-04	RTP01	PMP-942		40 50 00	BACK PRESSURE		DEW	Vendor supplied	Vendor supplied	A			Note 3; Included in dewatering aid system package
A	V-945A	I-12-04	RTP01	PMP-945		40 50 00	BALL		DEW	Vendor supplied	Vendor supplied	A			Note 3
A	V-945B	I-12-04	RTP01	PMP-945		40 50 00	PRESSURE RELIEF		DEW	Vendor supplied	Vendor supplied	A			Note 3
A	V-971A	I-12-04	RTP01	FI-971		40 50 00	BALL		DEW	Vendor supplied	Vendor supplied	A			Note 3; Included in dewatering aid system package
A	V-907A	I-12-04	RTP01	PMP-907	2"-WS-PULK-120408	40 50 00	BALL	2	WS	40 27 02	V335	A	35	12	
A	V-966A	I-12-04	RTP01	PI-966	PI-966	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	12	Pressure indicator valve*
A	V-966B	I-12-04	RTP01	PI-966	PI-966	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	12	Pressure indicator valve*
A	V-611A	I-12-05	RTP01	LPS-611	2"-SL-PULK-120501	40 50 00	BALL	2	SL	40 27 02	V335	A	15	120	
A	V-611B	I-12-05	RTP01	LPS-611	LPS-611	40 50 00	BALL	Supplier	SL	40 27 02	By Supplier	A	15	120	Drain Valve, NC
A	V-612A	I-12-05	RTP01	LPS-612	2"-SL-PULK-120503	40 50 00	BALL	2	SL	40 27 02	V335	A	15	120	
A	V-612B	I-12-05	RTP01	LPS-612	LPS-612	40 50 00	BALL	Supplier	SL	40 27 02	By Supplier	A	15	120	Drain Valve, NC
A	V-654B	I-12-05	RTP01	PSL-654	PSL-654	40 50 00	BALL	3/4*	UA	40 27 02	V335	A	15	50	Pressure switch valve*
A	V-654A	I-12-05	RTP01	PSL-654	PSL-654	40 50 00	BALL	3/4*	UA	40 27 02	V335	A	15	50	Pressure switch valve*
A	V-110C	I-12-05	RTP01	PMP-110	1-1/2"-FW-PULK-120505	40 50 00	DOUBLE SWING CHECK	1 1/2	FW	40 27 02	V640 or V642	A	20	78	
A	V-110D	I-12-05	RTP01	PMP-110	1-1/2"-FW-PULK-120505	40 50 00	BALL	1 1/2	FW	40 27 02	V335	A	20	78	
A	V-110E	I-12-05	RTP01	PMP-110	1-1/2"-FW-PULK-120505	40 50 00	BALL	1 1/2	FW	40 27 02	V335	A	20	78	
A	V-161A	I-12-05	RTP01	PI-161	PI-161	40 50 00	BALL	1/2*	FW	Vendor supplied	Vendor supplied	A	20	78	Part of seal water packaged system, Pressure indicator valve*
A	V-161B	I-12-05	RTP01	PI-161	PI-161	40 50 00	BALL	1/2*	FW	Vendor supplied	Vendor supplied	A	20	78	Part of seal water packaged system, Pressure indicator valve*
A	V-162	I-12-05	RTP01	PI-162	PI-162	40 50 00	BALL	Supplier	UA	Vendor supplied	Vendor supplied	A	106	100	Pressure indicator valve*
A	V-101C	I-12-05	RTP01	CMP-101	CMP-101	40 50 00	PRESSURE RELIEF	Supplier	UA	40 27 02	Vendor supplied	A	106	100	
A	V-101D	I-12-05	RTP01	CMP-101	X-102	40 50 00	BALL	Supplier	UA	40 27 02	Vendor supplied	A	106	100	Bypass air dryer/filter
A	V-103F	I-12-05	RTP01	DRM-103	DRM-103	40 50 00	PRESSURE RELIEF	Supplier	UA	Vendor supplied	Vendor supplied	A	106	100	Part of air receiver
A	V-103G	I-12-05	RTP01	DRM-103	DRM-103	40 50 00	BALL	Supplier	UA	Vendor supplied	Vendor supplied	A	106	100	Part of air receiver
A	V-607A	I-12-05	RTP01	PMP-607	2"-WS-PULK-120502	40 50 00	SWING CHECK	2	WS	40 27 02	V1693	A	35	20	
A	V-607B	I-12-05	RTP01	PMP-607	2"-WS-PULK-120502	40 50 00	BUTTERFLY	2	WS	40 27 02	V521	A	35	20	
A	V-653A	I-12-05	RTP01	PI-653	PI-653	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	20	Pressure indicator valve*
A	V-653B	I-12-05	RTP01	PI-653	PI-653	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	20	Pressure indicator valve*
A	V-401A	I-14-01	RTP01	TNK-401	2"-TW-PULK-140110	40 50 00	BUTTERFLY	2	TW	40 27 02	V521	A	35	25	
A	V-401B	I-14-01	RTP01	TNK-401	2"-TW-PULK-140113	40 50 00	BUTTERFLY	2	TW	40 27 02	V521	A	35	25	

CH2MHILL

CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	V-401C	I-14-01	RTP01	TNK-401	4"-DR-PULK-140118	40 50 00	BUTTERFLY	4	DR	40 27 02	V521	A	35	25	Drain Valve, NC
A	V-402A	I-14-01	RTP01	TNK-402	2"-TW-PULK-140111	40 50 00	BUTTERFLY	2	TW	40 27 02	V521	A	35	25	
A	V-402B	I-14-01	RTP01	TNK-402	2"-TW-PULK-140114	40 50 00	BUTTERFLY	2	TW	40 27 02	V521	A	35	25	
A	V-402C	I-14-01	RTP01	TNK-402	4"-DR-PULK-140119	40 50 00	BUTTERFLY	4	DR	40 27 02	V521	A	35	25	Drain Valve, NC
A	SP-405A	I-14-01	RTP01	PMP-405/406	2"-TW-PULK-140117	40 50 00	BALL	3/4*	TW	40 27 02	V335	A	35	25	Sample Port Valve
A	V-405B	I-14-01	RTP01	PMP-405	2"-TW-PULK-140118	40 50 00	SWING CHECK	2	TW	40 27 02	V631	A	35	25	
A	V-405C	I-14-01	RTP01	PMP-405	2"-TW-PULK-140118	40 50 00	BUTTERFLY	2	TW	40 27 02	V521	A	35	25	
A	V-461A	I-14-01	RTP01	PI-461	PI-461	40 50 00	BALL	1/2*	TW	40 27 02	V335	A	35	25	Pressure indicator valve*
A	V-461B	I-14-01	RTP01	PI-461	PI-461	40 50 00	BALL	1/2*	TW	40 27 02	V335	A	35	25	Pressure indicator valve*, NC
A	V-406A	I-14-01	RTP01	PMP-406	2"-TW-PULK-140101	40 50 00	BALL CHECK	2	TW	40 27 02	V631	A	35	25	
A	V-406B	I-14-01	RTP01	PMP-406	2"-TW-PULK-140101	40 50 00	BUTTERFLY	2	TW	40 27 02	V521	A	35	25	
A	V-462A	I-14-01	RTP01	PI-462	PI-462	40 50 00	BALL	1/2*	TW	40 27 02	V335	A	35	25	Pressure indicator valve*
A	V-462B	I-14-01	RTP01	PI-462	PI-462	40 50 00	BALL	1/2*	TW	40 27 02	V335	A	35	25	Pressure indicator valve*, NC
A	V-407A	I-14-01	RTP01	PMP-407	2"-WS-PULK-140103	40 50 00	SWING CHECK	2	WS	40 27 02	V1693	A	35	30	
A	V-407B	I-14-01	RTP01	PMP-407	2"-WS-PULK-140103	40 50 00	BUTTERFLY	2	WS	40 27 02	V521	A	35	30	
A	V-407C	I-14-01	RTP01	PMP-407	2"-WS-PULK-140119	40 50 00	SWING CHECK	2	WS	40 27 02	V1693	A	35	30	
A	V-407D	I-14-01	RTP01	PMP-407	2"-WS-PULK-140119	40 50 00	BUTTERFLY	2	WS	40 27 02	V521	A	35	30	
A	V-463A	I-14-01	RTP01	PI-463	PI-463	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	30	Pressure indicator valve*
A	V-463B	I-14-01	RTP01	PI-463	PI-463	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	30	Pressure indicator valve*, NC
A	V-510A	I-14-02	RTP01	TNK-510	2"-TW-HALE-120207	40 50 00	BUTTERFLY	2	TW	40 27 02	V521	A	35	25	BURIED VALVE (Bfly type)
A	V-510B	I-14-02	RTP01	TNK-510	2"-TW-PULK-140203	40 50 00	BUTTERFLY	2	TW	40 27 02	V521	A	35	25	
A	V-510G	I-14-02	RTP01	TNK-510	6"-DR-PULK-140212	40 50 00	BUTTERFLY	6	DR	40 27 02	V521	A	35	25	
A	V-561A	I-14-02	RTP01	PI-561	PI-561	40 50 00	BALL	1/2*	TW	40 27 02	V335	A	35	25	Pressure indicator valve*
A	V-561B	I-14-02	RTP01	PI-561	PI-561	40 50 00	BALL	1/2*	TW	40 27 02	V335	A	35	25	Pressure indicator valve*
A	V-501A	I-14-02	RTP01	PMP-501	3"-TW-PULK-140203	40 50 00	BUTTERFLY	3	TW	40 27 02	V521	A	35	25	
A	V-501B	I-14-02	RTP01	PMP-501	3"-TW-PULK-140209	40 50 00	BALL CHECK	3	TW	40 27 02	V631	A	35	48	
A	V-501C	I-14-02	RTP01	PMP-501	2"-TW-PULK-140209	40 50 00	BUTTERFLY	3	TW	40 27 02	V521	A	35	48	
A	V-501D	I-14-02	RTP01	PMP-501	2"-TW-PULK-140203	40 50 00	BUTTERFLY	3*	TW	40 27 02	V521	A	75	150	External connection
A	V-562A	I-14-02	RTP01	PI-562	PI-562	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	26	Pressure indicator valve*
A	V-562B	I-14-02	RTP01	PI-562	PI-562	40 50 00	BALL	1/2*	WS	40 27 02	V335	A	35	26	Pressure indicator valve*, NC
A	V-507A	I-14-02	RTP01	PMP-507	2"-WS-PULK-140201	40 50 00	BALL	2	WS	40 27 02	V335	A	35	26	
A	V-507B	I-14-02	RTP01	PMP-507	2"-WS-PULK-140211	40 50 00	BALL	2	WS	40 27 02	V335	A	35	26	
YARD PIPING VALVES															
A	TBD	C-07-20	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 16+80 - CARV shutoff
A	TBD	C-07-20	Pipeline A	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V101	A			Sta 16+80 - CARV shutoff
A	TBD	C-07-20	Pipeline A	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V101	A			Sta 16+80 - CARV shutoff
A	TBD	C-07-20	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 20+40 - Blowoff lateral
A	TBD	C-07-20	Pipeline A	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V134	A			Sta 20+40 - Blowoff lateral
A	TBD	C-07-21	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 21+40 - CARV shutoff
A	TBD	C-07-21	Pipeline A	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V101	A			Sta 21+40 - CARV shutoff
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 31+30 - Blowoff lateral
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 31+30 - Blowoff lateral
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V134	A			Sta 31+30 - Blowoff lateral
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	CA	40 27 02B	V134	A			Sta 31+30 - Blowoff lateral
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V134	A			Sta 31+30 - Blowoff lateral,
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 31+32 - CARV shutoff

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CLIENT: *PG&E*

PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062

REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 31+32 - CARV shutoff
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V101	A			Sta 31+32 - CARV shutoff
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	CA	40 27 02B	V101	A			Sta 31+32 - CARV shutoff
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V101	A			Sta 31+32 - CARV shutoff
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 33+26 - Blowoff lateral
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 33+26 - Blowoff lateral
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V134	A			Sta 33+26 - Blowoff lateral
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	CA	40 27 02B	V134	A			Sta 33+26 - Blowoff lateral
A	TBD	C-07-22	Pipeline A	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V134	A			Sta 33+26 - Blowoff lateral
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 46+00 - CARV shutoff
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 46+00 - CARV shutoff
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V101	A			Sta 46+00 - CARV shutoff
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	CA	40 27 02B	V101	A			Sta 46+00 - CARV shutoff
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V101	A			Sta 46+00 - CARV shutoff
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 53+50 - Blowoff lateral
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 53+50 - Blowoff lateral
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V134	A			Sta 53+50 - Blowoff lateral
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	CA	40 27 02B	V134	A			Sta 53+50 - Blowoff lateral
A	TBD	C-07-24	Pipeline A	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V134	A			Sta 53+50 - Blowoff lateral
A	TBD	C-07-31	Pipeline B	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 40+48 - CARV shutoff
A	TBD	C-07-31	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 40+53 - Blowoff lateral
A	TBD	C-07-31	Pipeline B	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 43+30 - CARV shutoff
A	TBD	C-07-31	Pipeline A	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 46+11 - Blowoff lateral
A	TBD	C-07-31	Pipeline B	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 46+16 - CARV shutoff
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 12+53 - Blowoff lateral
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V134	A			Sta 12+53 - Blowoff lateral
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	CA	40 27 02B	V134	A			Sta 12+53 - Blowoff lateral
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V134	A			Sta 12+53 - Blowoff lateral
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 13+41 - CARV shutoff
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V101	A			Sta 13+41 - CARV shutoff
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	CA	40 27 02B	V101	A			Sta 13+41 - CARV shutoff
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V101	A			Sta 13+41 - CARV shutoff
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 15+23 - Blowoff lateral
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V134	A			Sta 15+23 - Blowoff lateral
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	CA	40 27 02B	V134	A			Sta 15+23 - Blowoff lateral
A	TBD	C-07-25	Pipeline H	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V134	A			Sta 15+23 - Blowoff lateral
A	TBD	C-07-78	Pipeline I	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V101	A			Sta 12+00 - CARV shutoff
A	TBD	C-07-78	Pipeline I	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V101	A			Sta 12+00 - CARV shutoff
A	TBD	C-07-78	Pipeline I	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V101	A			Sta 12+00 - CARV shutoff
A	TBD	C-07-78	Pipeline I	TBD	TBD	TBD	GATE	1	FW	40 27 02B	V134	A			Sta 12+05 - Blowoff lateral
A	TBD	C-07-78	Pipeline I	TBD	TBD	TBD	GATE	1	RW	40 27 02B	V134	A			Sta 12+05 - Blowoff lateral
A	TBD	C-07-78	Pipeline I	TBD	TBD	TBD	GATE	1	SP	40 27 02B	V134	A			Sta 12+05 - Blowoff lateral
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	GATE	3/4	FW	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	GATE	3/4	FW	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	GATE	3/4	FW	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	GATE	3/4	FW	40 27 02B	V101 or V925	A			Sample tap

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CLIENT: *PG&E*

PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062

REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	GATE	3/4	CA	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	GATE	3/4	FW	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	GATE	3/4	CA	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	GATE	3/4	FW	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	GATE	3/4	CA	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	GATE	3/4	FW	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	GATE	3/4	CA	40 27 02B	V101 or V925	A			Sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	GATE	3/4	FW	40 27 02B	V101 or V925	A			Sample tap
A	TBD	C-07-31	Pipeline B		TBD	TBD	BUTTERFLY	12	FW	40 27 02B	V500	A			Isolation Valve, north of BNSF Railroad - Sta 48+45 on Pipeline B
A	TBD	C-07-31	Pipeline B		TBD	TBD	BUTTERFLY	12	FW	40 27 02B	V500	A			Isolation Valve, south of BNSF and north of I-40, Sta 45+45 on Pipeline B
A	TBD	C-07-31	Pipeline B		TBD	TBD	BUTTERFLY	12	FW	40 27 02B	V500	A			Isolation Valve, north of I-40 and south of I-40, Sta 43+20 on Pipeline B
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	BUTTERFLY	4	FW	40 27 02B	V500	A			Downstream of meter
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	BUTTERFLY	4	FW	40 27 02B	V500	A			Downstream of flow control valve
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	FLOW CONTROL	4	FW	40 27 02B		A			Flow control valve
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	NEEDLE OR GATE	1/4	FW	40 27 02B	V101	A			Pressure gauge
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	BUTTERFLY	4	FW	40 27 02B	V500	A			Upstream of flow control valve
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Upstream of meter
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	FLOW CONTROL	6	RW	40 27 02B		A			Flow control valve
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	SWING CHECK	6	RW	40 27 02B	V608	A			Check valve
A	TBD	M-02-01	FW-1	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Downstream of sample tap
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	BUTTERFLY	3	FW	40 27 02B	V500	A			Downstream of meter
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	BUTTERFLY	3	FW	40 27 02B	V500	A			Downstream of flow control valve
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	FLOW CONTROL	3	FW	40 27 02B		A			Flow control valve
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	NEEDLE OR GATE	1/4	FW	40 27 02B	V101	A			Pressure gauge
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	BUTTERFLY	3	FW	40 27 02B	V500	A			Upstream of flow control valve

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CLIENT: *PG&E*

PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062

REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	BUTTERFLY	4	RW	40 27 02B	V500	A			Upstream of meter
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	FLOW CONTROL	4	RW	40 27 02B		A			Flow control valve
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	SWING CHECK	4	RW	40 27 02B	V608	A			Check valve
A	TBD	M-02-01	FW-2	TBD	TBD	TBD	BUTTERFLY	4	RW	40 27 02B	V500	A			Downstream of sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Downstream of meter
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Downstream of flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	FLOW CONTROL	4	CA	40 27 02B		A			Flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	NEEDLE OR GATE	1/4	CA	40 27 02B	V101	A			Pressure gauge
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Upstream of flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	BUTTERFLY	4	CA/FW	40 27 02B	V500	A			Isolation between CA and FW lines
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Upstream of meter
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	FLOW CONTROL	6	RW	40 27 02B		A			Flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	SWING CHECK	6	RW	40 27 02B	V608	A			Check valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-1	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Downstream of sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Downstream of meter
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Downstream of flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	FLOW CONTROL	4	CA	40 27 02B		A			Flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	NEEDLE OR GATE	1/4	CA	40 27 02B	V101	A			Pressure gauge
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Upstream of flow control valve

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CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	BUTTERFLY	4	CA/FW	40 27 02B	V500	A			Isolation between CA and FW lines
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Upstream of meter
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	FLOW CONTROL	6	RW	40 27 02B		A			Flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	SWING CHECK	6	RW	40 27 02B	V608	A			Check valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-2	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Downstream of sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Downstream of meter
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Downstream of flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	FLOW CONTROL	4	CA	40 27 02B		A			Flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	NEEDLE OR GATE	1/4	CA	40 27 02B	V101	A			Pressure gauge
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Upstream of flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	BUTTERFLY	4	CA/FW	40 27 02B	V500	A			Isolation between CA and FW lines
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Upstream of meter
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	FLOW CONTROL	6	RW	40 27 02B		A			Flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	SWING CHECK	6	RW	40 27 02B	V608	A			Check valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-3	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Downstream of sample tap
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Downstream of meter

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CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MANUAL VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE / EQUIP. NO. [Note 1]	PIPE SPEC	VALVE TYPE	SIZE (IN)	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	VALVE REV.	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	REMARKS
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Downstream of flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	FLOW CONTROL	4	CA	40 27 02B		A			Flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	NEEDLE OR GATE	1/4	CA	40 27 02B	V101	A			Pressure gauge
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	BUTTERFLY	4	CA	40 27 02B	V500	A			Upstream of flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	BUTTERFLY	4	CA/FW	40 27 02B	V500	A			Isolation between CA and FW lines
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Upstream of meter
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	FLOW CONTROL	6	RW	40 27 02B		A			Flow control valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	SWING CHECK	6	RW	40 27 02B	V608	A			Check valve
A	TBD	M-05-02, M-05-05, M-05-06	IRL-4	TBD	TBD	TBD	BUTTERFLY	6	RW	40 27 02B	V500	A			Downstream of sample tap
Notes:															
1. See drawing I-00-02 for flow stream and material identification.															
2. Maximum Operating Pressure ratings apply to 73 degrees farenheit.															
3. The valve is part of a contingent system that may be constructed in the future.															
* Valves for instrumentation and control equipment will depend on the equipment that is supplied, which is to be determined. Contractor will have to coordinate the piping and valves with equipment supplied.															
NC= Normally closed															
TBD= To be determined															

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CLIENT: *PG&E* **PROJ. NO.:** 435062

PROJ. NAME: *Topock* **REV. NO.:** 0
PLANT AREA: *Remedy-Produced Water Conditioning Plant* **REV. DATE:** 8/20/2014
BY: CB
CHECKED: JP

SELF-CONTAINED AUTOMATED VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE/EQUIP NO. [Note 1]	VALVE TYPE	SIZE (IN)	FLUID	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	MAX OPERATING FLOW	MAX OPERATING FLOW UNITS	MAX OPERATING PRESSURE (PSI) [Note 2]	INLET PRESSURE*	OUTLET PRESSURE*	REMARKS
FRESHWATER SUPPLY, STORAGE, AND INJECTION EQUIPMENT VALVES																	
A	AVRV-011	I-01-01	HNWR1A	HNWR-1A	6"-FW-LCLF-010101	Air and vacuum release	1	Air	FW	33 12 16	TBD	1.67	scfs	180	130		Air and vacuum valve is installed on branch line from main piping, so it is smaller. In this case, with maximum flow rate of 1.67 scfs and 2 psi differential pressure, a 1 inch valve is probably sufficient. Maximum operating flow based on 750 gpm pump rate.
A	AVRV-011	I-01-01	SiteB	Site B	6"-FW-LCLF-010103	Air and vacuum release	1	Air	FW	33 12 16	TBD	1.67	scfs	245	156		Air and vacuum valve is installed on branch line from main piping, so it is smaller. In this case, with maximum flow rate of 1.67 scfs and 2 psi differential pressure, a 1 inch valve is probably sufficient. Maximum operating flow based on 750 gpm pump rate.
A	ARV-014	I-02-04	FW01	FW01	4"-FW-PVLK-020403	Air and vacuum release	1 or 2	Air	FW	33 12 16	A. Air Valve, Water Service	27	cfm	5			APCO 200 or equal
A	ARV-015	I-02-04	FW01	FW01	6"-FW-PULK-020401	Air and vacuum release	1 or 2	Air	FW	33 12 16	A. Air Valve, Water Service	54	cfm	85			APCO 200 or equal
A	FCV-012	I-02-04	FW01	FW01	4"-FW-PULK-020401	Downhole Flow Control	4	Water	FW	40 27 02	ASR LLC (see data sheet)	400	gpm	208			
A	ARV-014	I-02-04	FW02	FW02	4"-FW-PVLK-020403	Air and vacuum release	1 or 2	Air	FW	33 12 16	A. Air Valve, Water Service	27	cfm	60			APCO 200A or equal
A	ARV-015	I-02-04	FW02	FW02	6"-FW-PULK-020401	Air and vacuum release	1 or 2	Air	FW	33 12 16	A. Air Valve, Water Service	13.5	cfm	85			APCO 200A or equal
A	FCV-012	I-02-04	FW02	FW02	4"-FW-PULK-020401	Downhole Flow Control	4	Water	FW	40 27 02	ASR LLC (see data sheet)	200	gpm	130			
REMEDY-PRODUCED WATER CONDITIONING PLANT VALVES																	
A	FCV-511	I-14-02	RTP01	TNK-510	2"-TW-PULK-140204	Ball	2	Water	TW								Note 3
YARD PIPING VALVES																	
A	TBD	C-07-20	Pipeline A, Sta 16+80		TBD	Combination Air and vacuum valve	1	Air	FW, RW, SP	33 12 16	TBD	1.67	scfs	150			Three valves
A	TBD	C-07-21	Pipeline A, Sta 21+40		TBD	Combination Air and vacuum valve	1	Air	FW, RW	33 12 16	TBD	1.67	scfs	150			Two valves
A	TBD	C-07-22	Pipeline A, Sta 31+30		TBD	Combination Air and vacuum valve	1	Air	FW (2), RW, CA, SP	33 12 16	TBD	1.67	scfs	150			Five valves
A	TBD	C-07-24	1		TBD	Combination Air and vacuum valve	1	Air	FW (2), RW, CA, SP	33 12 16	TBD	1.67	scfs	150			Five valves
A	TBD	C-07-25	Pipeline H, Sta 13+25		TBD	Combination Air and vacuum valve	1	Air	FW, RW, CA, SP	33 12 16	TBD	1.67	scfs	150			Four valves, Sta will change to 13+41
A	TBD	C-07-27	Pipeline B		12" FW	FLANGED RESILIENT WEDGE GATE VALVE	2	Water	FW	33 12 16	Water Service	TBD	TBD	TBD			2 valves
A	TBD	C-07-28	Pipeline B		12" FW	FLANGED RESILIENT WEDGE GATE VALVE	2	Water	FW	33 12 16	Water Service	TBD	TBD	TBD			2 valves
A	TBD	C-07-31	Pipeline B, Sta 40+48		TBD	Combination Air and vacuum valve	1	Air	FW	33 12 16	TBD	1.67	scfs	150			Single valve
A	TBD	C-07-31	Pipeline B, Sta 43+30		TBD	Combination Air and vacuum valve	1	Air	FW	33 12 16	TBD	1.67	scfs	150			Single valve
A	TBD	C-07-31	Pipeline B, Sta 46+01		TBD	Combination Air and vacuum valve	1	Air	FW	33 12 16	TBD	1.67	scfs	150			Single valve
A	TBD	C-07-69	Pipeline J		8" FW	Brass Gate Valve	2	Water	FW	33 12 16	Water Service	TBD	TBD	TBD			2 valves
A	TBD	C-07-69	Pipeline B		8" FW	Brass Gate Valve	2	Water	FW	33 12 16	Water Service	TBD	TBD	TBD			2 valves
A	TBD	C-07-69	Pipeline J		12" FW	Air and vacuum release	2	Water	FW	33 12 16	A. Air Valve, Water Service	TBD	TBD	TBD			2" dia. Single body combination air valve and vaccum valve, 2 valves
A	TBD	C-07-69	Pipeline B		12" FW	Air and vacuum release	2	Water	FW	33 12 16	A. Air Valve, Water Service	TBD	TBD	TBD			2" dia. Single body combination air valve and vaccum valve, 2 valves
A	TBD	C-07-74	Pipeline L		2" TW	Air and vacuum release	3/4	Water	TW	33 12 16	A. Air Valve, Water Service	TBD	TBD	150			NETAFIM GUARDIAN MODEL 65AR1A075, 1 valve
A	TBD	C-07-74	Pipeline L		2" TW	Ball valve	3/4	Water	TW	33 12 16	A. Air Valve, Water Service	TBD	TBD	TBD			CAPRI BALL VALVE 600CP/150 SWP NO. 9302, 1 valve

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE/EQUIP NO. [Note 1]	VALVE TYPE	SIZE (IN)	FLUID	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	MAX OPERATING FLOW	MAX OPERATING FLOW UNITS	MAX OPERATING PRESSURE (PSI) [Note 2]	INLET PRESSURE*	OUTLET PRESSURE*	REMARKS
A	TBD	C-07-78	Pipeline I, Sta 12+00		TBD	Combination Air and vacuum valve	1	Air	FW, RW, SP	33 12 16	TBD	1.67	scfs	150			Three valves, Not shown on drawings yet
A	TBD		Pipeline L3, Sta 82 +/-		TBD	Air Release	1	Air	TW	33 12 16	A. Air Valve, Water Service	5.2	cfm	30			Netafim Guardian 3/4" 65ARIA075
Notes																	
1. See drawing I-00-02 for flow stream and material identification.																	
2. Maximum Operating Pressure ratings apply to 73 degrees farenheit.																	
3. The valve is part of a contingent system that may be constructed in the future.																	
*Inlet/Outlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.																	
TBD= To be determined																	

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CLIENT: *PG&E*
PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

SOLENOID VALVE SCHEDULE

REV.	TAG NO.	P&ID NO.	LOCATION ID	SECONDARY LOCATION ID	LINE/EQUIP NO. [Note 1]	VALVE TYPE	SIZE (IN)	FLUID	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	MAX OPERATING FLOW	MAX OPERATING FLOW UNITS	MAX OPERATING PRESSURE (PSI) [Note 2]	VALVE ACTUATOR TYPE	VOLTAGE (V)	FAIL POSITION	REMARKS
REMEDY-PRODUCED WATER CONDITIONING PLANT VALVES																		
A	SV-201	I-11-01	RTP01	PMP-201	1/2"-UW-PULK-110109	Solenoid	1/2	Water	UW	Vendor supplied	Vendor supplied	0.5	gpm	78	Solenoid	120	FC	By pump supplier
A	SV-217	I-11-01	RTP01	Solenoid Panel	6"-RW-PULK-110107	Solenoid	2	Air	IA	40 27 02	V940	1.5	scfs	115	Solenoid	120	FC	--
A	SV-202	I-11-02	RTP01	PMP-202	1/2"-UW-PULK-110209	Solenoid	1/2	Water	UW	Vendor supplied	Vendor supplied	0.5	gpm	78	Solenoid	120	FC	By pump supplier
A	SV-227	I-11-02	RTP01	Solenoid Panel	6"-RW-PULK-110207	Solenoid	2	Air	IA	40 27 02	V940	1.5	scfs	115	Solenoid	120	FC	--
A	SV-203	I-11-03	RTP01	PMP-203	1/2"-UW-PULK-110309	Solenoid	1/2	Water	UW	Vendor supplied	Vendor supplied	0.5	gpm	78	Solenoid	120	FC	By pump supplier
A	SV-237	I-11-03	RTP01	Solenoid Panel	6"-RW-PULK-110307	Solenoid	2	Air	IA	40 27 02	V940	1.5	scfs	115	Solenoid	120	FC	--
A	SV-204	I-11-04	RTP01	PMP-204	1/2"-UW-PULK-110409	Solenoid	1/2	Water	UW	Vendor supplied	Vendor supplied	0.5	gpm	78	Solenoid	120	FC	By pump supplier
A	SV-247	I-11-04	RTP01	Solenoid Panel	6"-RW-PULK-110407	Solenoid	2	Air	IA	40 27 02	V940	1.5	scfs	115	Solenoid	120	FC	--
A	SV-310	I-12-01	RTP01	PMP-310	1/2"-UW-PULK-120108	Solenoid	1/2	Water	UW	Vendor supplied	Vendor supplied	0.5	gpm	78	Solenoid	120	FC	By pump supplier
A	SV-320	I-12-01	RTP01	PMP-320	1/2"-UW-PULK-120108	Solenoid	1/2	Water	UW	Vendor supplied	Vendor supplied	0.5	gpm	78	Solenoid	120	FC	By pump supplier
A	SV-311	I-12-02	RTP02	Filter skid panel	2"-RW-PULK-120111	Solenoid	2	Air	IA	40 27 02	V940	1.5	scfs	115	Solenoid	24 VDC	FC	By filter supplier
A	SV-330	I-12-02	RTP03	PMP-330	1/2"-UW-PULK-120208	Solenoid	1/2	Water	UW	Vendor supplied	Vendor supplied	0.5	gpm	78	Solenoid	120	FC	By pump supplier
A	SV-340	I-12-02	RTP01	PMP-340	1/2"-UW-PULK-120208	Solenoid	1/2	Water	UW	Vendor supplied	Vendor supplied	0.5	gpm	78	Solenoid	120	FC	By pump supplier
A	SV-331	I-12-02	RTP02	Filter skid panel	2"-RW-PULK-120210	Solenoid	2	Air	IA	40 27 02	V940	1.5	scfs	115	Solenoid	24 VDC	FC	By filter supplier
Notes:																		
1. See drawing I-00-02 for flow stream and material identification.																		
2. Maximum Operating Pressure ratings apply to 73 degrees farenheit.																		
FC= Fail Closed																		

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CLIENT: *PG&E*

PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

PROJ. NO.: 435062

REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

ELECTRIC POWER AUTOMATED VALVE SCHEDULE

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE/EQUIP NO. [Note 1]	VALVE TYPE	SIZE (IN)	FLUID	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	CONTROL FEATURE MODIFICATIONS/SUPPLEMENTS	VALVE ACTUATOR TYPE	VOLTAGE (V)	SERVICE	TRAVEL TIME (SEC)	FAIL POSITION	REMARKS
FRESHWATER SUPPLY, STORAGE, AND INJECTION EQUIPMENT VALVES																				
A	FV-010	I-01-01	HNWR1A	STR-010	6"-FW-LCLF-0104	Butterfly	1-1/2	Water	FW	Vendor supplied	Vendor supplied	180	204	Vendor supplied	Electric Motor	120	O/C	*		Included with separator package
A	FV-010	I-01-01	SiteB	STR-010	6"-FW-LCLF-0104	Butterfly	1-1/2	Water	FW	Vendor supplied	Vendor supplied	245	264	Vendor supplied	Electric Motor	120	O/C	*		Included with separator package
A	FV-011	I-02-04	FW01	FW01	4"-FW-PULK-020401	Butterfly	4	Water	FW	40 27 02	V521	900	25	Limit switches	Electric Motor	120	O/C	*		--
A	FV-012	I-02-04	FW01	PMP-001	6"-RW-PULK-020401	Butterfly	6	Water	RW	40 27 02	V521	900	135	Limit switches	Electric Motor	120	O/C	*		--
A	FV-011	I-02-04	FW02	FW-02	4"-FW-PULK-020401	Butterfly	4	Water	FW	40 27 02	V521	900	25	Limit switches	Electric Motor	120	O/C	*		--
A	FV-012	I-02-04	FW02	PMP-001	6"-RW-PULK-020401	Butterfly	6	Water	RW	40 27 02	V521	900	75	Limit switches	Electric Motor	120	O/C	*		--
REMEDY-PRODUCED WATER CONDITIONING PLANT VALVES																				
A	FV-313	I-12-01	RTP01	FIL-311	FIL-311	Ball	3/4	Water	DR	Vendor supplied	Vendor supplied	35	23	Vendor supplied	Electric Motor	120	O/C	*	FC	By filter supplier
A	FV-313	I-12-02	RTP01	FIL-331	FIL-331	Ball	3/4	Water	DR	Vendor supplied	Vendor supplied	35	43	Vendor supplied	Electric Motor	120	O/C	*	FC	By filter supplier
A	FV-314	I-12-01	RTP01	FIL-312	FIL-312	Ball	3/4	Water	DR	Vendor supplied	Vendor supplied	35	23	Vendor supplied	Electric Motor	120	O/C	*	FC	By filter supplier
A	FV-314	I-12-02	RTP01	FIL-332	FIL-332	Ball	3/4	Water	DR	Vendor supplied	Vendor supplied	35	43	Vendor supplied	Electric Motor	120	O/C	*	FC	By filter supplier
A	FV-323	I-12-01	RTP01	FIL-321	FIL-321	Ball	3/4	Water	DR	Vendor supplied	Vendor supplied	35	23	Vendor supplied	Electric Motor	120	O/C	*	FC	By filter supplier
A	FV-323	I-12-02	RTP01	FIL-341	FIL-341	Ball	3/4	Water	DR	Vendor supplied	Vendor supplied	35	43	Vendor supplied	Electric Motor	120	O/C	*	FC	By filter supplier
A	FV-324	I-12-01	RTP01	FIL-322	FIL-322	Ball	3/4	Water	DR	Vendor supplied	Vendor supplied	35	23	Vendor supplied	Electric Motor	120	O/C	*	FC	By filter supplier
A	FV-324	I-12-02	RTP01	FIL-342	FIL-342	Ball	3/4	Water	DR	Vendor supplied	Vendor supplied	35	43	Vendor supplied	Electric Motor	120	O/C	*	FC	By filter supplier
A	FV-514	I-14-02	RTP01	TNK-510	2"-TW-HALE-140205	Ball	2	Water	TW	40 27 02	V335	900	25	Limit switches	Electric Motor	120	O/C	*		--

Notes

1. See drawing I-00-02 for flow stream and material identification.
2. Maximum Operating Pressure ratings apply to 73 degrees farenheit.

* Travel time to be determined by manufacturer

FC= Fail Closed

O/C=Open/Closed

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CLIENT: *PG&E*
PROJ. NO.: 435062

PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*
REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

PNEUMATIC AUTOMATED VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE/EQUIP NO. [Note 1]	VALVE TYPE	SIZE (IN)	FLUID	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	ACTUATOR TYPE AND CONTROL FEATURES	SERVICE	TRAVEL TIME (SEC)	FAIL POSITION	REMARKS
REMEDY-PRODUCED WATER CONDITIONING PLANT VALVES																		
A	XV-211	I-11-01	RTP01	TNK-201	2"-RW-PULK-110102	Butterfly	2	Water	RW	40 27 02	V521	35	46	Vendor supplied	O/C		FC	--
A	XV-212	I-11-01	RTP01	TNK-201	2"-RW-PULK-110103	Butterfly	2	Water	RW	40 27 02	V521	35	46	Vendor supplied	O/C		FC	--
A	XV-213	I-11-01	RTP01	TNK-201	1/2" IN 2"-CAU-110110	Ball	1/2	25% NaOH	CAU	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	--
A	XV-214	I-11-01	RTP01	TNK-201	1/2" IN 2"-ACD-110104	Ball	1/2	19% HCl	ACD	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	--
A	XV-215	I-11-01	RTP01	TNK-201	1/2" IN 2"-COG-110108	Ball	1/2	Polymer	COG	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	Note 3, Note 4
A	XV-217	I-11-01	RTP01	TNK-201	6"-RW-PULK-110107	Butterfly	6	Water	RW	40 27 02	V521	400	48	Limit switches	O/C	*	FC	--
A	XV-221	I-11-02	RTP01	TNK-202	2"-RW-PULK-110202	Butterfly	2	Water	RW	40 27 02	V521	35	46	Vendor supplied	O/C		FC	--
A	XV-222	I-11-02	RTP01	TNK-202	2"-RW-PULK-110203	Butterfly	2	Water	RW	40 27 02	V521	35	46	Vendor supplied	O/C		FC	--
A	XV-223	I-11-02	RTP01	TNK-202	1/2" IN 2"-CAU-110210	Ball	1/2	25% NaOH	CAU	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	--
A	XV-224	I-11-02	RTP01	TNK-202	1/2" IN 2" -ACD-110204	Ball	1/2	19% HCl	ACD	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	--
A	XV-225	I-11-02	RTP01	TNK-202	1/2" IN 2"-COG-110208	Ball	1/2	Polymer	COG	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	Note 3, Note 4
A	XV-227	I-11-02	RTP01	TNK-202	6"-RW-PULK-110207	Butterfly	6	Water	RW	40 27 02	V521	400	48	Limit switches	O/C	*	FC	--
A	XV-231	I-11-03	RTP01	TNK-203	2"-RW-PULK-110302	Butterfly	2	Water	RW	40 27 02	V521	35	46	Vendor supplied	O/C		FC	--
A	XV-232	I-11-03	RTP01	TNK-203	2"-RW-PULK-110303	Butterfly	2	Water	RW	40 27 02	V521	35	46	Vendor supplied	O/C		FC	--
A	XV-233	I-11-03	RTP01	TNK-203	1/2" IN 2"-CAU-110310	Ball	1/2	25% NaOH	CAU	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	--
A	XV-234	I-11-03	RTP01	TNK-203	1/2" IN 2"-ACD-110304	Ball	1/2	19% HCl	ACD	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	--
A	XV-235	I-11-03	RTP01	TNK-203	1/2" IN 2"-COG-110308	Ball	1/2	Polymer	COG	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	Note 3, Note 4
A	XV-237	I-11-03	RTP01	TNK-203	6"-RW-PULK-110307	Butterfly	6	Water	RW	40 27 02	V521	400	48	Limit switches	O/C	*	FC	--
A	XV-241	I-11-04	RTP01	TNK-204	2"-RW-PULK-110402	Butterfly	2	Water	RW	40 27 02	V521	35	46	Vendor supplied	O/C		FC	--
A	XV-242	I-11-04	RTP01	TNK-204	2"-RW-PULK-110408	Butterfly	2	Water	RW	40 27 02	V521	35	46	Vendor supplied	O/C		FC	--
A	XV-243	I-11-04	RTP01	TNK-204	1/2" IN 2"-CAU-110410	Ball	1/2	25% NaOH	CAU	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	--
A	XV-244	I-11-04	RTP01	TNK-204	1/2" IN 2"-ACD-110404	Ball	1/2	19% HCl	ACD	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	--
A	XV-245	I-11-04	RTP01	TNK-204	1/2" IN 2"-COG-110408	Ball	1/2	Polymer	COG	40 27 02	V335	0.17	80	Vendor supplied	O/C		FC	Note 3, Note 4
A	XV-247	I-11-04	RTP01	TNK-204	6"-RW-PULK-110407	Butterfly	6	Water	RW	40 27 02	V521	400	48	Limit switches	O/C	*	FC	--
A	XV-311A	I-12-01	RTP01	FIL-311	2"-RW-PULK-120103	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	23	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-311C	I-12-01	RTP01	FIL-311	2"-RW-PULK-120104	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	23	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-312A	I-12-01	RTP01	FIL-312	2"-RW-PULK-120109	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	23	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-312C	I-12-01	RTP01	FIL-312	2"-RW-PULK-120106	Butterfly	2	Water	TW	Vendor supplied	Vendor supplied	35	23	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-321A	I-12-01	RTP01	FIL-321	2"-RW-PULK-120103	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	23	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-321C	I-12-01	RTP01	FIL-321	2"-RW-PULK-120105	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	23	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-322A	I-12-01	RTP01	FIL-322	2"-RW-PULK-120105	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	23	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-322C	I-12-01	RTP01	FIL-322	2"-TW-PULK-120107	Butterfly	2	Water	TW	Vendor supplied	Vendor supplied	35	23	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-331A	I-12-02	RTP01	FIL-331	2"-RW-PULK-120202	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	43	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-331C	I-12-02	RTP01	FIL-331	2"-RW-PULK-120204	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	43	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-332A	I-12-02	RTP01	FIL-332	2"RW-PULK-120209	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	43	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-332C	I-12-02	RTP01	FIL-332	2"-RW-PULK-120206	Butterfly	2	Water	TW	Vendor supplied	Vendor supplied	35	43	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-341A	I-12-02	RTP01	FIL-341	2"-RW-PULK-120203	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	43	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-341C	I-12-02	RTP01	FIL-341	2"-RW-PULK-120205	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	43	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-342A	I-12-02	RTP01	FIL-342	2"-RW-PULK-120205	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	43	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-342C	I-12-02	RTP01	FIL-342	2"-RW-PULK-120205	Butterfly	2	Water	RW	Vendor supplied	Vendor supplied	35	43	Vendor supplied	O/C		FC	By filter supplier, Note 5
A	XV-610	I-12-05	RTP01	PMP-601	2"-UA-HEAD-120504	Ball	2	Comp. Air	UA	40 27 02-17	V335	15 scfm	115	Vendor supplied	O/C		FC	--
A	XV-411	I-14-01	RTP01	TNK-401	2"-TW-PULK-140110	Butterfly	2	Water	TW	40 27 02-25	V521	35	43	Vendor supplied	O/C		FC	--
A	XV-412	I-14-01	RTP01	TNK-402	2"-TW-PULK-140111	Butterfly	2	Water	TW	40 27 02-25	V521	35	43	Vendor supplied	O/C		FC	--

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CLIENT: *PG&E*
PROJ. NO.: 435062

PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

PNEUMATIC AUTOMATED VALVE LIST

REV.	TAG NO.	P&ID DWG. NO.	LOCATION ID	SECONDARY LOCATION ID	LINE/EQUIP NO. [Note 1]	VALVE TYPE	SIZE (IN)	FLUID	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	MAX OPERATING FLOW (GPM)	MAX OPERATING PRESSURE (PSI) [Note 2]	ACTUATOR TYPE AND CONTROL FEATURES	SERVICE	TRAVEL TIME (SEC)	FAIL POSITION	REMARKS
REMEDY-PRODUCED WATER CONDITIONING PLANT VALVES																		
A	XV-415	I-14-01	RTP01	PMP-405/ PMP-406	2"-TW-PULK-140101	Ball	2	Water	TW	40 27 02-17	V335	35	25	Vendor supplied	O/C		FC	--
A	XV-416	I-14-01	RTP01	PMP-405/ PMP-406	2"-TW-PULK-140102	Ball	2	Water	TW	40 27 02-17	V335	35	25	Vendor supplied	O/C		FC	--
Notes																		
1. See drawing I-00-02 for flow stream and material identification.																		
2. Maximum Operating Pressure ratings apply to 73 degrees farenheit.																		
3. The valve is part of a contingent system that may be constructed in the future.																		
4. Polymer: Nalco Ultrion 8187 (pH=3.5, SG-=1.34, Visc. @ 73F = 16 cps)																		
5. Assume negligible head loss from filters (vendor brochure says 0.8 psi)																		
* Travel time to be determined by manufacturer																		
FC= Fail Closed																		
O/C=Open/Closed																		

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CLIENT: *PG&E*
PROJ. NO.: 435062

PROJ. NAME: *Topock*
PLANT AREA: *Remedy-Produced Water Conditioning Plant*

REV. NO.: 0
REV. DATE: 8/20/2014
BY: CB
CHECKED: JP

MISCELLANEOUS VALVE LIST

REV.	TAG NO.	P&ID NO.	LOCATION ID	SECONDARY LOCATION ID	LINE/EQUIP NO. [Note 1]	VALVE TYPE	SIZE (IN)	FLUID	FLOW STREAM [Note 1]	VALVE SPECIFICATION	VALVE SPECIFICATION TYPE	MAX OPERATING FLOW	MAX OPERATING FLOW UNITS	MAX OPERATING PRESSURE (PSI) [Note 2]	INLET PRESSURE*	OUTLET PRESSURE*	REMARKS
A	TBD	I-12-03	RTP01	CAU FEED SYSTEM	TBD	Y Strainer	0.5	25% NaOH	CAU	Vendor supplied	Vendor supplied	0.17	gpm	80			Included in caustic feed package
A	TBD	I-12-03	RTP01	COG FEED SYSTEM	TBD	Y Strainer	0.5	Polymer	COG	Vendor supplied	Vendor supplied	0.17	gpm	80			Note 3; Note 4; Included in coagulant feed package
A	TBD	I-12-04	RTP01	ACD FEED SYSTEM	TBD	Y Strainer	0.5	19% HCl	ACD	Vendor supplied	Vendor supplied	0.17	gpm	80			Included in acid feed package
A	STR-110	I-12-05	RTP01	SEAL WATER	1.5"-FW-PULK-120505	Y Strainer	1.5	Water	FW	Bronze	*FPTxFPT Full Cap*	20	gpm	70			Mueller 351M, Nibco T-222-B or
A	FCV-511	I-14-02	RTP01	TNK-510	2''-TW-PULK-140204	Ball	2	Water	TW	Vendor supplied	Vendor supplied	0.17	gpm	80			Note 3
Notes																	
1. See drawing I-00-02 for flow stream and material identification.																	
2. Maximum Operating Pressure ratings apply to 73 degrees farenheit.																	
3. The valve is part of a contingent system that may be constructed in the future.																	
4. Polymer: Nalco Ultrion 8187 (pH=3.5, SG-=1.34, Visc. @ 73F = 16 cps)																	
*Inlet/Outlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.																	
TBD= To be determined																	

CONTROL VALVE DATA SHEET

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PROJECT TOPOCK 90% DEISGN
UNIT FRESHWATER INJECTION
WELL, FW-001
P.O.
ITEM 1
CONTRACT 435062

DATA SHEET 1 OF 1
SPEC 40 27 02
TAG **FCV-012**
DWG I-02-02
SERVICE Freshwater

1 Fluid: Water

SERVICE CONDITIONS

	Units	Max Flow	Norm Flow	Min Flow	Shutoff	
Flow Rate	gpm	**400**		**200**	**0**	
Inlet Pressure	psig	**Note 4**		**Note 4**	**5**	
Outlet Pressure	psig	**119**		**119**	**0**	
Inlet Temperature	°F	**86**		**86**		
Spec Wt/Spec Grav/Mol Wt		**1**		1	--	
Viscosity/Spec Heats Ratio		**1**		1	--	
Vapor Pressure P_v		**.13mmHg**		**.13mmHg**	--	
*Required C_v		**5.46**		**0.22**	--	
*Travel	%	**85**		**20**	**0**	
Allowable/*Predicted SPL	dBA	/	/	/	--	

LINE

Pipe Line Size & Schedule: In **4 inch Sch 40 CS**; Out **4 inch Sch. 40 CS**
Pipe Line Insulation None

VALVE BODY/BONNET

*Type **Downhole Flow Control**
*Size **4 inch**
Max Press/Temp **150 psig/130 deg F**
*Mfr & Model: **ASR V Smart**
*Body/Bonnet Matl **Type 304 Stainless Steel**
*Liner Material/ID
End Connection: In **Female NPT**; Out **Female NPT e**
Fig Face Finish
End Ext/Matl
*Flow Direction **Bidirectional**
*Type of Bonnet
Lub & ISO Valve Lube
*Packing Material **Manufacturer Standard**
Packing Type

TRIM

*Type
*Size Rated Travel
*Characteristic: **Equal Percentage**
*Balanced/Unbalanced
Rated C_V **10.5** F_L X_T
*Plug/Ball/Disk Material:
*Seat Material
*Cage/Guide Material
*Stem Material**: SS Shaft**

S/AC

1. 4-20 mA position feedback transmitter

ACTUATOR

*Type **Hydraulically Operated**
*Mfr & Model: **Food Grade Oil/GE or equivalent**
*Size Eff Area
On/Off **Modulating**
Spring Action Open/Close
*Max Allowable Pressure
*Min Required Pressure
Available Air Supply Pressure: N/A
Max Min
Material: /
Actuator Action:
Handwheel Type **None**
Air Failure Valve **None** Set at

POSITIONER

Input Signal: **4-20 mA**
*Type
*Mfr & Model **ASR**
*On **Incr Signal** Output: **Valve Opens**
Gauges Bypass
*Cam Characteristic

SWITCHES

Type Quantity
*Mfr & Model
Contacts/Rating
Actuation Points

AIR SET

*Mfr & Model :
*Set Pressure
Filter: Gauge :

E S

*Hydro Pressure
ANSI/FCI Leakage Class

CONTROL VALVE DATA SHEET

44		Continental Hydraulics, custom hydraulic power units (HPU) capable of operating one V-Smart valve. HPU is in NEMA-3R enclosures with one set of internal mounted controls including Hand/Off/Auto switch, pump Run/Stop push buttons, Valve Open/Stop/Valve Close selector switch, Power On/Pump run/Valve Closed/Valve Open position indication lights. The units include single solenoid control valves (controls the opening and closing of each valve), pre-set pressure relief valves, hydraulic speed controls (controls valve operating speed), check valves (allows the valve to maintain a fixed position when the solenoid is de-energized), pressure gages, oil reservoir with sight gage and 10 gallons food grade mineral oil. HPU enclosure dimensions a maximum of 33" x 25" x 17". Provide necessary hydraulic hoses with quick connect fittings and needle type control valve for speed adjustment.	83	
45			84		
46			Rev	Date	Revision
47			A	7/18/12	IFR
48			B	8/23/14	IFR
49					
50					

Notes:
*Information supplied by manufacturer unless already specified.
Note 1: This is a down hole flow and pressure control valve used is ASR wells located in a single pipe with bi-directional flow for injection and recovery.
Note 2: Well ID is 14" and valve will be in inline with a submersible pump.
Note 3: Well is 353' deep and will receive up to 200 gpm (injection) and 400 gpm nominal during recovery during backwashing.
Note 4: Column pressure is from gravity flow into well.

CONTROL VALVE DATA SHEET

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PROJECT TOPOCK 60% DEISGN
UNIT FRESHWATER INJECTION
WELL, FW-002
P.O.
ITEM 1
CONTRACT 435062

DATA SHEET 1 OF 1
SPEC
TAG **FCV-015**
DWG CH-I-XXX-0201AD.dwg
SERVICE Freshwater

Fluid: Water

SERVICE CONDITIONS

	Units	Max Flow	Norm Flow	Min Flow	Shutoff
Flow Rate	gpm	**200**		**100**	**0**
Inlet Pressure	psig	**Note 4**		**Note 4**	**5**
Outlet Pressure	psig	**88**		**88**	**0**
Inlet Temperature	°F	**86**		**86**	
Spec Wt/Spec Grav/Mol Wt		**1**		1	--
Viscosity/Spec Heats Ratio		**1**		1	--
Vapor Pressure P_v		**.13mmHg**		**.13mmHg**	--
*Required C_v		**5.46**		**0.22**	--
*Travel	%	**85**		**20**	**0**
Allowable/*Predicted SPL	dBA	/	/	/	--

LINE

Pipe Line Size & Schedule: In **4 inch Sch 40 CS**; Out **4 inch Sch 40 CS**
Pipe Line Insulation: None

VALVE BODY/BONNET

*Type **Downhole Flow Control**
*Size **4 inch**
Max Press/Temp **150 psig/130 deg F**
*Mfr & Model: **ASR V-Smart**
*Body/Bonnet Matl **Type 304 Stainless Steel**
*Liner Material/ID
End Connection: In **Female NPT**; Out **Female NPT**
Fig Face Finish
End Ext/Matl
*Flow Direction Bidirectional
*Type of Bonnet
Lub & ISO Valve: Lube
*Packing Material: Manufac Standard
Packing Type

TRIM

*Type
*Size: Rated Travel
*Characteristic: **Equal Percentage**
*Balanced/Unbalanced
Rated C_V **10.5** F_L X_T
*Plug/Ball/Disk Material:
*Seat Material
*Cage/Guide Material
*Stem Material**: SS Shaft**

ACTUATOR

*Type **Hydraulically Operated**
*Mfr & Model: **Food Grade Oil/GE or equivalent**
*Size: Eff Area
On/Off **Modulating**
Spring Action Open/Close
*Max Allowable Pressure
*Min Required Pressure
Available Air Supply Pressure: N/A
Max Min
Material: /
Actuator Action:
Handwheel Type **None**
Air Failure Valve **None** Set at

POSITIONER

Input Signal: **4-20 mA**
*Type
*Mfr & Model **ASR**
*On **Incr Signal** Output: **Valve Opens**
Gauges: Bypass
*Cam Characteristic

SWITCHES

Type Quantity
*Mfr & Model
Contacts/Rating
Actuation Points

AIR SET

*Mfr & Model :
*Set Pressure
Filter: Gauge :

CONTROL VALVE DATA SHEET

42	SPECIALS/ACCESSORIES	**Continental Hydraulics, custom hydraulic power units (HPU) capable of operating one V-Smart valve. HPU is in NEMA-3R enclosures with one set of internal mounted controls including Hand/Off/Auto switch, pump Run/Stop push buttons, Valve Open/Stop/Valve Close selector switch, Power On/Pump run/Valve Closed/Valve Open position indication lights. The units include single solenoid control valves (controls the opening and closing of each valve), pre-set pressure relief valves, hydraulic speed controls (controls valve operating speed), check valves (allows the valve to maintain a fixed position when the solenoid is de-energized), pressure gages, oil reservoir with sight gage and 10 gallons food grade mineral oil. HPU enclosure dimensions a maximum of 33" x 25" x 17". Provide necessary hydraulic hoses with quick connect fittings and needle type control valve for speed adjustment.**	81	TESTS	*Hydro Pressure
43			82		ANSI/FCI Leakage Class
44			83		
45			84		
46					
47					
48					
49					
50					

Rev	Date	Revision	Orig	App
A	7/18/11	IFR		
B	8/23/14	IFR		

Notes:
*Information supplied by manufacturer unless already specified.
Note 1: This is a down hole flow and pressure control valve used is ASR wells located in a single pipe with bi-directional flow for injection and recovery.
Note 2: Well is 139' deep and ID is 14" and valve will be in inline with a submersible pump.
Note 4: Column pressure is from gravity flow into well.
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Specialty Items Schedule

Item Number	P&ID	Line Number	SIZE	VENDOR	DESCRIPTION	Remarks
EDT-211/212	I-11-01	6"-RW-CPCV-110106	3"	Clark-Reliance or Schutte & Koerting	(2)-3" TLA PVC Eductors to completely (3 turnovers) mix a 21,000 gal tank for 30 minutes. Min. dP of 20 psi. Tank Dimensions are 8' W X 11ft H X 45' L	
EDT-221/222	I-11-02	6"-RW-CPCV-110206	3"	Clark-Reliance or Schutte & Koerting	(2)-3" TLA PVC Eductors to completely (3 turnovers) mix a 21,000 gal tank for 30 minutes. Min. dP of 20 psi. Tank Dimensions are 8' W X 11ft H X 45' L	
EDT-231/232	I-11-03	6"-RW-CPCV-110306	3"	Clark-Reliance or Schutte & Koerting	(2)-3" TLA PVC Eductors to completely (3 turnovers) mix a 21,000 gal tank for 30 minutes. Min. dP of 20 psi. Tank Dimensions are 8' W X 11ft H X 45' L	
EDT-241/242	I-11-04	6"-RW-CPCV-110406	3"	Clark-Reliance or Schutte & Koerting	(2)-3" TLA PVC Eductors to completely (3 turnovers) mix a 21,000 gal tank for 30 minutes. Min. dP of 20 psi. Tank Dimensions are 8' W X 11ft H X 45' L	

SECTION 40 50 00
POWER PLANT PIPING MATERIALS

PART 1 GENERAL

1.01 SUMMARY

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

1. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
2. American Society of Mechanical Engineers (ASME):
   a. B16.5, Pipe Flanges and Flanged Fittings.
   b. B16.20, Metallic Gaskets for Pipe Flanges - Ring Joint, Spiral-Wound, and Jacketed.
   c. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   d. B31.1, Power Piping.
3. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or Both.
   c. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   d. D2467, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   e. F441, Standard Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80
   f. F439, Standard Specification for Socket-Type Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80
4. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-95, Swage (D) Nipples and Bull Plugs.
5. Uniform Plumbing Code (UPC).

1.02 SYSTEM DESCRIPTION

A. Design Requirements: In accordance with this Section, ASME B31.1, NFPA 24, and the Uniform Plumbing Code (UPC), as applicable. Deviations and alternates are not permitted.

1.03 SUBMITTALS

A. Quality Control Submittals: Certificates of Compliance for all other materials.

1.04 DEFINITIONS

A. Certificates of Compliance (COCs):

1. Certify that materials are new and comply with requirements of Pipe Data Sheets material specification and grade, class, or type designation.
   a. Certify manufacturing standard that applies to components.
   b. Be signed by Manager of pipe manufacturer's Quality Control Department and shall indicate both the purchase order number and the engineer's project number.

PART 2 PRODUCTS

2.01 GENERAL

A. Piping materials and components shall be in accordance with pipe data sheets at end of Section.

PART 3 EXECUTION

3.01 SUPPLEMENTS

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

1. Piping System Index.
2. Pipe Material Specifications:
   a. CSLF – A53 B CS, Class 125.
   b. HALE – HDPE, SDR 11.
   c. HLAD – HDPE, Solvay Eltex TUB 124.
   d. HSLF – HDPE, SDR 9 (FM Approved).
   e. LCLF – A53 B Cement Lined CS, Class 125.
   f. PULK – CPVC, Class 150.
   g. PVLK – PVC, Class 150.
   h. SABD – A312 TP304/304L SS, Class 300.
   i. SUTK – A213 Type 316L, SS Tubing.

END OF SECTION

SECTION NO. 40 50 00
PIPE INDEX

Rev No.	Rev Date	Spec Design	Valve Rating	Pipe Material	Specification Limits	Size Range	Shut-off Valves		Check Valves		Service Code – Service
							≤2”	≥3”	≤2”	≥3”	
A		CSLF	CL 125 CI UL/FM	Carbon Steel	150 psig @ 150°F 175 psig @ 120°F	1/2”-16”	Ball	Gate	Swing	Wafer	EW or FRW – Emergency/Fire Water
A		HALE	--	HDPE, SDR 11	160 psig @ 75°F 82 psig @ 140°F	2”-12”	Gate	Gate	--	--	FW - Freshwater TW – Treated Water CA – Carbon Amended Groundwater CW – Chilled Water EX – Extracted Groundwater
A		HLAD	--	HDPE, Blue	230 psig @ 68°F 150 psig @ 140°F	2”-4”	--	--	--	--	Underground: IA – Instrument Air UA – Utility Air
A		HSLF	CL 125 CI UL/FM	HDPE, UL/FM	200 psig @ 73°F 100 psig @ 140°F	4”-14”	Gate	Gate	Swing	Swing	Underground: EW/FRW – Emergency/Fire Water
A		LCLF	CL 125 CI UL/FM	Cement Lined Carbon Steel	150 psig @ 150°F 175 psig @ 120°F	4”-24”	--	--	--	--	EW – Emergency/Fire Water (Aboveground) FW - Freshwater RW - Remedy Water CA – Carbon Amended Groundwater

SECTION NO. 40 50 00
PIPE INDEX

Rev No.	Rev Date	Spec Design	Valve Rating	Pipe Material	Specification Limits	Size Range	Shut-off Valves		Check Valves		Service Code – Service
							≤2”	≥3”	≤2”	≥3”	
A		PULK	CL 150	CPVC	150 psig @ 73°F 75 psig @ 150°F	1/2”-12”	Ball	Ball	Swing	Swing	CAU- Caustic COG – Coagulant CW – Chilled Water DR – Drain RW - Remedy Water SL – Slurry WS –Waste Stream ACD – Acid
A		PVLK	CL 150	PVC	150 psig @ 73°F 69 psig @ 120°F	1/2”-12”	Ball	Ball	Swing	Swing	CAU- Caustic COG – Coagulant DR – Drain RW - Remedy Water SL – Slurry WS –Waste Stream
A		SABD	CL 300	304/304L SS	720 psig @ 100°F 420 psig @ 700°F	1/2”-12”	Ball	Ball	Swing	Swing	CO2 – Carbon Dioxide
A		SUTK	1500#	316L Stainless Steel Tubing	600 psig @ 100°F 250 psig @ 300°F	1/4"-1”	Ball	--	Poppet	--	IA – Instrument Air

PIPING SPECIFICATION DESIGNATOR		
Piping Material	**Pressure Class**	**Service**
CS = Seamless Carbon Steel, A106-B, thru 24”	A = Class 150	ACD = 19% HCl
HA = HDPE w/ No Stripe, all Black	B = Class 300	CA = Carbon Amended Ground Water
HL = HDPE, Solvay Blue	L = Class 125 (ASME B16.1)	CAU = 25% Caustic
HS = HDPE w/ Red Stripe – FM Class 200	T = 1500 CWP (Tubing Valves)	CO2 = Carbon Dioxide
LC = Cement-lined Carbon Steel		COG = Coagulant
PU = CPVC (Chlorinated Polyvinyl Chloride)		DR = Drain
PV = PVC (Polyvinyl Chloride)		EW or FRW = Emergency/Fire Water
SA = Type 304/304L Stainless Steel		EX = Extracted Groundwater (IRZ, Riverbank, Transwestern or East Ravine)
SU = Type 316L Stainless Steel		FW = Fresh Water
		IA = Instrument Air
		RW = Remedy Produced Water
		SL = Slurry/solids
		TW = Treated (Filtered) Remedy Produced Water
		UA = Utility Air
		VT = Vent
		WS = Waste Stream
		CW – Chilled Water (includes supply (CWS) and return (CWR) for emergency shower eyewash

SECTION 40 50 00 - CSLF CARBON STEEL							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		150	175				
Temperature, Degrees°F		150	120				
Corrosion Allowance: 0.063”							
Notes:							
Item	**Size**	**Description**					
Pipe	1/2” – 2”	Carbon steel, ASTM A106, Grade B, seamless, ASME B36.10M, Schedule XS, PE.					
	4” – 16”	Carbon steel, ASTM A53/A53M, Grade B, ERW, ASME B36.10M, Std Wt, BE.					
Nipples	1/2” – 2”	Carbon Steel, ASTM A733 and ASTM A106, Grade B, seamless, ASME B36.10M, Schedule 160. Close nipples are not allowed.					
Fittings	1/2” – 2”	Forged Carbon steel, ASTM A105/A105M, socketweld, ASME B16.11, Class 3000.					
	4” – 16”	Carbon steel, ASTM A234/A234M, WPB, seamless, buttweld, ASME B16.9, Std Wt.					
	Sockolet	Forged carbon steel, ASTM A105/A105M, socketweld, MSS-SP-97, ASME B16.11, Class 3000.					
	Threadolet	Forged carbon steel, ASTM A105/A105M, threaded, MSS-SP-97, ANSI/ASME B1.20.1, ASME B16.11, Class 3000.					
	Weldolet	Forged carbon steel, ASTM A105/A105M, buttweld, MSS-SP-97, ASME B16.9, ASME B16.25, ASME B36.10M.					
Branch Connections	All Sizes	See Branch Connection Table.					
Bushings		Threaded bushings are not allowed.					
Reducing Inserts	1/2” – 2”	Forged Carbon steel, ASTM A105/A105M, socketweld, MSS-SP-79, Class 3000.					
Plugs	1/2” – 2”	Forged Carbon steel, ASTM A105/A105M, solid hex head, MNPT, ASME B16.11.					
Unions	1/2” – 2”	Forged Carbon steel, ASTM A105/A105M, socketweld, MSS-SP-83, Class 3000, bronze/steel seats, cadmium plated union ring.					

SECTION 40 50 00 - CSLF CARBON STEEL							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		150	175				
Temperature, Degrees°F		150	120				
Corrosion Allowance: 0.063”							
Notes:							
Item	**Size**	**Description**					
Flanges	1/2” – 2”	Forged carbon steel, ASTM A105/A105M, Class 150, ASME B16.5, flat face, socket weld, Schedule XS.					
	4” – 16”	Forged carbon steel, ASTM A105/A105M, Class 150, ASME B16.5, flat face, weld neck, Std Wt.					
	1/2” – 16”	Blind, Forged carbon steel, ASTM A105/A105M, Class 150, ASME B16.5, flat face.					
Bolting	1/2” – 16”	Alloy steel stud bolts, ASTM A193/A193M, Grade B7 w/2 heavy hex nuts, ASTM A194/A194M, Grade 2H (use cap screws with lug type butterfly valves).					
Gaskets	1/2” – 16”	Red rubber, 1/8” thick, 80 Durometer, full face, ASME B16.21, Class 150; Garlock Style 22.					
Valves	1/2” – 2”	Gate, VG1RBTHB02, bronze, CL 200, TE, UL/FM.					
	4” – 12”	Gate, VG1NSFHB02, CI, CL 125, flg’d, handwheel operator, UL/FM.					
	1/2” – 2”	Ball, VB2QBTLB02, bronze, 600 psi WOG, TE., UL/FM.					
	4” – 12”	Check, VC1NEFNB02, CI, CL 125, flg’d, UL/FM.					

BRANCH CONNECTION TABLE

BRANCH NOMINAL SIZE	HEADER NOMINAL SIZE																					
SIZE	.5	.75	1	1.5	2	4	6	8	10	12	14	16	18	20	24	26	28	30	36	42	48	SIZE
.5	T	TR	TR	TR	SO	SO	SO	SO	SO	SO	SO	SO										.5
.75		T	TR	TR	TR	SO	SO	SO	SO	SO	SO	SO										.75
1			T	TR	TR	SO	SO	SO	SO	SO	SO	SO										1
1.5				T	TR	SO	SO	SO	SO	SO	SO	SO										1.5
2					T	SO	SO	SO	SO	SO	SO	SO										2
4						T	TR	TR	TR	W	W	W										4
6							T	TR	TR	TR	TR	TR										6
8								T	TR	TR	TR	TR										8
									T	TR	TR	TR										10
										T	TR	TR										12
											T	TR										14
												T										16
																						18
																						20
																						24
																						26
																						28
																						30
																						36
																						42
																						48

LEGEND

SO = SOCKOLET (NOTE 1)
T = FULL SIZED TEE
TR = REDUCING TEE, W/ SWAGE OR REDUCER IF REQUIRED
W = WELDOLET

NOTES

1. THREADOLETS ARE REQUIRED FOR TEMPERATURE, INSTRUMENT, AND SAMPLE CONNECTIONS

SPEC CSLF

SECTION 40 50 00 - HALE: SINGLE WALL HDPE							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		160	133	101	82		
Temperature, Degrees°F		75	100	125	140		
Corrosion Allowance: 0.0”							
Notes:							
Item	**Size**	**Description**					
Pipe	2” – 12”	High Density Polyethylene, ASTM D3350 Class 345464C, SDR 11, plain end.					
Fittings	2” – 12”	Molded fittings, ASTM D3261, Match Pipe SDR Pressure Rating, IPS.					
Bolting	2” – 12”	Stainless steel stud bolts, ASTM A193/A193M, Grade B8M w/2 heavy hex nuts, ASTM A194/A194M, Grade 8M.					
Gaskets	2” – 12”	EPDM, 1/8” thick, 65 Durometer A, ASTM D1330, full face, ASME B16.21.					
Flanges	2” – 12”	Flange Adapter, Match Pipe SDR Pressure Rating, ASTM D3261 with medium pressure ductile iron back-up rings, ASTM 536-80, ANSI B16.5, Class 150.					
Valve Box		Cast Iron, Screw Type, 5-1/4” shaft with base and lid marked “WATER”, complete with extension stem and couplings for valve, and T-handle valve wrench (wrench length shall be sized such that the T-handle is 3’-0” above finished grade), specify depth of burial (centerline of valve to grade), 18” of Adjustment; EJIW 8550 Series.					
Valves	2” – 12”	See Section 40 27 02, Process Valves and Operators.					

BRANCH CONNECTION TABLE

BRANCH NOMINAL SIZE	HEADER NOMINAL SIZE																					
SIZE	.5	.75	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	28	30	36	42	48	SIZE
.5																						.5
.75																						.75
1																						1
1.5																						1.5
2					T	TR	TR	TR	TR	TR	TR											2
3						T	TR	TR	TR	TR	TR											3
4							T	TR	TR	TR	TR											4
6								T	TR	TR	TR											6
									T	TR	TR											8
										T	TR											10
											T											12
																						14
																						16
																						18
																						20
																						24
																						28
																						30
																						36
																						42
																						48

LEGEND

T = FULL SIZED TEE

TR = REDUCING TEE, W/ REDUCER IF REQUIRED

SPEC HALE

SECTION 40 50 00 - HLAD: SOLVAY ELTEX TUB 124 BLUE HDPE							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		230	200	180	150		
Temperature, Degrees°F		68	86	104	140		
Corrosion Allowance: 0.0”							
Notes:							
Item	**Size**	**Description**					
Pipe	2” – 4”	Solvay Eltex TUB 124 Blue HDPE, ASTM D3350 Class 346544C and ASTM D3035, PE100, plain end.					
Fittings	2” – 4”	Injection Molded, Match Pipe Pressure Rating, socket fusion.					
Bolting	2” – 4”	Stainless steel stud bolts, ASTM A193/A193M, Grade B8M w/2 heavy hex nuts, ASTM A194/A194M, Grade 8M.					
Gaskets	2” – 4”	EPDM, 1/8” thick, 65 Durometer A, ASTM D1330, full face, ASME B16.21.					
Flanges	2” – 4”	Flange Adapter, carbon steel backing rings with polypropylene covering, Class 150, ASME B16.5.					

BRANCH CONNECTION TABLE

BRANCH NOMINAL SIZE	HEADER NOMINAL SIZE																					
SIZE	.5	.75	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	28	30	36	42	48	SIZE
.5																						.5
.75																						.75
1																						1
1.5																						1.5
2					T	TWR	TWR															2
3						T	TWR															3
4							T															4
6																						6
																						8
																						10
																						12
																						14
																						16
																						18
																						20
																						24
																						28
																						30
																						36
																						42
																						48

LEGEND

T = FULL SIZED TEE

TR = REDUCING TEE

TWR = TEE WITH REDUCER

SPEC HLAD

SECTION 40 50 00 - HSLF: SINGLE WALL HDPE							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		200	162	132	100		
Temperature, Degrees°F		73	100	120	140		
Corrosion Allowance: 0.0”							
Notes:Pressure/Temp Rating is based on a 50 year life.							
Item	**Size**	**Description**					
Pipe	4” – 14”	High Density Polyethylene FM Approved, ASTM D3350 Class 345464C, Class 200, SDR 9, plain end.					
Fittings	4” – 6”	FM Molded Fittings, ASTM D3261, Match Pipe Pressure Rating, IPS.					
	8” – 14”	FM Fabricated Fittings, ASTM D3261, Match Pipe Pressure Rating, IPS.					
Branch Connections	All sizes	See Branch Connection Table.					
Bolting	4” – 14”	Stainless steel stud bolts, ASTM A193/A193M, Grade B8M w/2 heavy hex nuts, ASTM A194/A194M, Grade 8M.					
Gaskets	4” – 14”	EPDM, 1/8” thick, 65 Durometer A, ASTM D1330, full face, ASME B16.21.					
Flanges	4” – 14”	FM Flange Adapter, Match Pipe SDR Pressure Rating, ASTM D3261 with medium pressure ductile iron back-up rings, ASTM 536, Grade 65-45-12, ANSI B16.5, Class 150.					
Mechanical Joint Adapter Kit	4” – 14”	FM Mechanical Joint Adapter, AWWA C153/A21.53, ASTM D3216, SDR 9, IPS, with metal insert, metal gland, gasket, and attachment bolts and nuts.					
Valve Box		Cast Iron, Slide Type, 5-1/4” shaft with base and lid marked “WATER”, complete with extension stem and couplings for valve, and T-handle valve wrench (wrench length shall be sized such that the T-handle is 3’-0” above finished grade), specify depth of burial (centerline of valve to grade); Tyler 6860 (or approved equal).					

SECTION 40 50 00 - HSLF: SINGLE WALL HDPE							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		200	162	132	100		
Temperature, Degrees°F		73	100	120	140		
Corrosion Allowance: 0.0”							
Notes:Pressure/Temp Rating is based on a 50 year life.							
Item	**Size**	**Description**					
Fire Hydrants		250 psig working pressure, UL Listed/FM approved, AWWA C502, with 5-1/4” valve opening, one 4-1/2” pumper connection, two 2-1/2” hose connections with National Standard hose coupling threads, 1-1/4” pentagon operating nut, counterclockwise opening direction, 6” mechanical joint inlet; Mueller No. A-423 Super Centurion 250 (or approved equal).					
Indicator Posts		Adjustable type, UL Listed/FM approved, counterclockwise opening direction; Mueller No. A-20806 (or approved equal).					
Valves	4” – 12”	See Section 40 27 02, Process Valves and Operators.					
	4” – 12”	See Section 40 27 02, Process Valves and Operators.					
	4” – 12”	See Section 40 27 02, Process Valves and Operators.					
	4” – 12”	See Section 40 27 02, Process Valves and Operators.					

BRANCH CONNECTION TABLE

BRANCH NOMINAL SIZE	HEADER NOMINAL SIZE																					
SIZE	.5	.75	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	28	30	36	42	48	SIZE
.5																						.5
.75																						.75
1																						1
1.5																						1.5
2					T	TR	TR	TR	TR	TR	TR	TR										2
3						T	TR	TR	TR	TR	TR	TR										3
4							T	TR	TR	TR	TR	TR										4
6								T	TR	TR	TR	TR										6
									T	TR	TR	TR										8
										T	TR	TR										10
											T	TR										12
												T										14
																						16
																						18
																						20
																						24
																						28
																						30
																						36
																						42
																						48

LEGEND

T = FULL SIZED TEE

TR = REDUCING TEE, W/ REDUCER IF REQUIRED

SPEC HSLF

SECTION 40 50 00 - LCLF CEMENT LINED CARBON STEEL							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		150	175				
Temperature, Degrees°F		150	120				
Corrosion Allowance: 0.063”							
Notes:							
Item	**Size**	**Description**					
Pipe	4” – 24”	Carbon steel, Cement Lined, ASTM A53/A53M, Grade B, ERW, ASME B36.10M, AWWA C205, Std Wt, BE.					
Fittings	4” – 24”	Carbon steel, Cement Lined, ASTM A234/A234M, WPB, seamless, buttweld, ASME B16.9, AWWA C205, Std Wt.					
Bushings		Threaded bushings are not allowed.					
Flanges	4” – 24”	Forged carbon steel, ASTM A105/A105M, Class 150, ASME B16.5, slip-on, flat face.					
	4” – 24”	Blind, Forged carbon steel, ASTM A105/A105M, Class 150, ASME B16.5, flat face.					
Bolting	4” – 24”	Alloy steel stud bolts, ASTM A193/A193M, Grade B7 w/2 heavy hex nuts, ASTM A194/A194M, Grade 2H.					
Gaskets	4” – 24”	Red rubber, 1/8” thick, 80 Durometer, full face, ASME B16.21, Class 150; Garlock Style 22.					

SECTION 40 50 00 - PULK CPVC							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		150	115	75			
Temperature, Degrees°F		73	130	150			
Corrosion Allowance: 0.0”							
Notes:							
Item	**Size**	**Description**					
Pipe	1/2” – 12”	CPVC, rigid, ASTM D1784 Class 23447-B and ASTM F441, Schedule 80, PE.					
Fittings	1/2” – 12”	CPVC, solvent ends, socket type, ASTM D1784 Class 23447-B and ASTM F439, Schedule 80.					
Branch Connections	All Sizes	See Branch Connection Table.					
Reducing Inserts	1/2” – 12”	CPVC, solvent ends, socket type, ASTM D1784 Class 23447-B and ASTM F439, Schedule 80.					
Unions	1/2” – 3”	CPVC, solvent ends, socket type, ASTM D1784 Class 23447-B and ASTM F439, Schedule 80, with EPDM O-Rings. (Note: Depending on chemicals in pipe O-Rings can be EPDM or Viton.)					
Flanges	1/2” – 12”	CPVC, solvent ends, socket type, ASTM D1784 Class 23447-B and ASTM F439, Schedule 80, ASME Class 150 bolt pattern (match ANSI B16.5).					
Bolting	1/2” – 12”	Alloy steel stud bolts, ASTM A193/A194M, Grade B7 w/2 heavy hex nuts, ASTM A194/A194M, Grade 2H.					
Gaskets	1/2” – 12”	EPDM, 1/8” thick, 65 Durometer A, ASTM D1330, full face, ASME B16.21, Class 150. (Note: depending on chemicals in pipe gasket material can be EPDM or Viton.)					
Valves	1/2” – 2”	Ball, See Section 40 27 02, Process Valves and Operators, CPVC, union ends.					
	3” – 4”	Ball, See Section 40 27 02, Process Valves and Operators, CPVC, flg’d.					
	2” – 8”	Butterfly, See Section 40 27 02, Process Valves and Operators, CPVC, flg’d.					
	1/2” – 2”	Check, See Section 40 27 02, Process Valves and Operators, CPVC, union ends.					

BRANCH CONNECTION TABLE

HEADER NOMINAL SIZE

BRANCH NOMINAL SIZE	.5	.75	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	28	30	36	42	48
.5	T	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR										
.75		T	TR	TR	TR	TR	TR	TR	TR	TR	TR										
1			T	TR	TR	TR	TR	TR	TR	TR	TR										
1.5				T	TR	TR	TR	TR	TR	TR	TR										
2					T	TR	TR	TR	TR	TR	TR										
3						T	TR	TR	TR	TR	TR										
4							T	TR	TR	TR	TR										
6								T	TR	TR	TR										
8									T	TR	TR										
10										T	TR										
12											T										
14																					
16																					
18																					
20																					
24																					
28																					
30																					
36																					
42																					
48																					

LEGEND

T = FULL SIZED TEE

TR = REDUCING TEE, W/ REDUCER IF REQUIRED

SPEC PULK

SECTION 40 50 00 - PVLK PVC							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		150	140	69			
Temperature, Degrees°F		73	100	120			
Corrosion Allowance: 0.0”							
Notes:							
Item	**Size**	**Description**					
Pipe	1-1/2” – 12”	PVC, rigid, ASTM D1784 Class 12454-B and ASTM D1785, Schedule 80, PE.					
Fittings	1-1/2” – 12”	PVC, socket type, ASTM D1784 Class 12454-B and ASTM D2467, Schedule 80.					
Branch Connections	All Sizes	See Branch Connection Table.					
Bushings		Threaded bushings are not allowed.					
Reducing Inserts	1-1/2” – 12”	PVC, socket type, ASTM D1784 Class 12454-B and ASTM D2467, Schedule 80.					
Unions	1-1/2” – 3”	PVC, socket type, ASTM D1784 Class 12454-B and ASTM D2467, Schedule 80, with EPDM O-Rings. (Note: depending on chemicals in pipe O-Rings can be EPDM or Viton.)					
Flanges	1-1/2” – 12”	PVC, socket type, FF, ASTM D1784 Class 12454-B and ASTM D2467, Schedule 80, Class 150 (match ANSI B16.5).					
Bolting	1-1/2” – 12”	Alloy steel stud bolts, ASTM A193/A194M, Grade B7 w/2 heavy hex nuts, ASTM A194/A194M, Grade 2H.					
Gaskets	1-1/2” – 12”	EPDM, 1/8” thick, 65 Durometer A, full face, ASME B16.21, Class 150. (Note: depending on chemicals in pipe gasket material can be EPDM or Viton.)					
Valves	1/2” – 4”	Ball, See Section 40 27 02, Process Valves and Operators, PVC, CL 150, socket type.					
	1/2” – 4”	Check, See Section 40 27 02, Process Valves and Operators, PVC, CL 150, socket type.					

BRANCH CONNECTION TABLE

HEADER NOMINAL SIZE

BRANCH NOMINAL SIZE	.5	.75	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	28	30	36	42	48
.5																					
.75																					
1																					
1.5				T	TR	TR	TR	TR	TR	TR	TR										
2					T	TR	TR	TR	TR	TR	TR										
3						T	TR	TR	TR	TR	TR										
4							T	TR	TR	TR	TR										
6								T	TR	TR	TR										
8									T	TR	TR										
10										T	TR										
12											T										
14																					
16																					
18																					
20																					
24																					
28																					
30																					
36																					
42																					
48																					

LEGEND

T = FULL SIZED TEE

TR = REDUCING TEE, W/ REDUCER IF REQUIRED

SPEC PVLK

SECTION 40 50 00 - SABD TYPE 304/304L STAINLESS STEEL							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		720	600	510			
Temperature, Degrees°F		100	200	350			
Corrosion Allowance: 0.0”							
Notes:							
Item	**Size**	**Description**					
Pipe	1/2” – 2”	Stainless steel, ASTM A312/A312M, TP304/304L (dual certified), fusion welded, ASME B36.19M, Schedule 40S, PE.					
	3” – 12”	Stainless steel, ASTM A312/A312M, TP304/304L (dual certified), fusion welded, ASME B36.19M, Schedule 40S, BE.					
Nipples	1/2” – 2”	Stainless steel, ASTM A733 and ASTM A312/A312M, TP316/316L (dual certified), seamless, ASME B36.19M, Schedule 40S, close nipples are not allowed. Threaded nipples shall not be larger than 1”.					
Swages	1/2” – 4”	Stainless steel, seamless, solution annealed, ASTM A403/A403M, WP304/304L (dual certified), MSS SP-95. Swage ends shall match wall thickness of connecting pipe. Threaded ends shall not exceed 1” NPS and shall be Schedule 80S.					
Fittings	1/2” – 2”	Forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), socketweld, ASME B16.11, Class 3000.					
	3” – 12”	Stainless steel, ASTM A403/A403M, WP304/304L-S, buttweld, ASME B16.9, Schedule 40S.					
	Sockolet	Forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), socketweld, MSS-SP-97, ASME B16.11, Class 3000.					
	Threadolet	Forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), threaded, MSS-SP-97, ANSI/ASME B1.20.1, ASME B16.11, Class 3000					
	Weldolet	Forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), buttweld, MSS-SP-97, ASME B16.9, ASME B16.25, ASME B36.10M.					
Branch Connections	All Sizes	See Branch Connection Table.					
Bushings		Threaded bushings are not allowed.					

SECTION 40 50 00 - SABD TYPE 304/304L STAINLESS STEEL							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		720	600	510			
Temperature, Degrees°F		100	200	350			
Corrosion Allowance: 0.0”							
Notes:							
Item	**Size**	**Description**					
Reducing Inserts	1/2” – 2”	Forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), socketweld, MSS-SP-79, Class 3000.					
Plugs	1/2” – 2”	Forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), solid hex head, MNPT, ASME B16.11.					
Unions	1/2” – 2”	Forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), socketweld, MSS-SP-83, Class 3000.					
Flanges	1/2” – 2”	Forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), raised face, socketweld, Schedule 40S, Class 300, ASME B16.5.					
	3” – 12”	Forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), raised face, weld neck, Schedule 40S, Class 300, ASME B16.5.					
	1/2” – 12”	Blind, forged stainless steel, ASTM A182/A182M, F304/304L (dual certified), raised face, Class 300, ASME B16.5.					
Orifice Flanges	3” – 12”	Forged Stainless Steel, ASTM A182/A182M, F304/F304L (dual certified), Class 300, ASME B16.36, raised face, weld neck, Schedule 40S, 1/2" NPS socket weld pressure taps.					
Bolting	1/2” – 12”	Alloy steel stud bolts, ASTM A193/A193M, Grade B7 w/2 heavy hex nuts, ASTM A194/A194M, Grade 2H.					
Gaskets	1/2” – 12”	1/8” thick, reinforced teflon, ring type, Class 300, ASME B16.5; Garlock Style 3510.					
Insulating Gasket Set	1/2” – 12”	1/8” thick insulating gasket set, consisting of plain faced phenolic with EPDM seal, ring type gasket, mylar bolt sleeves and washers, suitable for 225°F, Class 300, ASME B16.5; Step-Ko Products.					
Valves	1/2” – 3/4”	Ball, See Section 40 27 02, Process Valves and Operators, 316 SS, CL 600, TE.					

SECTION 40 50 00 - SABD TYPE 304/304L STAINLESS STEEL						
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE						
Pressure, psig	720	600	510			
Temperature, Degrees°F	100	200	350			
Corrosion Allowance: 0.0”						
Notes:						

Item	Size	Description
	1/2” – 2”	Ball, See Section 40 27 02, Process Valves and Operators, 316L SS, CL 600, SW.
	1/2” – 2”	Ball, See Section 40 27 02, Process Valves and Operators, 316L SS, CL 600, SW x FNPT.
	3” - 4”	Ball, See Section 40 27 02, Process Valves and Operators, 316L SS, CL 300, flg’d, lever operator.
	6” – 12”	Ball, See Section 40 27 02, Process Valves and Operators, 316L SS, CL 300, flg’d, gear operator.

BRANCH CONNECTION TABLE

HEADER NOMINAL SIZE

BRANCH NOMINAL SIZE	.5	.75	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	28	30	36	42	48
.5	T	TR	TR	TR	SO	SO	SO	SO	SO	SO	SO										
.75		T	TR	TR	TR	SO	SO	SO	SO	SO	SO										
1			T	TR	TR	SO	SO	SO	SO	SO	SO										
1.5				T	TR	SO	SO	SO	SO	SO	SO										
2					T	SO	SO	SO	SO	SO	SO										
3						T	TR	TR	TR	W	W										
4							T	TR	TR	W	W										
6								T	TR	TR	TR										
8									T	TR	TR										
10										T	TR										
12											T										
14																					
16																					
18																					
20																					
24																					
28																					
30																					
36																					
42																					
48																					

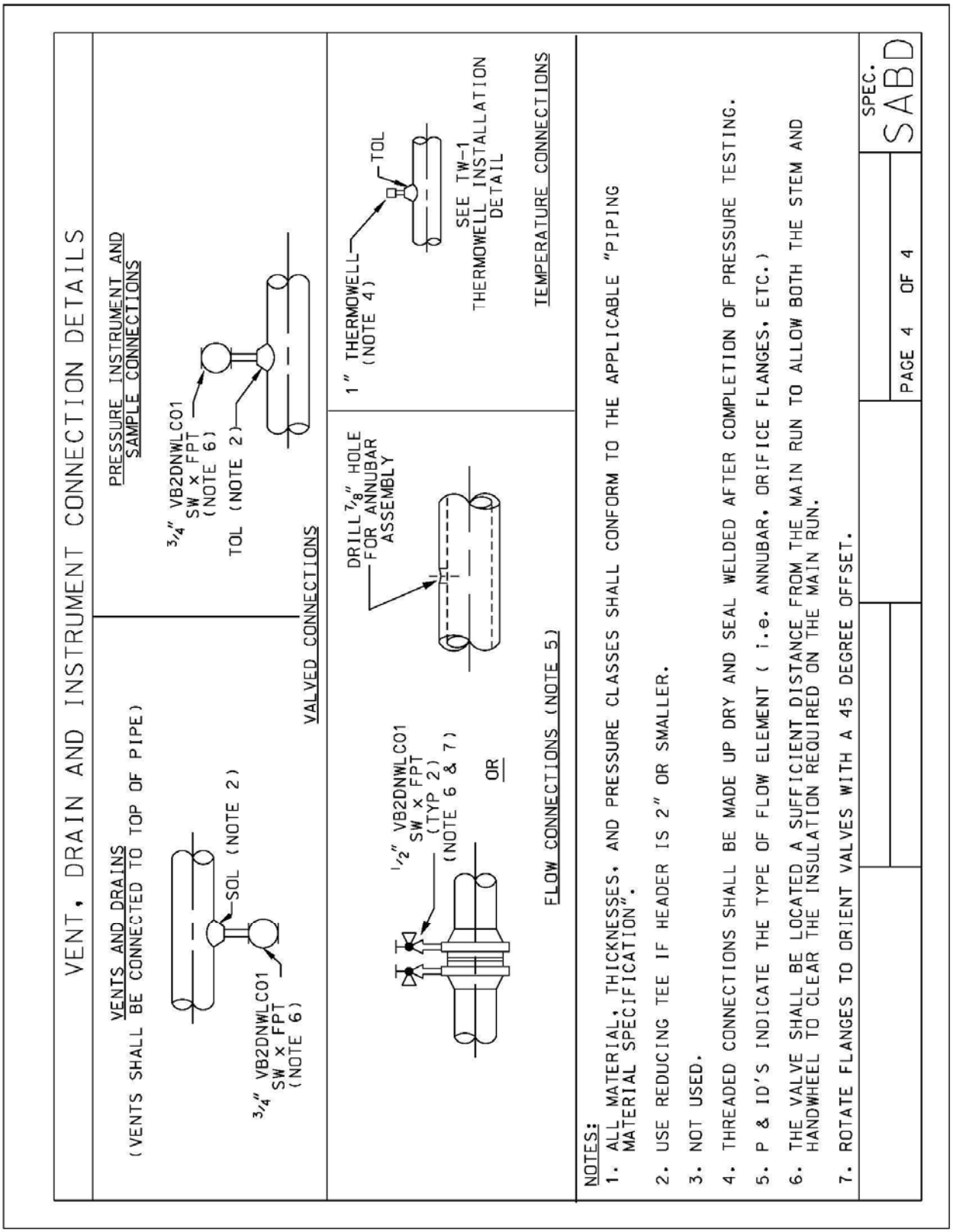
LEGEND

SO = SOCKOLET (NOTE 1)
T = FULL SIZED TEE
TR = REDUCING TEE, W/ SWAGE OR REDUCER IF REQUIRED
W = WELDOLET

NOTES

1. THREADOLETS ARE REOUIRED FOR TEMPERATURE CONNECTIONS

SPEC SABD



SECTION 40 50 00 - SUTK TYPE 316L STAINLESS STEEL (TUBING)							
MAXIMUM ALLOWABLE PRESSURE/TEMPERATURE							
Pressure, psig		1500	1500	800	330	100	
Temperature, Degrees°F		100	200	300	400	450	
Corrosion Allowance: 0.0”							
Notes:							
Item	**Size**	**Description**					
Tubing	1/4” – 1”	Stainless steel, ASTM A213/A213M, Type 316, seamless, fully annealed, stress relieved, tubing to be free of scratches, suitable for bending and flaring.					
Tubing Schedule	Size, OD	1/4”	3/8”	1/2”	3/4”	1”	
	Min. Wall Thickness	0.035”	0.035”	0.049”	0.065”	0.083”	
Tube Fittings	All Sizes	Stainless steel, Type 316, tube fittings; Swagelok, or Equal.					
Valves	1/4” – 1/2”	Check, See Section 40 27 02, Process Valves and Operators, 316 SS, 2000 psig, tube fittings.					
	1/4" – 1”	Ball, See Section 40 27 02, Process Valves and Operators, 316 SS, 1500 psig, flg’d.					

SECTION 40 50 10
UNDERGROUND PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This Specification covers minimum requirements for procuring, receiving, storing, handling, fabricating, assembling, erecting, cleaning, filling, flushing, examining, testing, restoring and inspecting of underground piping systems.

B. For underground fire protection piping, the Engineer shall comply with all applicable licensure requirements.

C. Engineer's Work shall include fabrication and installation of all underground piping systems as defined on Drawings.

1.02 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B1.20.1, Pipe Threads, General Purpose (Inch).
   b. B31.1, Power Piping.
   c. BPVC Section II, Materials Part C, Specifications for Welding Rods, Electrodes, and Filler Metals.
   d. BPVC Section IX, Welding and Brazing Qualifications
2. ASTM International (ASTM): D2774, Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
   a. D2774, Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
   b. F2164, Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure.
3. U.S. Department of Labor Occupational Safety and Health Administration (OSHA): 29 CFR Parts 1926/1910 as applicable.

1.03 SUBMITTALS

A. Action Submittals: Testing fluid data.

B. Informational Submittals:

1. As-built mark-ups of Engineer furnished drawings showing any modifications made by Engineer in the field.
2. Bonding Procedure Specifications and Bonding Performance Qualification Test results in accordance with ASME B31.1, Appendix III.
3. Brazing Procedure Specifications and Brazing Performance Qualification Test results in accordance with ASME BPVC, Appendix IX.
4. Hydrotest procedures.
5. Hydrotest reports, containing at least the following information:
   a. Complete description of pipe system including boundary limits, complete line numbers, Drawings and P&IDs indicating test boundaries.
   b. Test description including test pressure, test medium, temperature of test medium, ambient temperature, time of day, test duration, leakage rate, and date of test.
   c. Record of joint repairs including date, extent of repairs, and responsible individual.
   d. Record of cleaning including date and responsible individual.
   e. Signature, date, and title of Engineer's and Owner's representative witnessing operation.
6. Quality Control Manual and Quality Assurance Manual
7. Manufacturer's recommendations for handling, storage, and installation of components.

1.04 QUALITY ASSURANCE

A. Welders and welding procedures shall be in accordance with Section 05 05 23, Welding, of power plant piping.

B. Bonders and bonding procedures shall be qualified in accordance with requirements of ASME B31.1, Appendix III, Paragraph III-5.0.

C. Qualification Test:

1. May be required of any heat fusion operator or bonder at discretion of Engineer
2. Personnel who fails test shall be prohibited from working on Project or be re-qualified at option of Engineer.

1.05 STORAGE AND HANDLING

A. General:

1. Store and handle materials in manner that will minimize corrosion and prevent damage to pipe and piping components, including their end connections and coatings.
2. Do not allow pipe to roll or fall from conveyance (e.g., truck, trailer).
3. Store pipe above ground on wooden supports. Until ready for installation use sufficient number of supports to prevent pipe from sagging or coming into contact with ground. Either contoured or padded blocks shall also be used with coated pipe to prevent damage to coatings.
4. Store and handle valves, hydrants, and post indicators in accordance with manufacturer's recommendations and with aid of lifting lugs when provided by manufacturer.

B. Plastic Piping: In accordance with ASTM D2321 and ASTM D2774 and manufacturer's recommendations.

C. End Protection: Material furnished by Engineer in accordance with this Specification shall have machined surfaces protected until installation as follows:

1. Flange Faces:
   a. Cover with bolted or clamped plastic, wood or sheet metal cover of adequate size and strength to prevent damage to face.
   b. Coat carbon steel faces with suitable rust preventative.
2. Buttweld Ends: Cover with sheet metal or plastic protectors to prevent damage to bevels.
3. End protectors for stainless steel material shall be nonmetallic.
4. Threaded Connections:
   a. Plugged or capped.
   b. If the plugs or caps are shown on Drawings, they shall be of material specified.
   c. Temporary thread protectors used during shipment and handling shall be plastic or sheet metal.

D. Acceptance at Job Site:

1. Repair damage to pipe, fittings, specialty items, coatings, or linings to Engineer's satisfaction at no extra cost.
2. Damaged items not repaired to Engineer's satisfaction shall be removed from Site and replaced.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe, fittings, flanges: In accordance with Section 40 27 02, Process Valves and Operators.

B. Valves: Provide necessary grease and lubricant.

2.02 PIPE BEDDING

A. Bedding materials shall be as specified in Section 31 23 23.15, Trench Backfill.

1.1 CONCRETE

A. Materials: ASTM C387 or ASTM C1480 packaged, dry, combined ingredients with Type V cement.

B. Mixing: In a clean metal container, mix package of dry materials by hand or machine. Following manufacturer's instructions, add clean water in sufficient quantity to produce slump of 2 to 3 inches.

PART 3 EXECUTION

3.01 GENERAL

A. The Work required by this Specification shall be conducted in compliance with applicable OSHA Standards.

3.02 PIPE TRENCHING

A. Perform in accordance with Section 31 23 23.15, Trench Backfill.

3.03 PIPE BEDDING

A. Bed preparation shall be performed in accordance with Section 31 23 23.15, Trench Backfill.

B. Plastic (PVC, CPVC, HDPE) pipe shall be bedded in accordance with ASTM D2321 and ASTM D2774 and manufacturer's recommendations.

3.04 TRENCH BACKFILL

A. Backfill and compaction shall be performed in accordance with Section 31 23 23.15, Trench Backfill.

B. Plastic (PVC, CPVC, HDPE) pipe shall be backfilled in accordance with ASTM D2321 and ASTM D2774 and manufacturer's recommendations.

C. Backfill and compaction shall not be performed until after successful field pressure test or radiographic examination and completion of coating and lining activities.

D. Obtain written approval from Engineer prior to backfilling trenches.

3.05 INSTALLATION

A. General:

1. Inspect pipe and clean all debris from interior and exterior surfaces prior to installation.
2. Install potable water piping and floor drain piping in accordance with IPC International Plumbing Code.
3. Install fire protection piping in accordance with NFPA 24 and AWWA C600.
4. Install all other underground piping in accordance with ASME B31.1.
5. Lower pipe and fittings carefully into trench.
6. Pipe shall not be laid in water or when trench conditions are unsuitable to perform the Work.
7. Lay pipe true to line and grade. Lay pipe on its permanent bedding, without block supports, to attain required grade. Remove and re-lay pipe if grade deviates by 1/4 inch or more from grade indicated. Remove bedding as required around flanges and bell joints to allow pipe to lay solidly on bedding.
8. When liquid must be drained from piping system due to flushing, pressure testing, or for leak repair, drainage operation shall be as directed by Engineer, but in no case shall liquid be drained into trench.
9. When Work is not in progress, open ends of pipe and fittings shall be securely closed so that no water, earth, or other foreign material enters pipe.
10. Pipe ends left for future connections shall be blind flanged, capped, or closed in accordance with Drawings.
11. Pipe Penetrations: Through or under concrete and masonry surfaces:
    a. Protect pipe from breakage.

b. Pipe passing under footing or through foundation wall shall be provided with relieving arch; or provide steel or cast iron wall sleeve 2 pipe sizes greater than pipe passing through.
c. Unless otherwise specified on Drawings, annular space between sleeve and pipe shall be caulked with coal tar, asphaltum compound, or other approved noncombustible sealant material.

B. Plastic Pipe:

1. PVC, CPVC, and HDPE piping shall be installed in accordance with ASTM D2321 and ASTM D2774 and manufacturer's recommendations.
2. Care shall be taken to ensure that bending and lowering of pipe into trench does not result in kinking or buckling.

C. Flanged Joints:

1. Make up with flange faces parallel, and bolt holes straddling normal horizontal and vertical centerlines of flanges, unless otherwise shown on Drawings.
2. Gaskets and gasket surfaces on flanges shall be clean, unpainted, and undamaged.
3. Bolt threads shall be coated with lubricant suitable for service temperature.
4. Flanges shall be made up by tightening diametrically opposite bolts in succession to load gasket evenly.
5. When flanged joint has been made up and subsequently loosened, install new gasket prior to retightening.

D. Polyethylene Butt Fusion Joints:

1. Fabricate and assemble in accordance with the manufacturer's recommendations.
2. Shall not be threaded, cemented or solvent welded.
3. Join by thermal butt fusion method with equipment manufactured by McElroy Manufacturing, Inc., Tulsa, Oklahoma.

E. Bonded Joints:

1. Bond plastic piping systems (e.g., PVC, CPVC, FRP) with either solvent cement or adhesive.
2. Qualified bonders shall make joints using qualified bonding procedures and in accordance with the pipe manufacturer's recommendations.

F. Valves: Install in accordance with manufacturer's recommendations. Particular attention should be given to manufacturer's recommendations for weld end type valves utilizing resilient seats.

3.06 FIELD QUALITY CONTROL

A. General:

1. Inspect, examine, clean, and test piping in accordance with requirements of ASME B31.1, NFPA 24, and this Specification.
2. Procedures shall be subject to approval of Engineer.
3. Engineer shall witness each critical operation (e.g., pressure testing, cleaning, disinfection).

B. Bonded and Brazed Joint Inspection and Testing:

1. Visually inspect each system prior to pressure testing for material defects and improper installation. Correct defects and installation problems before performing pressure test.
2. Engineer reserves right to have any joints cut out and tested (e.g., weld, heat fusion, bonded), irrespective of defects.
3. Furnish equipment and personnel to cut out joints designated by ENGINEER for testing.
4. Bonded joints shall be tested in accordance with ASME B31.1, Appendix III, Paragraph 5.1.2.

C. Pressure Tests:

1. General:
   a. Piping Line Report specifies test pressure of piping systems. All pressure tests shall be hydrostatic unless otherwise stated on Report.
   b. Notify Engineer minimum of 48 hours prior to pressure tests. For Fire Protection piping, the authority having jurisdiction shall also be notified prior to the pressure tests.
   c. Document pressure tests with test report witnessed by Engineer.
   d. A safety valve or relief valve may be used at the pressure source to protect systems under test. The test crew shall be responsible for venting all sections of piping systems not under direct test to prevent overpressuring any part of system through valve leakage or excess flows.
   e. In event piping system cannot be successfully pressure tested, correct problem and retest.

2. Pressure Test:
   a. Pretest Inspection:
      1) Notify Engineer when piping system is ready for pretest inspection.
      2) Verify components in piping system conform to appropriate Pipe Material Specification in Section 40 50 00, Power Plant Piping Materials (e.g., material, wall thickness, valve numbers, valve ratings, flange ratings) and latest revision of Piping and Instrumentation Diagrams, and is ready for pressurization.
      3) Engineer will inspect each piping system using copy of supplement Piping Pretest Checklist located at end of section.
      4) Joints shall be left exposed (uncoated and unpainted) and accessible until pressure testing has been completed.
      5) Inspect plugs and caps for conformance to Specification.
      6) To prevent movement during testing, place sufficient backfill over plastic pipe and pipe utilizing bell and spigot type joints.
   b. Testing shall be performed as soon as possible after installation Hydrotest Procedure: In accordance with requirements of ASME B31.1, ASTM F2164, or NFPA 24 and this Specification.
      1) Plastic Pipe:
         a) Do not pressure test with compressible fluid (e.g., air, gas).
         b) Follow manufacturer's recommendations for pressurization rates and holding times.
         c) Joints in plastic piping shall be set, cured, or hardened in accordance with manufacturer's recommendations prior to testing.
         d) Do not perform hydrostatic test when temperature is above 80 degrees F.
      2) Polyethylene Pipe:
         a) Initial pressure test for polyethylene pipe shall be applied and allowed to stand without makeup pressure for approximately 2 to 3 hours to allow for diametric expansion or pipe stretching to stabilize.
         b) After this equilibrium period, test section shall be returned to original test pressure and maintained for minimum of 1 hour.

3) Quality of test fluid shall not be detrimental to equipment or pipe system materials. Obtain approval by Engineer before using any test fluid.
   a) Water for testing equipment and piping containing austenitic stainless steel materials shall contain less than 50 ppm chloride ion.
   b) Do not perform hydrostatic test when temperature is below 32 degrees F, without Engineer approval.

c. Pneumatic Test:
   1) Pneumatic testing shall be done with compressed air or nitrogen.
   2) Do not perform pneumatic test when temperature is below 60 degrees F, without Engineer approval.
   3) Test joints with soap bubble method.

d. Post Pressure Test Inspection:
   1) Notify Engineer when piping system is ready for post-test inspection.
   2) Verify piping system has been flushed, dried, restored, and connected to satisfaction of Engineer, and is ready for operation.
   3) Engineer will inspect each piping system using supplement Piping Test and Post-Test Checklist located at end of section.

D. Repair of Leaks and Defects:

1. Repair leaks, and perform additional examination and retest.
2. Remove or repair defective joints as required by Engineer.
3. Repairs shall be made in accordance with procedures approved by Engineer.
4. Examination and inspection of completed joint repair shall be same as required for original joint or by alternate method that will ensure equal or greater soundness of joint.

E. Restoration:

1. After successful completion of hydrostatic testing, flush and drain lines. Water used for flushing and pressure testing shall be disposed of as directed by Engineer.
2. Open valves that were closed during hydrostatic test, for drainage of bonnet cavity. Partially open and close valves during flushing operation to flush foreign material out of system.

3. Care shall be exercised in draining piping so as not to create a vacuum. Open vents within system prior to draining. After piping systems are drained, close vents or drains that were opened prior to testing.
4. Remove temporary blanks and blinds.
5. Valves:
    a. Notify Engineer prior to valve restoration so Engineer may witness restoration.
    b. Restore, if required, valves after successful pressure testing.
    c. Restoration shall include removal of jacks; reinstallation of flappers, balls, and pistons; and replacing of bonnet gaskets on valves that were disassembled.
    d. Engineer will sign tag that was previously placed on valve and indicate that valve is ready for operation.
6. Each system shall be connected to equipment where applicable and be ready for operation.
7. Protection of flanges and drain hubs.
    a. Flanges: Cover with bolted or clamped plastic, wood or sheet metal cover of adequate size and strength to prevent damage to face. Coat carbon steel flange faces with suitable rust preventative.
    b. Drain Hubs: Cover with plastic or sheet metal caps.
    c. All covers shall be securely taped to prevent the intrusion of water or foreign materials.

F. Special Cleaning and Drying: Oil, gas, air, and chemical piping which has been flushed or hydrostatically tested shall be pigged to push the water out immediately after the flush or test, and thoroughly purged and dried with air or nitrogen before placing in service.

3.07 SUPPLEMENTS

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

1. Piping Pretest Checklist.
2. Piping Test and Post-Test Checklist.
3. Power Piping Standard PP-1, - Dielectric Flanged Joint.

END OF SECTION

PIPING PRETEST CHECKLIST

INSPECTION DATE _____

INSPECTED BY _____

PLANT _____ SUB-ENGINEER ____

SYSTEM/LINE NO. ____ DWG REF. ____

	Description	Engineer/ Owner Initials	Sub-Engineer Initials	Date
1.	All material/equipment (valve numbers, piping materials, flange ratings) complies with specifications, Drawings and P&ID's.			
2.	All flange bolting and gaskets correctly installed.			
3.	Vents installed at system high points.			
4.	Gauges calibrated and installed.			
5.	Blinds correctly installed.			
6.	Temporary plugs and caps have been installed.			

REMARKS

_____

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PIPING TEST AND POST-TEST CHECKLIST

INSPECTION DATE _____ TEST PACKAGE NO._____

INSPECTED BY _____

PLANT _____ SUB-ENGINEER ____

SYSTEM/ LINE NO. ____ DWG REF. _____

TEST MEDIUM _____ TEST PRESSURE, PSIG _____ TEST TEMP, °F _____

TEST PRESSURE HOLDING TIME _____MIN AMBIENT TEMP _____

Description	Engineer/ Owner Initials	Sub-Engineer Initials	Date
1. Test Complete and Acceptable			
2. If partial tests were made, define:			
a.			
b.			
3. System ready for post-test check:			
a. Test blinds removed.			
b. Final line flush complete.			

REMARKS

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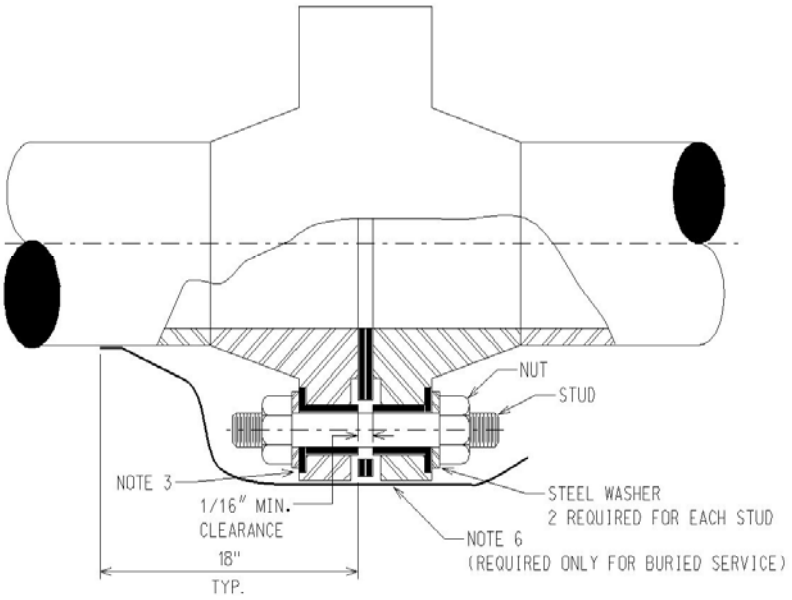


NOTES:

1. GASKET SHALL BE OF NON-METALIC OR NON-GRAPHITE-IMPREGNATED MATERIAL. MATERIAL TO BE PHENOLIC LAMINATE AS SUITABLE TO SERVICE TEMPERATURE OF LINE AND THE FLANGE TYPE, PSIPRODUCTS, F. H. MALONEY OR EQUAL.

2. SLEEVES AND WASHERS SHALL BE ONE PIECE OF ACETAL RESIN OR NYLON MATERIAL. USE TWO FOR EACH STUD.

3. REMOVE BURRS OR OTHER FOREIGN PARTICLES FROM FLANGE FACES, BOLT HOLES AND STUDS.

4. FOLLOW MANUFACTURER'S RECOMMENDED PRACTICE FOR INSTALLATION.

5. TEST FLANGE AFTER INSTALLATION AND REPLACE ANY CRACKED SLEEVES OR WASHERS WHICH MAY CAUSE "SHORTING OUT." USE CONTINUITY TESTER, FLASHLIGHT WITH LEADS, ETC.

6. AFTER INSTALLATION IS COMPLETE, PRIMER AND THREE WRAPS OF TAPE SHALL BE APPLIED TO FLANGE PERIMETERS AND EXTENDED 18" ON BOTH SIDES OF FLANGES. USE SCOTCHRAP, POLYKEN, OR EQUAL TO MANUFACTURER'S INSTRUCTIONS.

POWER PIPING STANDARD

PP-1
DIELECTRIC FLANGED JOINT

PP1.DGN 1 NONE

WHD 08/16/06
CAJ 08/16/06
SDH 08/16/06
NA / /

SECTION 40 50 20
ABOVEGROUND PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This Section covers minimum requirements for receiving, storing, handling, fabrication, assembly, erection, cleaning, filling, flushing, examination, testing, restoration and inspection of complete aboveground piping systems.

B. Contractor's Work shall include fabrication of piping system, including loose piping furnished with equipment and miscellaneous structural attachments for supports

C. Piping 2-1/2 inches and larger will be shown on Drawings. Piping and tubing 2 inches and smaller shall be routed and designed by contractor, except as otherwise noted on Drawings.

1.02 REFERENCES

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

1. American Society of Mechanical Engineer's (ASME):
   a. A13.1, Scheme for the Identification of Piping Systems.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   c. B31.1, Power Piping.
   d. BPVC Section II, Materials Part C Specification for Welding Rods, Electrodes, and Filler Metals.
   e. BPVC Section IX, Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
2. ASTM International (ASTM):
   a. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A525, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
3. BOCA, Basic Plumbing Code and Local Plumbing Code.
4. Manufacturers' Standardization Society of the Valve and Fittings Industry (MSS):
   a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
   b. SP-69, Pipe Hangers and Supports - Selection and Application.

c. SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.

5. Pipe Fabrication Institute (PFI): ES-3, Fabricating Tolerances.
6. U.S. Department of Labor Occupational Safety and Health Administration (OSHA): 29 CFR Parts 1926/1910.

1.03 SUBMITTALS

A. Action Submittals:

1. Isometric Drawings:
   a. Proposed field routing of Contractor Designed pipe.
   b. Show identification by line number and include bill of material.
   c. Include pipe support types and locations.
2. Contractor designed pipe support systems.
3. Testing fluid data.

B. Informational Submittals:

1. Hydrotest procedures.
2. Hydrotest reports, containing at least the following information:
   a. Complete description of pipe system including boundary limits, complete line numbers, Drawings and P&IDs indicating test boundaries.
   b. Record of Cleaning including date and responsible individual.
   c. Test description including test pressure, test medium, temperature of test medium, ambient temperature, time of day, test duration, leakage rate, and date of test.
   d. Record of joint repairs including date, extent of repairs, and responsible individual.
   e. Record of cleaning including date and responsible individual.
   f. Signature, date, and title of Engineer’s and Owner’s representative witnessing operation.
3. Quality Control Manual and Quality Assurance Manual.
4. Liquid penetrate evaluations, magnetic particle examinations, and any other examinations performed.
5. Manufacturer’s recommendations for handling, storage, and installation of components.
6. Record drawing mark ups of engineer furnished drawings showing any modifications made by Contactor in field. Manufacturer’s recommendation for handling, storage, and installation of components.

1.04 QUALITY ASSURANCE

A. Bonders and bonding procedures shall be qualified in accordance with requirements of ASME B31.1, Appendix III, Paragraph III-5.0.

B. Brazers and brazing procedures shall be qualified in accordance with ASME Section IX of the Boiler and Pressure Vessel Code.

C. Check Test:

1. May be required of any heat fusion operator, binder, or brazer at discretion of Engineer.
2. Personnel who fails test shall be prohibited from working in Project or be requalified at option of Engineer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General:

1. Store and handle materials in manner that will minimize corrosion and prevent damage to pipe and piping components, including their end connections and coatings.
2. Store pipe aboveground on Subcontractor furnished dunnage. Use sufficient number of supports to prevent pipe from sagging or coming into contact with ground. Either contoured or padded blocks shall also be used with coated pipe to prevent damage to coatings.
3. If pipe shall be partially or completely submerged due to rainfall, or any other cause, pipe shall be carefully examined, and water, together with any dirt, trash, or other foreign matter that may have entered shall be removed.

B. Special Piping (e.g., PVC, CPVC, polyethylene) materials shall be handled and stored in accordance with manufacturer’s recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Piping materials: Provide as specified in Section 40 50 00, Power Plant Piping Materials.

B. Valves:

1. As specified in Power Plant Valves section.

2. Provide necessary grease and lubricant required.

C. Pipe Supports/Hangers:

1. Pipe supports shall be in accordance with Section 40 05 15, Piping Support Systems.
2. Supports and hangers for Contractor designed piping shall be as shown on Engineer's standard support drawings.
3. Design of supports not shown on drawings shall be performed by designers experienced in design of pipe supports for process plant piping. Pipe support and hangers shall be approved by engineer prior to installation
4. Fabricate in accordance with MSS-SP-89.
5. Conform to MSS-SP-89.
6. Miscellaneous attachments for hangers, supports, guilds shall be of material similar to pipe and suitable for operating temperature.
7. Support assemblies shall have minimum yield strength safety factor of two and minimum ultimate strength factor for four.
8. Manufactures:
   a. Anvil International.
   b. Bergen-Power.

D. Markings and Identification:

1. Pipe Markings: Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
2. Pipe Identification Markers and Arrows: Refer to Section 10 14 00, Signage.

PART 3 EXECUTION

3.01 GENERAL

A. The Work required by this Specification shall be conducted in compliance with applicable OSHA Standards.

3.02 INSTALLATION

A. General:

1. Preinstallation Inspection: Inspect each pipe spool, valve, threaded opening and gasket surface for damage and internal cleanliness prior to installing

B. Piping:

1. In accordance with requirements of ASME B31.1 and this Section.
2. Install perpendicular or parallel to major equipment, building structure, and floor levels.
3. Piping, including tubing, shall be installed in accordance with the following requirements:
   a. Do not install above or within horizontal distance of 3 feet from electrical equipment such as switchgear, switchboard, control panel, motor control, contactor, communication equipment, batteries, battery charger, and motor generator.
   b. Install with minimum of 7 feet 6 inches of headroom over passageway and walkway. Pipe shall not be run near the floor, nor across walkways or working spaces where they would be a hazard.
   c. Where piping is specified to be field routed clearances shall be maintained to allow installation, operation, and maintenance of equipment.
4. Thermal Expansion: Install piping so that excessive or destructive expansion forces will not exist in either cold condition or under conditions of maximum temperature.

C. Joints:

1. Threaded:
   a. Tapered and conforming to ASME B1.20.1.
   b. Use Teflon as joint sealant for threaded joints.
2. Flanged Joints:
   a. Make up with flange faces parallel, and bolt holes straddling normal horizontal and vertical centerlines of flanges, unless otherwise shown on Drawings.
   b. Protect gaskets and flange faces from damage until installation is complete.
   c. Special precautions must be taken when making up steel-to-cast iron flanged joints. Steel flange shall be flat faced or have its raised face removed.
   d. Gaskets:
      1) Temporary Flanged Joint: May be made up with less expensive sheet gaskets and special gaskets saved for permanent installation.
      2) Verify that proper gaskets are installed for permanent installation.

3) Special care shall be taken during installation of spiral wound gaskets so gasket is not rendered ineffective by misalignment or overstressing.

e. Gaskets and gasket surfaces on flanges shall be clean, unpainted, and undamaged.

f. Bolt threads shall be coated with lubricant suitable for service temperature. The lubricant shall be applied to the full length of all bolt threads. All bolts shall extend completely through their nuts by at least one full effective thread, but not more than 3/8 inch.

g. Flanges shall be made up by tightening diametrically opposite bolts in succession to load gasket evenly.

h. Replace cap screws and machine bolts that have bottomed out before joint is tight with proper length screws or bolts.

i. When flanged joint has been made up and subsequently loosened, install new gasket prior to retightening.

j. Dielectric flanged joints shall be installed in accordance with Power Piping Standard PP-1, Dielectric Flanged Joints located at end of section

3. Bonded Joints (PVC, CPVC, RTRP): Make in accordance with manufacturer's recommendations and by qualified bonders using qualified bonding procedures.

4. HDPE Pipe Welded Joints:

a. Install joints per manufacturer's instructions using a hydraulic butt fusion machine or manual machine equipped with torque wrench. Equipment shall be able to achieve and maintain a heating tool temperature range of 400 to 450 degrees F and an interface pressure of 60 to 90 psi.

b. Clean interior and exterior of pipe and fitting ends with clean, dry, lint-free cloth.

c. Align ends to be joined in the fusion machine without forcing ends into alignment. Adjust alignment as necessary and tighten clamps to prevent slippage.

d. Place facing tool between ends to be joined and face them to provide a clean, smooth, parallel mating surface. If stops are present, face ends down to the stops. Remove all shavings after facing without touching ends.

e. Re-check alignment of ends and check for slippage against the fusion pressure. There shall be no detectable gaps between ends. Align outside diameters.

f. Heating tool shall maintain the manufacture's recommended temperature range. Place the tool between ends to be joined. Move ends against heating tool to achieve full contact. Hold ends

against heating tool without force until the following melt bead size is formed:

Pipe Diameter (inches)	Required Melt Bead Size (inches)
2 to 4	1/8 to 3/16
4 to 12	3/16 to 1/4
12 to 24	1/4 to 7/16
24 to 54	7/16 to 9/16

g. Upon forming proper melt bead size, quickly separate ends and remove heating tool. Quickly inspect melted ends and bring ends together applying joining force recommended by manufacturer, using 60 to 90 psi interfacial pressure to form a double bead rolled over surface of pipe on both ends.
h. Hold joining force against ends until joint is cool to the touch. Cooling period shall be 30 to 90 seconds per inch of pipe diameter. Heavier wall thicknesses may require longer cooling times as recommended by manufacturer.
i. Upon completing the joint, inspect to verify a double bead has been formed on both sides, uniformly rounded and consistent in size all around joint. Remove faulty joints and re-joint.

5. Grooved Joints:
   a. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
   b. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
   c. Install the grooved piping system in accordance with the latest installation instructions.
   d. Products shall not be installed with standard grooved end pipe or components. (Installing AGS products in combination with standard grooved end products could result in joint separation and/or leakage.)
   e. Use approved grooving tool roll sets to groove the pipe.
   f. Couplings installation shall be complete when visual metal-to-metal contact is reached.
   g. Grooved end product manufacturer to be ISO-9001 certified.

D. Cutting and Drilling Structures:

1. Drilling and cutting of structures required for proper installation of piping or bolts shall be performed only with written permission of Contractor.
2. Holes in grating or floor plate shall be banded and reinforced as required for strength and safety.

E. Equipment Connections:

1. When attaching piping to equipment connections, special care shall be taken that excessive stresses are not transmitted to, and imposed upon, such connections.
2. Field heating to accommodate minor fit-up problems is not allowed.
3. Owner's Inspector shall witness installation.
   a. After startup, if connecting piping is exerting excessive strains on equipment, contact Engineer for further instructions.
   b. Piping which vibrates excessively shall be anchored or snubbed as directed by the Engineer.

F. Tie-ins: Verify all tie-in dimensions before fabrication of final tie-in spools.

G. Piping Tolerances:

1. Dimensional tolerances for fabricated piping shall be in accordance with PFI ES-3 and this Specification.
2. Internal misalignment of buttweld ends in critical piping to be joined shall not exceed 1/16 inch for NPS 24 and smaller and 1/8-inch for NPS 26 and larger.
3. Dimensions of installed piping shall be in accordance with PFI Standard ES-3 unless otherwise noted.
4. Flanges in pipe runs shall not be out of square more than 3/64 inch per foot of outside diameter of flange.
5. Angular tolerances shall be plus or minus 1/2 degree.
6. After piping has been positioned, check flanges and connections to mechanical rotating equipment for alignment. Flanges shall be parallel within 1/64 inch per foot of flange diameter and not put any strain on equipment casings.
7. Flex hoses and expansion joints shall be installed straight and without strain or as indicated on Drawings.
8. No cold springing will be allowed for pipe fit-up.
9. Remove improperly fitted pipe and replace.

H. Branch and Instrument Connections: Conform to requirements of appropriate Material Specifications in Section 40 50 00, Power Plant Piping Materials.

I. Special Piping: Install PVC, CPVC, polyethylene, fiberglass, plastic-lined steel, or preinsulated, in strict accordance with this Section and manufacturer's recommendations.

J. Valves:

1. In accordance with Section 40 27 02, Process Valves and Operators.
2. Control valves shall be installed in such a manner that they can be operated from main operating floors or platforms, except as otherwise noted on Drawings. Use of ladders or special operating devices may be used for valves not normally operated.

K. Pipe Supports/Hangers:

1. General:
   a. Weld pipe supports to structural steel framing by shielded metal arc method only and in accordance with Section 05 05 23, Welding, and AWS D1.1. Welds shall run parallel to axis of beam span and shall be staggered, with cooling allowed between subsequent deposits.
   b. Make weldments of attachments to piping prior to postweld heat treatment.

3.03 FIELD FINISHING

A. Piping, Components and Supports:

1. All PVC and CPVC pipe and fittings located outdoors or within 5 of the exterior boundary of the roof and sunshade shall be coated with the two coats of semi-gloss acrylic latex.
2. Prepare surface by hand sanding with medium grit sandpaper.
3. Apply coating in accordance with manufacturer's instructions (minimum two coats).
4. Color determined by Engineer.

3.04 FIELD QUALITY CONTROL

A. General:

1. Inspect, examine, clean, and test piping in accordance with requirements of ASME B31.1, Chapter VI, and this Section.

2. Procedures shall be subject to approval of Engineer.
3. Engineer shall witness each critical operation (e.g., pressure testing, cleaning and drying, disinfection).

B. Pressure Tests:

1. General:
   a. Piping Line Report specifies which piping systems are to be pressure tested and test pressure. All pressure tests shall be hydrostatic, unless otherwise specified on the Piping Line Report.
   b. Notify Engineer minimum of 48 hours prior to pressure test.
   c. Document field tests with test report witnessed by Engineer.
   d. Vents and drains that are downstream of last block valve and open to atmosphere do not require pressure testing.
   e. A safety valve or relief valve shall be used at the pressure source to protect systems under test. The Contractor shall be responsible for venting all sections of piping systems and vessels not under direct test to prevent overpressuring any part of system through valve leakage or excess flows.
   f. Flanged joints at which test blinds have been removed do not require testing.
   g. Remove filter elements from system prior to pressure testing.
   h. Equipment appurtenances such as level bridles, shall be tested separately when equipment is excluded from pressure testing.
   i. Control valves shall be included in pressure test with valves in open position.
   j. Verify pressure relief devices have test gags and components included in test can withstand test pressure.
   k. Tag all valves included in test boundaries to indicate status, i.e., open for block and control valves, internals removed or blocked open for check valves.
   l. In event piping system cannot be successfully pressure tested, correct problem and retest.
2. Test Records: Records shall be made of each piping system test utilizing the Piping Checklists, or approved substitute
3. Hydro Test:
   a. Pretest Inspection:
      1) Notify Engineer when piping system is ready for pretest inspection.
      2) Verify components in piping system conform to requirements of appropriate Pipe Material Specification in Section 40 50 00, Power Plant Piping Materials (e.g.,

material, wall thickness, valve numbers, valve ratings, flange ratings, etc.) and latest revision of Piping and Instrumentation Diagrams, and is ready for pressurization.

a) Engineer will inspect each piping system using copy of Piping Pretest Checklist located at end of section.
b) Joints shall be left exposed (uninsulated and unpainted) until testing has been completed.
c) Isolate equipment listed in the Supplement, Status of Equipment during Pressure Test, located at end of section, from piping systems that will be pressure tested.

3) Supports, shoes, guides, and anchors shall be inspected for proper type, installation, and location.
4) Spring supports shall have their hydrotest pins installed.
5) Inspect plugs and caps for conformance to Specification.
6) Valve tags shall be inspected for purpose of identifying status. Tag shall indicate block and control valves are open or that check valves have had their internals removed, jacked open, or left unaltered.

b. Hydrotest Procedure: In accordance with requirements of ASME B31.1 and this Specification.

1) Plastic Pipe:
   a) Do not pressure test with compressible fluid (e.g., air, gas).
   b) Joints in plastic piping shall be set, cured, or hardened in accordance with manufacturer’s recommendations prior to testing.
   c) Temperature of plastic piping shall not exceed 80 degrees F during pressure testing without prior approval of Engineer.
2) Quality of test fluid shall not be detrimental to equipment or pipe system materials. Obtain approval by Engineer before using any test fluid.
3) Water for testing equipment and piping containing austenitic stainless steel materials shall contain less than 50 ppm chloride ion.
4) Do not perform hydrostatic test on metallic systems when temperature is below 32 degrees F, without Engineer approval.
5) Observe each pipe system to ensure that supports, including spring supports, are not overloaded due to weight of test medium.

6) Remove insulation that becomes wet during hydrostatic testing.

c. Pneumatic Test:
   1) Pneumatic testing shall be done with compressed air or nitrogen.
   2) Do not perform pneumatic test when temperature is below 60 degrees F, without Engineer approval.
   3) Lines to be pressure tested by pneumatic testing shall be given an application of a leak detection fluid which shall reveal the presence of leaks by an easily visible means, such as bubble formation. Generally pneumatic test pressures shall be limited to 100 psig. When specified, pneumatic tests with a test pressure that is above 100 psig, the piping shall be taken to test pressure, held for a suitable time, then lowered to system operating pressure to conduct visual inspection.
   4) Air compressors shall be equipped with discharge filters for removal of water, oil and foreign matter. Maximum discharge temperature of oil lubricated air compressors shall be 300 degrees F.

d. Initial Service Testing
   1) In accordance with ASME B31.1.
   2) Permissible only with prior written authorization from Engineer.

e. Notify Engineer minimum of 48 hours prior to Initial Service Tests.

f. Post-Pressure Test Inspection:
   1) Notify Engineer when piping system is ready for post-test inspection.
   2) Verify piping system has been flushed, dried, restored, and connected to satisfaction of Engineer, and is ready for operation.
   3) Pressure relief valves, spring hangers, and expansion joints shall be inspected to see that gags, hydrotest pins, shipping spacers, and shipping ties have been removed. Spring hangers shall be set to the Cold position.
   4) Engineer will inspect each piping system using Piping Test and Post-Test Checklist located at end of section.

C. Repair of Leaks and Defects:

1. Repair leaks, and perform additional examination and retest.

2. Remove or repair defective joints as required by Engineer.
3. Repairs shall be made in accordance with procedures approved by Engineer.
4. Examination and inspection of completed joint repair shall be same as required for original joint or by alternate method that will ensure equal or greater soundness of joint.

D. Restoration:

1. After successful completion of hydrostatic testing, flush and drain lines. Water used for flushing and pressure testing shall be disposed of as directed by Engineer.
2. Open valves that were closed during hydrostatic test, for drainage of bonnet cavity. Partially open and close valves during flushing operation to flush foreign material out of system.
3. Care shall be exercised in draining vessels and piping so as not to create a vacuum. Open vents within system prior to draining. After piping systems and vessels are drained, close vents, drains, and other internals that were opened prior to testing.
4. Remove temporary blanks and blinds.
5. Valves, orifice plates, expansion joints, and short pieces of piping which have been removed shall be reinstalled with proper gaskets in place.
6. Valves:
    a. Notify Engineer prior to valve restoration so Engineer may witness restoration.
    b. Restore, if required, valves after successful pressure testing.
    c. Restoration shall include removal of jacks; reinstallation of flappers, balls, and pistons; and replacing of bonnet gaskets on valves that were disassembled.
    d. Engineer will sign tag that was previously placed on valve and indicate that valve is ready for operation.
7. Remove temporary piping supports after lines have been drained. Restraining parts that were supplied with hangers and expansion joints for their protection when carrying test loads shall be removed upon completion of system test and permanently reattached to supports with 3/16-inch minimum stainless steel wire.
8. Remove and replace special length bolting and temporary gaskets with line class bolts and gaskets.
9. Each system shall be connected to equipment where applicable and be ready for operation.
10. Seal terminal points of piping systems that are left for future connections with blinds or plugs.

3.05 SUPPLEMENTS

A. The supplements listed below or Engineer approved alternates, following "End of Section," are part of this Specification:

1. Piping Pretest Checklist.
2. Status of Instruments During Pressure Test.
3. Piping Test and Post-Test Checklist.
4. Power Piping Standard PP-1, - Dielectric Flanged Joint.

END OF SECTION

PIPING PRETEST CHECKLIST

INSPECTION DATE _____

INSPECTED BY _____

PLANT _____ CONTRACTOR _____

SYSTEM/LINE NO. _____ DWG REF. _____

	Description	Contractor Initials	Sub-Contractor Initials	Date
1.	All material/equipment (valve, pipe materials, specialty items) comply with Specifications and Piping and Instrumentation Diagrams.			
2.	All threaded connections, flange bolting, gaskets, and socket welds correctly installed.			
3.	All PWHT completed and acceptable.			
4.	All NDE (hardness, MT, PT, RT, UT) acceptable.			
5.	Instrumentation protected/secure.			
6.	Rotating equipment internals protected/secure.			
7.	Expansion joints, relief valves, orifice plates, meters, control valves, filter elements, internal refractories, and other special items protected/secure.			
8.	Gauges calibrated and installed.			
9.	Status of block and control valves and check valve internals have been tagged.			
10.	Blinds correctly installed.			
11.	Temporary plugs and caps have been replaced.			
12.	Low point drains are installed as needed.			
13.	High point vents are installed as needed.			

REMARKS

_____

_____

_____

STATUS OF INSTRUMENTS DURING PRESSURE TEST (1)

	Block & Vent	Remove	Blind Off	Include In Test	Refer to Notes
Analyzers	X				
Control Valves				X	
Flow Indicating Switches, Bellows Type	X				
Flow Instruments-D/P Cell & Bellows Type	X				
Flow Instruments-Rotameters		X			2
Flow Meters-Positive Displacement Type			X		2
Flow Meters-Turbine Type			X		2
Flow Switches-Vane Type		X			
Gauge Glasses				X	3
Level Instruments-Displacer Type				X	3
Level Instruments-D/P Cell & Bellows Type	X				
Level Switches-Float Type				X	3
Orifice Plates		X			4
Pressure Gauges	X				
Pressure Instruments-All Types	X				
Pressure Regulators		X			
Pressure Switches	X				
PSV's			X		5,2
PSV's-3/4" and 1" Screwed		X			2
Rupture Discs		X			
Steam Traps		X			2
Thermowells				X	

NOTES:

1. All instruments shall be protected from damage due to freezing. In preparation for cold weather and during cold weather all instruments must be drained and process lead lines blown out with air or nitrogen.
2. Fabricate and install temporary spool or cap if necessary for test.
3. Caution - do not overpressure instrument. Check with Engineer for maximum test pressure allowed by manufacturer.
4. Install after hydrotesting and line flushing.
5. Blinds are not required on PSV outlets discharging into a system being tested at 15 psig or less.

PIPING TEST AND POST-TEST CHECKLIST

INSPECTION DATE _____ TEST PACKAGE NO._____

INSPECTED BY _____

PLANT _____ CONTRACTOR _____

SYSTEM/LINE NO. ____ DWG REF. _____

TEST MEDIUM _____ TEST PRESSURE, PSIG _____ TEST TEMP, °F _____

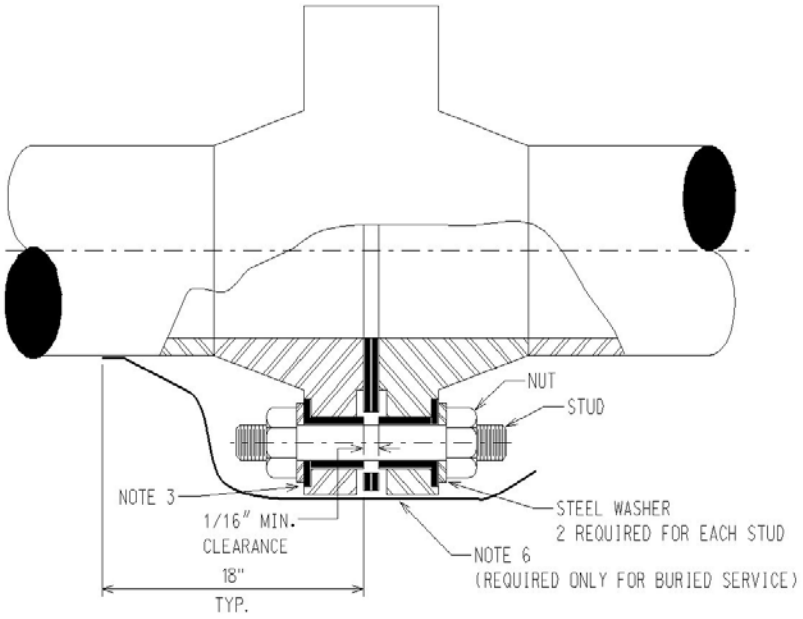
TEST PRESSURE HOLDING TIME _____ MIN AMBIENT TEMP _____

Description	Contractor Initials	Sub-Contractor Initials	Date
1. Test Complete and Acceptable			
2. If partial tests were made, define:			
3. System ready for post-test check:			
a. Test blinds removed.			
b. Final line flush complete.			
c. Vents properly plugged.			
d. Drains properly valved and plugged.			
e. Instruments properly installed.			
f. Expansion joints, relief valves, control valves, in-line meters, filter elements, orifice plates, in-line strainers, and other special items clean and properly installed			
g. Rotating equipment properly in-line.			
h. Temporary supports removed.			
i. Permanent supports restored			

REMARKS

_____

_____



NOTES:

1. GASKET SHALL BE OF NON-METALIC OR NON-GRAPHITE-IMPREGNATED MATERIAL. MATERIAL TO BE PHENOLIC LAMINATE AS SUITABLE TO SERVICE TEMPERATURE OF LINE AND THE FLANGE TYPE, PSIPRODUCTS, F. H. MALONEY OR EQUAL.

2. SLEEVES AND WASHERS SHALL BE ONE PIECE OF ACETAL RESIN OR NYLON MATERIAL. USE TWO FOR EACH STUD.

3. REMOVE BURRS OR OTHER FOREIGN PARTICLES FROM FLANGE FACES, BOLT HOLES AND STUDS.

4. FOLLOW MANUFACTURER'S RECOMMENDED PRACTICE FOR INSTALLATION.

5. TEST FLANGE AFTER INSTALLATION AND REPLACE ANY CRACKED SLEEVES OR WASHERS WHICH MAY CAUSE "SHORTING OUT." USE CONTINUITY TESTER, FLASHLIGHT WITH LEADS, ETC.

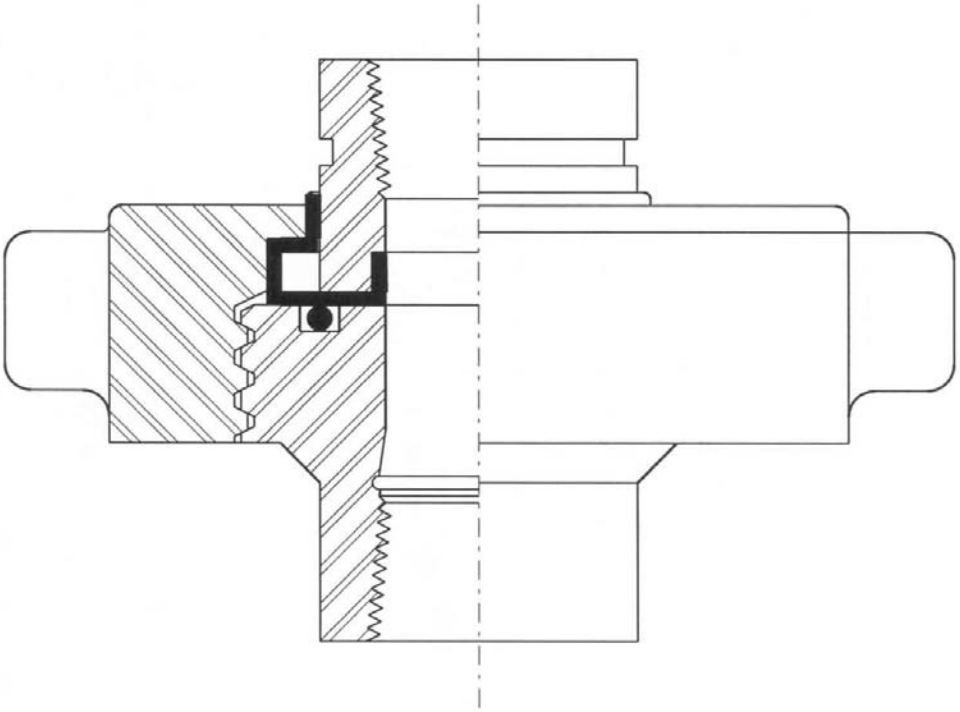
6. AFTER INSTALLATION IS COMPLETE, PRIMER AND THREE WRAPS OF TAPE SHALL BE APPLIED TO FLANGE PERIMETERS AND EXTENDED 18" ON BOTH SIDES OF FLANGES. USE SCOTCHRAP, POLYKEN, OR EQUAL TO MANUFACTURER'S INSTRUCTIONS.

POWER PIPING STANDARD

PP-1
DIELECTRIC FLANGED JOINT

PP1.DGN 1 NONE

WHD 08/16/06
CAJ 08/16/06
SDH 08/16/06
NA / /



POSITIVE PRESSURE SEAL PROVIDED BY "O" RING FOR USE WITH GAS, CRUDE, BRINE, WATER, AIR, AMMONIA AND LUBRICATING OILS - UP TO 275 DEG. F.

SIZES: 1000# CWP OCTAGON NUT
1/2" - 3/4" - 1" - 1 1/4" - 1 1/2" - 2"

SIZES: 3000# CWP HANDLE BAR OR OCTAGON NUT
1/2" - 3/4" - 1" - 1 1/4" - 1 1/2" - 2" - 2 1/2" - 3"

AFTER INSTALLATION IS COMPLETE, PRIMER AND THREE WRAPS OF TAPE SHALL BE APPLIED TO UNION AND EXTENDED 18" ON BOTH SIDES OF UNION. USE SCOTCHRAP, POLYKEN, OR EQUAL TO MANUFACTURER'S INSTRUCTIONS. COATING IS ONLY REQUIRED FOR BURIED SERVICE.

POWER PIPING STANDARD

PP-2
DIELECTRIC THREADED JOINT

PP2.DGN 0 NONE

WHD 11/12/01
SDH 11/12/01
SDH 11/12/01
NA / /

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Test type.
   d. Method of isolation.
   e. Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
4. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.

b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

5. Items that do not require testing include tank atmospheric vents.
6. Test Pressure: As specified by equipment manufacturer.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.

5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

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

where:

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

7. Correct leakage greater than allowable, and retest as specified.
8. Pneumatic and/or hydropneumatic pressure testing shall not be allowed.

3.03 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

D. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

G. Defective Piping Sections: Replace and retest as specified.

3.04 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 40 90 00
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:

1. Section 40 91 00, Instrumentation and Control Components.
2. Section 40 91 01, PLC and HMI Application Programming.
3. Section 40 91 02.01, I&C Analytical Measurement Components.
4. Section 40 91 02.03, I&C Flow Measurement Components.
5. Section 40 91 02.05, I&C Level Measurement Components.
6. Section 40 91 02.07, I&C Pressure Measurement Components.
7. Section 40 95 60, Telemetry System.
8. Section 40 95 80, Fiber Optic Communication System.

B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.

1. Process instrumentation including primary elements, transmitters, control devices, and control panels.
2. Programmable controllers.
3. Computers and networks for Human Machine Interface (HMI).
4. Applications Software: Provided by Application Programmer for PLCs and SCADA systems. Programming Software and Communication Hardware. Work related to supporting this activity includes:
    a. Early delivery of programming equipment to Engineer’s office.
    b. Setup and demonstration testing of programming equipment at Application Programmer’s office.
    c. Delivery of PLCs and HMIs to staging site provided by Contractor.
    d. Demonstration testing at staging site.
    e. Assistance with onsite checkout of applications software.
    f. For additional related requirements refer to:
        1) Article Sequencing and Scheduling in this section.

2) Sections that cover the equipment for which Engineer will provide applications software.

g. Staging Site: Provide for development and testing of applications software. See Section 01 50 00, Temporary Facilities and Controls (to be completed), for staging site requirements.

1.02 REFERENCES

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

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   d. B32, Standard Specification for Solder Metal.
   e. B88, Standard Specification for Seamless Copper Water Tube.
3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
5. International Society of Automation (ISA):
   a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
   b. S5.1, Instrumentation Symbols and Identification.
   c. S5.4, Instrument Loop Diagrams.
   d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
   e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
6. International Conference on Energy Conversion and Application (ICECA).
7. National Electrical Code (NEC).

8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 1, Industrial Control and Systems General Requirements.
9. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
10. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
11. Underwriters Laboratories, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. DCU: Distributed Control Unit.
2. FDT: Factory Demonstration Test.
3. HMI: Human-Machine Interface.
4. HVAC: Heating, Ventilating, and Air Conditioning.
5. I&C: Instrumentation and Control.
6. I/O: Input and Output.
7. O&M: Operation and Maintenance.
8. P&ID: Process and Instrument Diagram.
9. PC: Personal Computer.
10. PIC: Process Instrumentation and Control.
11. PLC: Programmable Logic Controller.
12. RTU: Remote Terminal Unit.
13. SCADA: Supervisory Control and Data Acquisition.
14. SLDC: Single Loop Digital Controller.
15. SSDT: Staging Site Demonstration Test.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: 8 hours of actual instruction time.

D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.

1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
3. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, DCUs, SLDC, and fieldbus devices.

E. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:

1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
2. Programming in any programming or scripting language.

F. Rising/Falling: Define action of discrete devices about their setpoint.

1. Rising: Contacts close when an increasing process variable rises through setpoint.
2. Falling: Contacts close when a decreasing process variable falls through setpoint.

G. Signal Types:

1. Analog Signal, Current Type:
   a. 4 to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
      1) Transmitter Type: Number 2, two-wire.

2) Transmitter Load Resistance Capacity: Class L.
3) Fully isolated transmitters and receivers.

2. Analog Signal, Voltage Type: 1 to 5V dc within panel where common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
   a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid state switches.
   c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SYSTEM DESCRIPTION

A. Detailed Wiring Design: Panel wiring diagrams, interconnecting wiring diagrams, and loop wiring diagrams are included in Contract Drawings and designed to completely show control panel wiring, terminations, wire numbers, interfaces with other systems, hardwired functions, interlocks, and wiring of components to be provided.

B. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
3. PIC design as shown and specified includes:
   a. Functional requirements, performance requirements, and component specifications.
   b. P&IDs, block diagrams, and network diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

C. Use a qualified PIC System Integrator for at least the following work:

1. For PIC Equipment and Ancillaries:
   a. Completing detail design.
   b. Submittals.
   c. Equipment, enclosures, and ancillaries.

d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
e. Verify readiness for operation.
f. Verify correctness of final power and signal connections (lugging and connecting).
g. Adjusting and calibrating.
h. Starting up.
i. Testing and coordination of testing.
j. Training.
k. Assist Engineer with Functional Test Part 2 as defined in Article Field Quality Control.

2. Verify following Work not by PIC System Integrator is provided:
   a. Correct type, size, and number of signal wires with their raceways.
   b. Correct electrical power circuits and raceways.
   c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
   d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. Non-PIC Equipment Directly Connected to PIC Equipment:
   a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with PIC.
   c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
   d. Test to demonstrate required interface and operation with PIC.
   e. Examples of items in this category, but not limited to the following:
      1) Valve operators, position switches, and controls.
      2) Chemical feed pump and feeder speed/stroke controls.
      3) Automatic samplers.
      4) Motor control centers.
      5) Adjustable speed and adjustable frequency drive systems.
   f. Examples of items not in this category:
      1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
      2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 SUBMITTALS

A. General:

1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
2. Partial Submittals not in accordance with Project Schedule will not be accepted.
3. Submittal Format:
   a. Hard Copy: Required for all submittals.
   b. Electronic Copies: Required unless otherwise noted for specific items.
      1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
      2) Documents created specifically for Project:
         a) Text and Graphics: Microsoft Word.
         b) Lists: Microsoft Excel, unless otherwise noted for specific items.
         c) Drawings: AutoCAD.
4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
5. Legends and Abbreviation Lists:
   a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
   b. Use identical abbreviations in PIC subsections.
   c. Submit updated versions as they occur.
6. Activity Completion:
   a. Action Submittals: Completed when reviewed and approved.
   b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals:

1. Bill of Materials: List of required equipment.
   a. Group equipment items by enclosure and field, and within an enclosure, as follows:
      1) PIC Components: By component identification code.
      2) Other Equipment: By equipment type.
   b. Data Included:
      1) Equipment tag number.
      2) Description.

3) Manufacturer, complete model number and all options not defined by model number.
4) Quantity supplied.
5) Component identification code where applicable.
6) For panels, include panel reference number and name plate inscription.

c. Formats: Hard copy and Microsoft Excel.

2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
   a. Catalog information, marked to identify proposed items and options.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
3. Instrument List:
   a. Engineer will provide an initial Instrument List in Microsoft Excel. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.
   b. Applicable fields to be completed include, but are not limited to:

Instrument List Characteristics	
Item	**Initially Completed By**
Tag Number	Engineer
Loop Number	Engineer
Description	Engineer
Manufacturer and complete model number, including power and signal requirement	Contractor
Size and scale range	Engineer
Set Points	Engineer
Reference P&IDs, Electrical, Mechanical, Interconnection Drawings and Installation Details Drawings	Engineer
Instrument detail number	Engineer

   c. Submit updated version of Instrument List.

d. Electronic Copies: Microsoft Excel.

4. Component Data Sheets: Data sheets for I&C components.
   a. Format:
      1) Similar to ISA TR20.00.01.
      2) Microsoft Excel, one component per data sheet.
      3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
   b. Content: Specific features and configuration data for each component, including but not limited to:
      1) Tag Number.
      2) Component type identification code and description.
      3) Location or service.
      4) Service conditions.
      5) Manufacturer and complete model number.
      6) Size and scale range.
      7) Setpoints.
      8) Materials of construction.
      9) Options included.
      10) Power requirements.
      11) Signal interfaces.
      12) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
   c. Electronic Copies: Microsoft Excel.
5. Sizing and Selection Calculations:
   a. Primary Elements:
      1) Complete calculations plus process data used. Example for Flow Elements:
         a) Minimum and maximum values, permanent head loss, and assumptions made.
   b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
   c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.
6. Preliminary Panel Elevation Drawings: Provide prior to submitting Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and location of front of panel devices.
   b. Panel Legend and Bill of Material (BOM): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and enunciator inscriptions.
   c. Submit electronic copies of Drawings.

7. Panel Construction Drawings:
    a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
    b. Panel Legend and BOM: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and enunciator inscriptions.
    c. Bill of Materials: List devices mounted within panels that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
    d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
    e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
    f. Submit electronic copies of Drawings.
8. Detailed Wiring Diagrams:
    a. Refer to Drawings for Detailed Wiring Diagrams including:
        1) Panel Wiring Diagrams for discrete control and power circuits.
        2) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
        3) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.
    b. Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.
    c. Submit electronic copies of Drawings.
9. Panel Wiring Diagrams:
    a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
    b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.
    c. Diagram Type:
        1) Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
        2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.

d. Item Identification: Identify each item with attributes listed.
   1) Wires: Wire size, number and color. Cable number if part of multi-conductor cable.
   2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
   3) Components:
      a) Tag number, terminal numbers, and location ("FIELD," enclosure number, or MCC number).
      b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
   4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
   5) Relay Coils:
      a) Tag number and its function.
      b) On right side of rung where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
   6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
   7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.
e. Show each circuit individually. No "typical" diagrams or "typical" wire lists will be allowed.
f. Ground wires, surge protectors, and connections.
g. Wire and Cable Names: Show names and wire color corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.

10. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
    a. Conform to the minimum requirements of ISA S5.4.
    b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
    c. Show loop components within a panel and identify each component, component terminals, and panel terminals.

d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
    1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
    2) Identify the component by tag and description.
    3) Identify panel and component terminal numbers.
e. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
f. Divide each loop diagram into areas for panel face, back-of-panel, field and PLC.
g. One Drawing Per Loop: Show each loop individually. No "typical" loop diagrams will be allowed.
h. Show:
    1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
    2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
    3) Tabular summary on each analog loop diagram:
        a) Transmitting Instruments: Output capability.
        b) Receiving Instruments: Input impedance.
        c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
        d) Total loop impedance.
        e) Reserve output capacity.
    4) Circuit and raceway schedule names.

11. Communications and Digital Networks Diagrams:
    a. Scope: Includes connections to telephone system, Ethernet network, remote I/O, and Fieldbus (for example, Modbus, Profibus, Foundation Fieldbus, Device Net, etc.).
    b. Format: Network schematic diagrams for each different type of network.
    c. Show:
        1) Interconnected devices, both passive and active.
        2) Device names and numbers.
        3) Terminal numbers.
        4) Communication Media: Type of cable.
        5) Connection Type: Type of connector.
        6) Node and device address numbers.
        7) Wire and cable numbers and colors.

12. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
    a. Required voltages, currents, and phases(s).
    b. Maximum heat dissipations Btu per hour.
    c. Calculations.
    d. Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 110 degrees F.
13. Panel Plumbing Diagrams: For each panel containing piping and tubing. Show type and size for:
    a. Pipes and Tubes: Thickness, pressure rating, and materials.
    b. Components: Valves, regulators, and filters.
    c. Connections to panel-mounted devices.
    d. Panel interface connections.
    e. Submit electronic copies of Drawings.
14. Installation Details: Include modifications or further details required and define installation of I&C components.
15. Spares, expendables, and test equipment.
16. Electronic Copies: Microsoft Excel.
17. PLC I/O List:
    a. Managed by Engineer:
        1) During construction Engineer will maintain PLC I/O List and give electronic Microsoft Excel copies to PIC System Integrator.
        2) Engineer will assign PLC I/O points to specific chassis, slot, and point addresses.
    b. PLC I/O List Changes: Changes to PLC I/O List reflecting actual equipment and instrumentation provided.
        1) Mark up electronic file of latest PLC I/O List from Engineer. Highlight changed cells with yellow, new rows with red, and rows to be deleted with green.
        2) Submit marked up copies changes at 30-day intervals.
18. PLC I/O List: Submit I/O assignment and Rack/Slot/Point.
19. Shop Drawings for Changes Impacting PLC and SLDC Programming:
    a. Submit details of changes required to PLC and SLDC monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.
    b. Submit changes at 30-day intervals.
20. Color schedule for control panels.

21. Applications Software Documentation: For equipment for which Engineer does not provide applications software provide:
    a. Complete configuration documentation for microprocessor based programmable devices.
    b. For each device, include program listings and function block diagrams, as appropriate, showing:
        1) Functional blocks or modules used.
        2) Configuration, calibration, and tuning parameters.
        3) Descriptive annotations.
    c. Refer to PIC subsections for additional requirements.

C. Informational Submittals:

1. Statements of Qualification:
    a. PIC System Integrator.
    b. PIC System Integrator's site representative.
    c. Resume for each PIC System Integrator's onsite startup and testing team member (engineers, technicians, and software/configuring personnel).
2. Operation and Maintenance Data: In accordance with Section 01 78 23, Operation and Maintenance Data (to be completed), and in addition the following:
    a. General:
        1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
        2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.
    b. Final versions of Legend and Abbreviation Lists.
    c. Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.
    d. Provide the following items as defined under heading Action Submittals:
        1) Bill of materials.
        2) Catalog cuts.
        3) Instrument list.
        4) Component data sheets.
        5) Detailed Wiring Diagrams: As-built drawings.
            a) Panel wiring diagrams.
            b) Loop diagrams.
            c) Interconnecting wiring diagrams.

6) Panel plumbing diagrams.
7) Applications software documentation.

e. Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
   1) Content for Each O&M Manual:
      a) Table of Contents.
      b) Operations procedures.
      c) Installation requirements and procedures.
      d) Maintenance requirements and procedures.
      e) Troubleshooting procedures.
      f) Calibration procedures.
      g) Internal schematic and wiring diagrams.
      h) Component and I/O Module Calibration Sheets from field quality control calibrations.
   2) Provide PDF file will linked index to all manuals.

f. List of spares, expendables, test equipment and tools provided.

g. List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.

3. Provide Manufacturer's Certificate of Proper Installation where specified.

4. Testing Related Submittals:
   a. Factory Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures:
         a) Proposed test procedures, forms, and checklists.
         b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
      3) Test Documentation: Copy of signed off test results.
   b. Staging Site Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation: Copy of signed-off test results when tests are completed.
   c. Functional Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.

2) Final Test Procedures: Proposed test procedures, forms, and checklists.
3) Test Documentation:
a) Copy of signed-off test results.
b) Completed component calibration sheets.

d. Performance Test:
1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
2) Final Test Procedures: Proposed test procedures, forms, and checklists.
3) Test Documentation: Copy of signed-off test results.

5. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).
6. Maintenance Service Agreement: Prior to Substantial Completion, submit service agreements signed by Owner and maintenance provider for work required under Article Maintenance Service.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. PIC System Integrator: Minimum of 5 years' experience providing, integrating, installing, and starting up similar systems as required for this Project.
2. PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

1. General: Refer to Section 01 31 19, Project Meetings (to be completed), for PIC coordination meetings.
2. PIC Schedule Coordination Meeting:
a. Timing: Following Engineer review of PIC Schedule.
b. Purpose: Discuss Engineer's comments and resolve scheduling issues.
3. Training Coordination Meeting:
a. Timing: Following Engineer review of preliminary training plan.
b. Purpose:
1) Resolve required changes to proposed training plan.
2) Identify specific Owner personnel to attend training.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements (to be completed).

B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

A. Refer to Section 01 31 13, Project Coordination (to be completed), for Contractor's scheduling requirements for applications software testing.

B. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:

1. Shop Drawing Reviews by Engineer:
   a. Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
   b. Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures (to be completed).
2. Test Prerequisite: Associated test procedures Submittals completed.
3. PLC and HMI Configuring Equipment Delivered to Application Programmer's office:
   a. Refer to PIC subsections for a definition of this equipment.
4. PLC and SCADA Applications Software Configuring by Engineer at Engineer's Office.
   a. Prerequisite: PLC and SCADA configuring equipment demonstration test.
5. Equipment Delivered to Staging Site: Refer to PIC subsections for a definition of this equipment.
   a. Prerequisites:
      1) PLC and SCADA applications software configuring by Engineer at Engineer's office completed.
      2) FDT completed.

6. Staging Site Demonstration Test Prerequisite: PLC and SCADA staging equipment delivered to staging site.
7. PLC and SCADA Applications Software Configuring and Testing by Engineer:
   a. Prerequisite: Staging site demonstration test completed.
8. PLC and SCADA Shipment to Site:
   a. General Prerequisites:
      1) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
      2) FDT and SSDT completed.
   b. Additional prerequisite for equipment previously shipped to Engineer's office and staging site: Completion of PLC and SCADA application software configuring and testing by Engineer at Staging Site.
9. PLC and HMI Installation Prerequisite: Equipment received at Site.
10. Functional Test Part 1 Prerequisite: PLC and SCADA installation complete.
11. Functional Test Part 2 Prerequisite: Functional Test Part 1 completed.
12. Performance Test Prerequisite: Functional Test Part 2 completed and facility started up.

1.09 MAINTENANCE

A. Maintenance Service Agreement:

1. Duration of 1 year unless otherwise noted in PIC subsections.
2. Start on date of Substantial Completion.
3. Performed by factory-trained service engineers with experience on PIC systems to be maintained.
4. PIC Systems Covered: PIC components except for Engineer provided applications software.
5. Materials and labor for preventive maintenance and monthly Site visits.
6. Materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m. Monday through Friday.
7. Response Time: Service engineer shall be onsite within 24 hours of request by Owner.
8. Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.
9. Repair or replace components or software found to be faulty.
10. Replace and restock within 1 month onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.

11. Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each Site visit.

B. Telephone Support: As specified in PIC subsections.

C. Software Subscription: As specified in PIC subsections.

1.10 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up SCADA.

C. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.

1. Chemical for analyzers.
2. Calibration/test gas for combustible gas detection.
3. Corrosion-inhibiting vapor capsules.
4. pH Sensor Overhaul Kits: Two.
5. Spray pump filter adhesive; Hoffman Model A-FLTAD. One pint per panel with air filters.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software (except for Engineer provided applications software) whether indicated or not, necessary to effect required system and loop performance.

B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and "Or-Equals".
2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
2. Implement same or similar functions in same or similar manner. For example control logic, sequence controls, and display layouts.

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

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

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Components for Each Loop: Furnish equipment that is necessary to achieve required loop performance.

2.03 SERVICE CONDITIONS

A. Standard Service Conditions: The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:

1. Computer Room, Air Conditioned:
   a. Temperature: 60 degrees F to 80 degrees F.
   b. Relative Humidity: 40 percent to 60 percent.
   c. NEC Classification: Nonhazardous.
2. Inside, Air Conditioned:
   a. Temperature:
      1) Normal: 60 degrees F to 80 degrees F.
      2) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.

b. Relative Humidity:
   1) Normal: 10 percent (winter) to 70 percent (summer).
   2) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
c. NEC Classification: Nonhazardous.

3. Inside:
   a. Temperature: 20 to 140 degrees F.
   b. Relative Humidity: 10 to 100 percent.
   c. NEC Classification: Nonhazardous.
4. Inside, Corrosive:
   a. Temperature: 40 to 104 degrees F.
   b. Relative Humidity: 10 to 100 percent.
   c. NEC Classification: Nonhazardous.
5. Inside, Hazardous:
   a. Temperature: 20 to 104 degrees F.
   b. Relative Humidity: 10 to 100 percent.
6. Outside:
   a. Temperature: 20 to 158 degrees F.
   b. Relative Humidity: 10 to 100 percent.
   c. NEC Classification: Nonhazardous.
7. Outside, Hazardous:
   a. Temperature: 20 to 158 degrees F.
   b. Relative Humidity: 0 to 100 percent

B. Standard Service Conditions for Panels and Consoles: Unless otherwise noted, in Drawings, design equipment for continuous operation in these environments:

1. Freestanding Panel and Consoles:
   a. Inside, Air Conditioned: NEMA 1.
   b. Inside: NEMA 12.
2. Smaller Panels and Assemblies (that are not freestanding):
   a. Inside, Air Conditioned: NEMA 12.
   b. All Other Locations: NEMA 4X.
3. Field Elements: Outside.

C. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

2.04 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

1. Location and Inscription: As shown on Drawings
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 1/2-inch-high, white on black background, unless otherwise noted.

B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.

1. Inscription:
   a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
   b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
   c. Refer to P&IDs on Drawings.
2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.

3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch-high, imposed.
4. Mounting: Affix to component with 16- or 18-gauge stainless steel wire or stainless steel screws.

2.05 MECHANICAL SYSTEM COMPONENTS

A. Reference Section 40 91 00, Instrumentation and Control Components.

2.06 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

A. Shown on Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.

B. Supplemented by Loop Descriptions in Application Programming specifications.

2.07 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes for Electrical Systems.

B. Wiring External to PIC Equipment:

1. Special Control and Communications Cable: Provided by PIC System Integrators noted in Component Specifications and PIC subsections.
2. Other Wiring and Cable: As specified in Section 26 05 05, Conductors.

C. Wires within Enclosures:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than No. 18 AWG.
2. Analog Signal Circuits:
   a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.

b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Beldon No. 1121A.
c. Size: No. 18 AWG, minimum.

3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than No. 18AWG.
4. Special Signal Circuits: Use manufacturer's standard cables.
5. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady PermaSleev.
      2) Tyco Electronics.

D. Terminate and identify wires entering or leaving enclosures as follows:

1. Analog and discrete signal, terminate at numbered terminal blocks.
2. Special signals terminated using manufacturer's standard connectors.
3. Identify wiring in accordance with requirements in Section 26 05 05, Conductors.

E. Terminal Blocks for Enclosures:

1. Quantity:
   a. Accommodate present and spare indicated needs.
   b. Wire spare I/O points to terminal blocks.
   c. One wire per terminal for field wires entering enclosures.
   d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
   e. Spare Terminals: 20 percent of connected terminals, but not less than 10 per terminal block, unless otherwise shown on Drawings.
2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

F. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
   a. Locate signal ground at dc power supply for loop.
   b. Use to ground wire shields for loop.

c. Ground Wire Shields in Following Locations: Signal receiving equipment.

4. Ground terminal block rails to ground bus.

G. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

H. Intrinsic Safety System Installation:

1. Comply with NEC Article 504, Intrinsically Safe Systems.
2. Install intrinsically safe circuits in a separate wire way that:
   a. Is separated from non-intrinsically safe circuits as specified by NEC.
   b. Is colored light blue and has message “Intrinsically Safe Circuits Only” on raceway cover every 6 inches.

I. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.

1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the wiring diagrams.
2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer’s standard connectors for the device to which the signals terminate.

J. Electrical Transient Protection:

1. General:
   a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
   b. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details on Drawings.
   c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles assembles, and field-mounted analog transmitters and receivers.

2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.

2. Surge Suppressor Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Surge Suppressors.
3. Installation and Grounding of Suppressors:
   a. As shown. See Surge Suppressor Installation Details.
   b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

2.08 PANEL FABRICATION

A. General:

1. Nominal Panel Dimensions: As shown on Drawings.
2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
3. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator's facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
4. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.
5. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Freestanding Panels:
   a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel and on panel.
   b. Ventilated Panels:
      1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
      2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
      3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
      4) Louver Construction: Stamped sheet metal.
      5) Ventilation Fans:
         a) Furnish where required to provide adequate cooling.

b) Create positive internal pressure within panel.
c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.

6) Air Filters: Washable aluminum, Hoffman Series A-FLT.

c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
1) Where shown on Drawings.

2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.
3. Space Heaters: Thermostatically controlled to maintain internal panel temperatures above dewpoint.

C. Freestanding Panel Construction:

1. Materials:
a. Sheet steel, unless otherwise shown on Drawings.
b. Minimum Thickness: 12-gauge, unless otherwise noted.
2. Panel Front:
a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
b. No seams or bolt heads visible when viewed from front.
c. Panel Cutouts: Smoothly finished with rounded edges.
d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
3. Internal Framework:
a. Structural steel for instrument support and panel bracing.
b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Door:
a. Full height, fully gasketed access door where shown on Drawings.
b. Latch: Three-point, Southco Type 44.
c. Handle: “D” ring, foldable type.
d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
f. Front and Side Access Doors: As shown on Drawings.

D. Nonfreestanding Panel Construction:

1. Based on environmental design requirements and referenced in Article Environmental Requirements:
   a. Panels shown as indoor:
      1) Enclosure Type: NEMA 12.
      2) Materials: Steel.
   b. Other Panels:
      1) Enclosure Type: NEMA 4X.
      2) Materials: Type 316 stainless steel.
2. Metal Thickness: 14-gauge, minimum.
3. Doors:
   a. Rubber-gasketed with continuous hinge.
   b. Stainless steel lockable quick-release clamps.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. H. F. Cox.

E. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels:

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

F. Control Panel Electrical:

1. Power Distribution within Panels:
   a. Feeder Circuits:
      1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
      2) Make provisions for feeder circuit conduit entry.
      3) Furnish terminal block for termination of wires.
   b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
      1) Locate to provide clear view of and access to breakers when door is open.
      2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
         a) Branch Circuit Breakers: 15 amps at 250V ac.
   c. Circuit Wiring: P&IDs and Control Diagrams on Drawings. Use following rules for circuit wiring:
      1) Devices on Single Circuit: 20, maximum.
      2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down

entire operation, do not group all units on same branch circuit.

3) Branch Circuit Loading: 12 amperes continuous, maximum.
4) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
5) Provide 120V ac plugmold for panel components with line cords.

2. Signal Distribution:
   a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
   b. Within Panels: 4 to 20 mA dc signals may be distributed as 1V dc to 5V dc.
   c. Outside Panels: Isolated 4 to 20 mA dc only.
   d. Signal Wiring: Twisted shielded pairs.
   e. RTD and Thermocouple Extension Cable:
      1) Continuous field to panel with no intermediate junction boxes or terminations.
      2) RTDs in motor windings are considered a 600-volt circuit.
      3) Terminate thermocouple extension wire directly to loop instrument.
3. Signal Switching:
   a. Use dry circuit type relays or switches.
   b. No interruption of 4 to 20 mA loops during switching.
   c. Switching Transients in Associated Signal Circuit:
      1) 4 to 20 mA dc Signals: 0.2 mA, maximum.
      2) 1V dc to 5V dc Signals: 0.05V, maximum.
4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.
5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
6. Internal Panel Lights for Freestanding Panels:
   a. Type: Switched 100-watt incandescent back-of-panel lights.
   b. Quantity: One light for every 4 feet of panel width.
   c. Mounting: Inside and in the top of back-of-panel area.
   d. Protective metal shield for lights.
7. Service Outlets for Freestanding Panels:
   a. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
   b. Quantity:
      1) Panels 4 Feet Wide and Smaller: One.
      2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
   c. Mounting: Evenly spaced along back-of-panel area.

d. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle.

8. Internal Panel Lights and Service Outlets for Smaller Panels:
   a. Internal Panel Light: Switched undercounter type LED strip light.
9. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted on Drawings:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

   b. Lettering Color:
      1) Black on white and yellow buttons.
      2) White on black, red, and green buttons.
10. Standard Light Colors and Inscriptions:
   a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in wiring diagram:

Tag Function	Inscription(s)	Color
ON	ON	Red

Tag Function	Inscription(s)	Color
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

b. Lettering Color:
   1) Black on white and amber lenses.
   2) White on red and green lenses.

G. Control Panel Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
   a. Locking-fork-tongue or ring-tongue lugs.
   b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
   c. Wires terminated in a crimp lug, maximum of one.
   d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
   a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
   b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.

7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
12. Conductors Carrying Foreign Voltages within a Panel:
    a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
    b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.
13. Harness Wiring:
    a. 120V ac: No. 14 AWG, MTW.
    b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
14. Panel Work:
    a. No exposed connections.
    b. Allow adjustments to equipment to be made without exposing these terminals.
    c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
15. Plastic Wire Ducts Color:
    a. 120V ac: White.
    b. 24V dc: Gray.
    c. Communications Cables and Fiber Optic Jumpers: Orange.
16. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
17. Make plastic wire ducts the same depth.
18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

H. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.

I. Factory Finishing:

1. Furnish materials and equipment with manufacturer's standard finish system in accordance with Section 09 90 00, Painting and Coating.
2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
3. Stainless Steel and Aluminum: Not painted.
4. Steel Panels:
    a. Sand panel and remove mill scale, rust, grease, and oil.
    b. Fill imperfections and sand smooth.
    c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
    d. Sand surfaces lightly between coats.
    e. Dry Film Thickness: 3 mils, minimum.
    f. Color: Gray or as otherwise noted on Drawings.

2.09 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Part 3, Article Protection.
2. Manufacturers and Products:
    a. Northern Instruments; Model Zerust VC.
    b. Hoffmann Engineering; Model A-HCI.

2.10 TEST EQUIPMENT AND TOOLS

A. Digital Multimeter:

1. Type: Industrial True RMS Digital Multimeter, CAT IV 600V protection with test leads, removable test probes, long reach alligator clips, magnetic hanger, temperature probe, and carrying case.
2. Quantity: Two.
3. Manufacturers and Products:
    a. Fluke; Model 87V/E Industrial Electrician Combo Kit.
    b. Greenlee; Model DM-860.
    c. Extech; Model EX530.

B. Clamp-on Ammeter:

1. Type: True RMS Digital Clamp-on meter with 3-1/2-digit display and protective case.
2. Quantity: One.
3. Manufacturers and Products:
    a. TES; Model 3040.
    b. Fluke; Model 337E.
    c. Greenlee; Model CMI-100.
    d. Extech; Model EX830.

C. DC Digital Process Signal Calibrator:

1. Type: Portable, two-channel, with test leads, rechargeable batteries, charger, and carrying case.
2. Quantity: Two.
3. Manufacturers and Products:
    a. Transmation; Model 1045-01.
    b. Fluke; Model 789.
    c. Extech; Model CMM17.

D. Datalogger:

1. Type: Portable Handheld Multichannel Datalogger, USB communications, Graphical Display, with Analysis Software.
2. Quantity: One.
3. Manufacturers and Products:
    a. Graphtec; Model GL200A.
    b. Omega; Model OM-DAQPRO-5300.

E. Pressure and Electrical Calibrator:

1. Type: Test leads, rechargeable batteries, ac charger, pressure transducer modules, and protective case.
2. Pressure Ranges: Appropriate for pressure devices provided.
3. Quantity: One.
4. Manufacturers and Products:
    a. Transmation; Model 1091PLUS-LP.
    b. Fluke; Model 717/718.
    c. Heise; Model PTE-1.

F. Pressure Pump Kit:

1. Type: Hand pump (0 to 600 psig), calibration labels, tubing, fittings, and carrying case.
2. Quantity: One.
3. Manufacturers and Products;
   a. Transmation; Pump Kit 22980P-300.
   b. Fluke; Model 700PTP-1.
   c. Heise; Model TP1-40.

G. Small Tool Kit:

1. Type: Kit of instrument maintenance tools in soft, zipper case.
2. Quantity: One.
3. Manufacturer and Product: Jensen Tools; Model JTK-47GC Field Engineer's Kit.

H. Large Tool Kit:

1. Type: Kit of instrument maintenance tools in high-density polyethylene case.
2. Quantity: One.
3. Manufacturer and Product: Jensen Tools; Model JTK-17LST.

I. Screw Starters:

1. Type: Kits of slotted screw starters with magnetic retrievers.
2. Quantity: One.
3. Manufacturer and Products: Jensen Tools; Models 23B021 and 23B023.

J. Terminal Kit:

1. Type: Kit of solderless terminals and cable ties.
2. Quantity: One.
3. Manufacturer and Product: Jensen Tools; Model 23B210.

2.11 SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer's decision will be final regarding acceptability and completeness of testing.

4. Procedures, Forms, and Checklists:
    a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
    b. Describe each test item to be performed.
    c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
6. Conducting Tests:
    a. Provide special testing materials and equipment.
    b. Wherever possible, perform tests using actual process variables, equipment, and data.
    c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
    d. Define simulation techniques in test procedures.
    e. Test Format: Cause and effect.
        1) Person conducting test initiates an input (cause).
        2) Specific test requirement is satisfied if correct result (effect), occurs.
    f. For PIC systems for which Engineer provides applications software, provide sufficient temporary software configuring to allow FDT and SSDT testing of these subsystems.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
2. Location: PIC System Integrator’s facility.
3. Integrated Test:
    a. Interconnect and test PIC, except for primary elements and smaller panels.
    b. Exercise and test functions.
    c. Provide stand-alone testing of smaller panels.
    d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
    a. Control panels.
    b. Test equipment.
3. Location: PIC System Integrator’s facility.

4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
    a. Simulate each discrete signal at terminal strip.
    b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PLCs and remote I/O and between PLCs and computers.
6. Operation of communications between the PLC system, single loop controllers (SLC).
7. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:
    a. One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.
    b. One of each type of function in each panel; for example, but not limited to enunciator operation, controller operation, and recorder operation.
    c. All required and shown functions for 100 percent of loops.
8. Non-loop-Specific Functions:
    a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
    b. Timing: Include tests for timing requirements.
    c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
9. Correct deficiencies found and complete prior to shipment to Site.
10. Failed Tests:
    a. Repeat and witnessed by Engineer.
    b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
11. Make following documentation available to Engineer at test site both before and during FDT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of FDT procedures.
    c. List of equipment to be tested including make, model, and serial number.
    d. Approved hardware Shop Drawings for equipment being tested.
    e. Approved preliminary software documentation Submittal.
12. Daily Schedule for FDT:
    a. Begin each day with meeting to review day’s test schedule.
    b. End each day with each meeting to review day’s test results and to review or revise next day’s test schedule.

D. Staging Site Demonstration Test (SSDT):

1. Scope: Demonstrate that the specified PIC equipment and standard software has been properly installed at staging site and is ready for applications software development by Engineer.
2. Refer to PIC subsections for additional details.

2.12 MAINTENANCE OF PROGRAMMING EQUIPMENT

A. Provide for maintenance of programming equipment while at Engineer's office. Repair or replace failed equipment within 2 days of notice by Engineer.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of positioners and I/P transducers.
3. Correct control action.
4. Switch settings and dead bands.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

3.02 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.

C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes for Electrical Systems.

D. Mechanical Systems:

1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
2. Plastic Tubing Support: Except as shown on Drawings, provide continuous support in conduit or by aluminum tubing raceway system.

3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
4. Tubing and Conduit Bends:
    a. Tool-formed without flattening, and of same radius.
    b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
    c. Slope instrument connection tubing in accordance with installation details.
    d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
    e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
    f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
    g. Blow debris from inside of tubing.
    h. Make up and install fittings in accordance with manufacturer's recommendations. Verify makeup of tube fittings with manufacturer's inspection gauge.
    i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
    j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
    k. Provide separate support for components in tubing runs.
    l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
    m. Keep tubing and conduit runs at least 12 inches from hot pipes.
    n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
    o. Securely attach tubing raceways to building structural members.
5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

1. Coordinate PIC testing with Owner and affected Subcontractors.
2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
3. Engineer may actively participate in tests.
4. Engineer reserves right to test or retest specified functions.
5. Engineer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PIC site representative to supervise and coordinate onsite PIC activities.
3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Leak Tests: During Functional Test Part 1, conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.

D. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Refer to article Sequence of Work under Section 01 31 13, Project Coordination (to be completed), for a definition of project milestones.
3. Refer to Section 01 91 14, Equipment Testing and Facility Startup (to be completed), for overall testing requirements.
4. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

E. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation. Divide Functional Test for each facility into two parts.
2. Functional Test Part 1: Performed by PIC System Integrator to test and document PIC, excluding Engineer provided applications software, is

ready for operation. For PIC Subsystems for which Engineer provides applications software, provide sufficient temporary software configuring to allow testing of these subsystems

3. Preparation for Testing: Performed by PIC System Integrator to test and document PIC is ready for operation.
    a. Loop/Component Inspections and Tests:
        1) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
        2) Provide space on forms for signoff by PIC System Integrator.
        3) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
            a) Project name.
            b) Loop number.
            c) Tag number for each component.
            d) Checkoffs/Signoffs for Each Component:
                (1) Tag/identification.
                (2) Installation.
                (3) Termination wiring.
                (4) Termination tubing.
                (5) Calibration/adjustment.
            e) Checkoffs/Signoffs for the Loop:
                (1) Panel interface terminations.
                (2) I/O interface terminations with PLCs.
            f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
            g) Total loop operational.
            h) Space for comments.
        4) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLCs I/O module and include the following:
            a) Project name.
            b) Loop number.
            c) Component tag number or I/O module number.
            d) Component code number for I&C elements.
            e) Manufacturer for I&C elements.
            f) Model number/serial number for I&C elements.
            g) Summary of Functional Requirements; For Example:
                (1) Indicators and recorders, scale and chart ranges.

(2) Transmitters/converters, input and output ranges.
(3) Computing elements' function.
(4) Controllers, action (direct/reverse) and control modes (P, I, D).
(5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
(6) I/O Modules: Input or output.

h) Calibrations, for example, but not limited to:
(1) Analog Devices: Actual inputs and outputs at 0, 25, 50, 75, and 100 percent of span, rising and falling.
(2) Discrete Devices: Actual trip points and reset points.
(3) Controllers: Mode settings (P&ID).
(4) I/O Modules: Actual inputs or outputs of 0, 25, 50, 75, and 100 percent of span, rising and falling.
(5) Space for comments.

b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.
c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
d. FDT-Repeat:
1) Repeat FDT onsite with installed PIC equipment and software.
2) As listed in PIC subsections, certain portions of FDT may not require retesting.
3) Use FDT test procedures as basis for this test.
4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.

4. Functional Test Part 2: Combined effort between Contractor, PIC System Integrator, and Engineer to confirm PIC, including applications software, is ready for operation.
a. Prerequisite: Completion of Functional Test Part 1.
b. Joint test with Engineer. Repeat of Engineer's SSDT application software tests, except using real field sensors and equipment. Plant interlocking and communications with PLCs and SCADA tested on loop-by-loop basis.

c. Test procedures provided by Engineer based on Functional Test Part 1 and on SSDT application software tests.
d. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.

5. Functional Test:
   a. Scope: Confirm PIC, including applications software, is ready for operation.
   b. Refer to PIC subsections for additional requirements.
   c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
6. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

F. Performance Tests Prior to Facility Startup:

1. Communications Performance:
   a. Fiber optic and network equipment to be configured and communicating on network.
   b. Radio systems to be configured, tested, and tuned.

G. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform a witnessed jointly with Engineer and Application Programmer Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and non-loop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.
3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.

5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
6. Make O&M data available to Engineer at Site both before and during testing.
7. Follow daily schedule required for FDT.
8. Determination of Ready for Operation: When Functional Test has been completed.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: As required by each PIC subsection.

3.05 TRAINING

A. General:

1. Provide an integrated training program for Owner's personnel.
2. Perform training to meet specific needs of Owner's personnel.
3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
4. Provide instruction on two working shift(s) as needed to accommodate the Owner's personnel schedule.
5. Owner reserves the right to reuse videotapes of training sessions.

B. Management Seminar:

1. Length: 2 days.
2. Location: Owner's facility.
3. Objective: Provide overview for non-operations and maintenance personnel for understanding the PIC.
4. Attended by management, engineering, and other non-operations and non-maintenance personnel.
5. Primary Topics:
   a. PIC Overview: How hardware and software are used for operation and control of facilities.
   b. Block Diagram Presentation of PIC: How and what information flows within system and what is done by each functional unit.
   c. Process/Operator Interface: Explanation and demonstration of how to use HMI PC to access displays, reports, and controls.
   d. Management-oriented explanation of data management displays and printouts.
   e. Walk-through of installed systems.

C. Operations and Maintenance Training:

1. General:
   a. Refer to specific requirements specified in PIC Subsections.
   b. Include review of O&M data and survey of spares, expendables, and test equipment.
   c. Use equipment similar to that provided.
   d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
2. Operations Training: For Owner's operations personnel on operation of I&C components.
   a. Training Session Duration: 5 instructor days.
   b. Number of Training Sessions: Two.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
   e. Content: Conduct training on loop-by-loop basis.
      1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
      2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, enunciator acknowledgement and resetting.
      3) Interfaces with PIC subsystems.
3. Maintenance Training:
   a. Training Session Duration: 3 instructor days.
   b. Number of Training Sessions: One per day.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed for routine maintenance of PIC.
   e. Content: Provide training for each type of component and function provided.
      1) Loop Functions: Understanding details of each loop and how they function.
      2) Component calibration.
      3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
      4) Troubleshooting and diagnosis for equipment and software.
      5) Replacing lamps, chart paper, and fuses.

6) I&C components removal and replacement.
7) Periodic preventive maintenance.

3.06 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer's recommendations.

END OF SECTION

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.02 REFERENCES

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

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

1.03 INSTRUMENTATION SCHEDULE

A. The Instrumentation Schedule spreadsheet (located at the end of this section) is intended to be a summary of instrumentation equipment required for this project. Not all instrumentation details are shown on the schedule. Some requirements may be shown in the instrumentation schedule such as enclosure rating and instrument span that are not described in the specifications. Both are required for a complete specification.

B. The instruments listed in the schedule are specified in the following sections:

1. Section 40 91 02.01, I&C Analytical Measurement Components.
2. Section 40 91 02.03, I&C Flow Measurement Components.
3. Section 40 91 02.05, I&C Level Measurement Components.
4. Section 40 91 02.07, I&C Pressure Measurement Components.

C. If an instrument is shown in the P&IDs or on the site plan, then the device shall be provided whether or not it is shown on the instrumentation schedule.

PART 2 PRODUCTS

2.01 GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

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

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

2.02 MECHANICAL SYSTEMS COMPONENTS

A. Flow Element, Rotameter, Purge:

1. For air or water service, unless otherwise noted.
2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
5. Integral inlet needle valves.
6. Integral Differential Pressure Regulators:
   a. For water service.
   b. For air service for level ranges greater than 10 feet of water.

7. Rotameters for water service.
8. Manufacturers and Products:
    a. Fischer & Porter; Series 10A3130.
    b. Brooks; Series DS-1350.
    c. Yokogawa; RA Series.

B. Manifold, Three-Valve Equalizing:

1. Type: For isolation and equalization of differential pressure transducers.
2. Materials: Stainless steel.
3. Manufacturers and Products:
    a. Anderson, Greenwood and Co.; Type M1.
    b. Evans.

C. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturers and Products:
    a. Ashcroft Utility; Gauge Series 1000.
    b. Marsh; Standard Gauge Series.
    c. AmetekU.S.; Gauge Series P500.
    d. Acculite; Series 2000.

D. Valve, Needle:

1. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
2. Size: 0.020-inch orifice.
3. Manufacturers and Products:
    a. Whitey; Model 21RF2.
    b. Hoke; 3700 Series.

E. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.

3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Flomite 7100 Series.

F. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Catalog No. RF or No. RS.
   b. Hoke;3100 through 3300 Series.

G. Valve, Three-Way:

1. Type: Ball valve.
2. Materials: Brass or stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Selecto-Mite Series.

H. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
   a. Body and Stem: Type 316stainless steel.
   b. Handle: Black nylon.
   c. Packing Gland: Teflon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.
5. Manufacturers and Products:
   a. Whitey; Series 457.
   b. Hoke; Multi-Mite Series.

I. Spool Valve, Five-Port:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.

2. Materials: Aluminum construction with Teflon impregnated aluminum spool, stainless steel spring, and Buna-N O-rings.
3. Size: Normally closed or opened, as noted.
4. Coil: 115V ac, unless noted otherwise.
5. Accessories: Lead wires, blanking plates, air fittings, DIN rail mounts as needed.
6. Solenoid Enclosure: NEMA 4 or as noted to meet area classification.
7. Manufacturer and Product: SMC Pneumatics, VQZ 3000 Series, Model VQZ3121-3L1-NT7 with VV5QZ-32-10C base.

J. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. Materials:
   a. Body: Brassed or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
   b. Valve Seat: Buna-N.
3. Size: Normally closed or opened, as noted.
4. Coil: 115V ac, unless noted otherwise.
5. Solenoid Enclosure: NEMA 4 or as noted to meet area classification.
6. Manufacturer and Product: ASCO; Red Hat Series 8260.

K. Pressure Regulator, Air:

1. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 scfh to 300 scfh with 100 psi supply pressure.
2. Setscrew for outlet pressure adjustment.
3. Integral filter and relief valve.
4. Manufacturers and Products:
   a. Masoneilan; Series 77-4.
   b. Fisher; Series 67FR.
   c. Parker; 8000 Series.

L. Pressure Regulator, Water:

1. Materials:
   a. Body: Bronze.
   b. Spring Case: Cast iron.
   c. Seat Rings: Brass.
   d. Valve Disk and Holder: Buna-N and bronze.

e. Diaphragm: Buna-N diaphragm.

2. Sizing: For maximum of 7 psi offset pressure.
3. Manufacturers and Products:
   a. Fisher; Controls Type 95H or95L.
   b. Masoneilan; Series 17.

M. Test Tap:

1. Manufacturers and Products:
   a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
   b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
   c. Parker; CPI Series precision quick couplings.

N. Copper Tubing and Fittings:

1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on Drawings.
3. Manufacturers:
   a. Parker-Hannifin.
   b. Swagelok tube fittings.

O. Plastic Tubing and Fittings:

1. Tubing:
   a. Polyethylene capable of withstanding 190 psig at 175 degrees F.
   b. Manufacturers and Products:
      1) Dekoron; Type P.
      2) Imperial Eastman; Poly-Flo black instrument tubing.
2. Fittings:
   a. Type: Brass compression.
   b. Manufacturers and Products:
      1) Imperial Eastman; Poly-Flo tube fittings.
      2) Dekoron; E-Z fittings.

P. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on Drawings.

Q. Stainless Steel Fittings:

1. Compression Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
   b. Manufacturers and Products:
      1) Parker Flodar; BA Series.
      2) Swagelok tube fittings.
      3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
2. Socket Weld Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.

R. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.

S. Purge Set:

1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on Drawings and as required in this section.
2. Pressure Gauge Scale Range: 150 percent of the process variable.
3. Mounting:
   a. Within consoles, panels, or a separate enclosure as shown.
   b. For separate enclosure mounted purge sets, refer to paragraphs Nonfreestanding Panel Construction and Factory Finishing for enclosure requirements.

T. Tubing Raceways:

1. Cable tray systems complete with tees, elbows, reducers, and covers.
2. Size in accordance with manufacturer’s recommendations for intended service.
3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on Drawings.

4. Manufacturers:
   a. Globetray.
   b. Cope.

U. Air Supply Sets:

1. Parts: Integrally Mounted:
   a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
   b. Valves: Manual drain, manual shutoff, pressure relief, and check valve.
   c. Pressure gauge.
   d. Inlet filter muffler.
   e. Power: 120V ac.
   f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
   g. Manufacturers and Products:
      1) ITT Pneumotive; GH Series.
      2) Gast.
2. Simplex Air Supply Sets:
   a. Air Receiver: 2 gallons.
   b. Compressors: One.
3. Duplex Air Supply Sets:
   a. Air Receiver: 20 gallons.
   b. Compressors: Two.
   c. Automatic Failover Control: Factory set at 20 psig.

2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.

e. Insulation:
   1) Thermoplastic rated for minus55 degrees C to plus 110 degrees C.
   2) Two funneled shaped inputs to facilitate wire entry.
f. Mounting:
   1) Standard DIN rail or raised SIN rail to facilitate field termination.
   2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
   3) End Stops: Minimum of one at each end of rail.
g. Wire Preparation: Stripping only permitted.
h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
i. Marking System:
   1) Terminal number shown on both sides of terminal block.
   2) Allow use of preprinted and field marked tags.
   3) Terminal strip numbers shown on end stops.
   4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
   5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
j. Test Plugs: Soldered connections for 18 AWG wire.
   1) Pin Diameter: 0.079 inch.
   2) Quantity: 10 (need two plugs per test meter).
   3) Manufacturers and Product:
      a) Entrelec; Type FC2.
      b) Allen-Bradley.
      c) Phoenix.

2. Terminal Block, General Purpose:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 24 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25 inch, maximum.
   g. Test Sockets: One screw test socket 0.079-inch diameter.
   h. Manufacturers and Products:
      1) Entrelec; Type M4/6.T
      2) Allen-Bradley; 1492-W4.
      3) Phoenix.
      4) Or equal.

3. Terminal Block, Ground:
    a. Wire Size: 24 AWG to 10 AWG.
    b. Rated Wire Size: 10 AWG.
    c. Color: Green and yellow body.
    d. Spacing: 0.25 inch, maximum.
    e. Grounding: Electrically grounded to mounting rail.
    f. Manufacturers and Products:
        1) Entrelec; Type M4/6.P.
        2) Allen-Bradley; 1492-WG4.
        3) Phoenix.
        4) Or equal.
4. Terminal Block, Blade Disconnect Switch:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 10 amp.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Gray body, orange switch.
    f. Spacing: 0.25 inch, maximum.
    g. Manufacturer and Product: Entrelec; Type M4/6.SNT.
5. Terminal Block, Sensor:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 20 amp.
    c. Wire Size: 24 AWG to 14 AWG.
    d. Rated Wire Size: 14 AWG.
    e. Color: Gray body.
    f. Spacing: 0.25 inch, maximum.
    g. Test Sockets: One screw test socket 0.079-inch diameter.
    h. Manufacturers and Product:
        1) Entrelec.
        2) Allen-Bradley; 1492-WTS3.
        3) Phoenix.
        4) Or equal.
6. Terminal Block Diode:
    a. Rated Voltage: 24V dc.
    b. Rated Current: 30 ma.
    c. Wire Size: 16 AWG.
    d. Manufacturers and Product:
        1) Entrelec
        2) Allen-Bradley.
        3) PhoenixContact; ST-IN.
        4) Or equal.

7. Terminal Block, Fused, 24V dc:
    a. Rated Voltage: 600V dc.
    b. Rated Current: 25 amp.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Gray body.
    f. Fuse: 0.25 inch by 1.25 inches.
    g. Indication: LED diode 24V dc.
    h. Spacing: 0.512 inch, maximum.
    i. Manufacturers and Product:
        1) Entrelec; Type ML10/13.SFD.
        2) Allen-Bradley.
        3) Phoenix.
        4) Or equal.
8. Terminal Block, Fused, 120V ac:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 25 amp.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Gray body.
    f. Fuse: 0.25 inch by 1.25 inches.
    g. Indication: Neon lamp, 110V ac.
    h. Leakage Current: 1.8 mA, maximum.
    i. Spacing: 0.512 inch, maximum.
    j. Manufacturers and Product:
        1) Entrelec; Type ML10/13.SFL.
        2) Allen-Bradley.
        3) Phoenix.
        4) Or equal.
9. Terminal Block, Fused, 120V ac, High Current:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 35 amps.
    c. Wire Size: 18 AWG to 8 AWG.
    d. Rated Wire Size: 8 AWG.
    e. Color: Gray.
    f. Fuse: 13/32 inch by 1.5 inches.
    g. Spacing: 0.95 inch, maximum.
10. Manufacturers and Product:
    a. Entrelec; Type MB10/24.SF.
    b. Allen-Bradley.
    c. Phoenix.
    d. Or equal.

B. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Provide hold down clips.
2. Signal Switching Relay:
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 5 amps at 28V dc or 120V ac.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.
3. Manufacturers and Products:
   a. Potter and Brumfield; Series KH/KHA.
   b. IDEC, Type RR.
   c. Or equal.
4. Control Circuit Switching Relay, Non-latching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
   k. Manufacturer and Product: Potter and Brumfield; Series KUP.
5. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).

g. Expected Mechanical Life: 500,000 operations.
h. Expected Electrical Life at Rated Load: 50,000 operations.
i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.

6. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 30V dc or 277V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
   i. Time Delay Setpoint: As noted or shown.
   j. Mode of Operation: As noted or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.
   l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.

C. Surge Suppressors:

1. General:
   a. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
   b. Response: 5 nanoseconds maximum.
   c. Recovery: Automatic.
   d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
   e. Enclosure Mounted: Encapsulated inflame retardant epoxy.
2. Suppressors on 120V ac Power Supply Connections:
   a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
   b. First-Stage Clamping Voltage: 350 volts or less.
   c. Second-Stage Clamping Voltage: 210 volts or less.
   d. Power Supplies for Continuous Operation:
      1) Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
      2) All Other Applications: Minimum 30 amps at 130V ac.

3. Suppressors on Analog Signal Lines:
    a. Test Waveform: Linear 8-microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
    b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
        1) dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
        2) dc Clamping Voltage Tolerance: Plus or minus 10 percent.
        3) Maximum Loop Resistance: 18 ohms per conductor.
4. Manufacturers and Products:
    a. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series.
    b. 120V ac Lines: Emerson Edco HSP-121.
    c. Field Mounted at Two-Wire Instruments:
        1) Encapsulated in stainless steel pipe nipples.
        2) Emerson Edco SS64 series.
    d. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
        1) Enclosure:
            a) NEMA 4X Type 316 stainless steel with door.
            b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
        2) Emerson Edco; SLAC series.

D. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
    a. Protect instruments from damage due to power supply failure.
    b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
    a. Type: Indicating.
    b. Mount so fuses can be easily seen and replaced.

E. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.

2.04 SUPPLEMENT

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

1. Instrument Schedule.

PART 3 EXECUTION (NOT USED)

END OF SECTION

DWG # P&ID	Tag No.		DESCRIPTION	Type	Specification Section	Min. NEMA Rating	Size	SP/ Range	Units	DWG. DET. Reference	Notes
I-01-01	FE 072		Flow Element	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	HNWR-1A
I-01-01	FE 071		Flow Element	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	HNWR-1A
I-01-01	FE 071		Flow Element	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	SITE B
I-01-01	FIT 072		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	HNWR-1A
I-01-01	FIT 071		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	HNWR-1A
I-01-01	FIT 071		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	SITE B
I-01-01	LT 051		Level Transmitter	Submersible	40_91_02.05_1.01B	-	-	0-XXX	FT	LT / 9	HNWR-1A
I-01-01	LT 051		Level Transmitter	Submersible	40_91_02.05_1.01B	-	-	0-XXX	FT	LT / 9	SITE B
I-01-01	PIT 061		Pressure Indicating Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	PT / 7	HNWR-1A
I-01-01	PIT 061		Pressure Indicating Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	PT / 7	SITE B
I-02-01	LSH 155		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	
I-02-01	LSL 155		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	
I-02-01	LT 156		Level Transmitter	Submersible	40_91_02.05_1.01B	-	-	0-XXX	FT	LT / 9	
I-02-02	FE 071		Flow Element	Magnetic	40_91_02.03_1.01A	4X	4"	0-XXX	GPM	FM / 1	
I-02-02	FE 072		Flow Element	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	
I-02-02	FIT 071		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	4"	0-XXX	GPM	FM / 1	
I-02-02	FIT 072		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	
I-02-02	LSH 053		Level Switch	Float	40_91_02.05_1.01C	4X	-	-	-	FS / 11	
I-02-02	LSH 051		Level Switch	Float	40_91_02.05_1.01C	4X	-	-	-	FS / 11	
I-02-02	LT 052		Level Transmitter	Submersible	40_91_02.05_1.01B	-	-	0-XXX	FT	LT / 9	
I-02-02	LT 053		Level Transmitter	Submersible	40_91_02.05_1.01B	-	-	0-XXX	FT	LT / 9	
I-02-02	PI 061		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-02-02	PI 062		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-02-02	PIT 061		Pressure Indicating Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	PT / 7	
I-02-02	PIT 062		Pressure Indicating Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	PT / 7	
I-11-01	AE 281	A	Sensor	pH	40_91_02.01_1.01B	4X	-	0-14	pH	Civil Detail	
I-11-01	AE 281	B	Sensor	Conductivity	40_91_02.01_1.01E	4X	-	10 - 20k	uS	Civil Detail	
I-11-01	AE 282		Sensor	Turbidity	40_91_02.01_1.01D	4X	-	0 - 4000	FNU	Civil Detail	
I-11-01	AIT 281		Analyzer Transmitter	Multiparameter	40_91_02.01_1.01A	4X	-	-	-	Pipe or Wall Mount	
I-11-01	FE 071		Flow Element	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	
I-11-01	FIT 071		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	
I-11-01	LE 252		Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-11-01	LIT 252		Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-11-01	LSH 251		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-11-01	LSL 251		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-11-01	PI 261		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-11-02	AE 283	A	Sensor	pH	40_91_02.01_1.01B	4X	-	0-14	pH	Civil Detail	
I-11-02	AE 283	B	Sensor	Conductivity	40_91_02.01_1.01E	4X	-	10 - 20k	uS	Civil Detail	
I-11-02	AE 284		Sensor	Turbidity	40_91_02.01_1.01D	4X	-	0 - 4000	FNU	Civil Detail	

DWG # P&ID	Tag No.		DESCRIPTION	Type	Specification Section	Min. NEMA Rating	Size	SP/ Range	Units	DWG. DET. Reference	Notes
I-11-02	AIT 283		Analyzer Transmitter	Multiparameter	40_91_02.01_1.01A	4X	-	-	-	Pipe or Wall Mount	
I-11-02	LE 254		Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-11-02	LIT 254		Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-11-02	LSH 253		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-11-02	LSL 253		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-11-02	PI 262		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-11-03	AE 285	A	Sensor	pH	40_91_02.01_1.01B	4X	-	0-14	pH	Civil Detail	
I-11-03	AE 285	B	Sensor	Conductivity	40_91_02.01_1.01E	4X	-	10 - 20k	uS	Civil Detail	
I-11-03	AE 286		Sensor	Turbidity	40_91_02.01_1.01D	4X	-	0 - 4000	FNU	Civil Detail	
I-11-03	AIT 285		Analyzer Transmitter	Multiparameter	40_91_02.01_1.01A	4X	-	-	-	Pipe or Wall Mount	
I-11-03	LE 256		Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-11-03	LIT 256		Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-11-03	LSH 255		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-11-03	LSL 255		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-11-03	PI 263		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-11-04	AE 289		Sensor	Turbidity	40_91_02.01_1.01D	4X	-	0 - 4000	FNU	Civil Detail	
I-11-04	AE 287	A	Sensor	pH	40_91_02.01_1.01B	4X	-	0-14	pH	Civil Detail	
I-11-04	AE 287	B	Sensor	Conductivity	40_91_02.01_1.01E	4X	-	10 - 20k	uS	Civil Detail	
I-11-04	AE 288		Sensor	Turbidity	40_91_02.01_1.01D	4X	-	0 - 4000	FNU	Civil Detail	
I-11-04	AIT 289		Analyzer Transmitter	Multiparameter	40_91_02.01_1.01A	4X	-	-	-	Pipe or Wall Mount	
I-11-04	AIT 287		Analyzer Transmitter	Multiparameter	40_91_02.01_1.01A	4X	-	-	-	Pipe or Wall Mount	
I-11-04	FE 271		Flow Element	Magnetic	40_91_02.03_1.01A	4X	6"	0-XXX	GPM	FM / 1	
I-11-04	FIT 271		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	x	0-XXX	GPM	FM / 1	
I-11-04	LE 258		Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-11-04	LIT 258		Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-11-04	LSH 257		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-11-04	LSH 258		Level Switch	Float	40_91_02.05_1.01C	4X	-	-	-	FS / 11	x
I-11-04	LSL 257		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-11-04	PI 264		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-11-04	PI 265		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-12-01	DPIT 361		Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-12-01	DPIT 362		Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-12-01	DPIT 363		Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-12-01	DPIT 364		Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-12-01	FE 371		Flow Element	Magnetic	40_91_02.03_1.01A	4X	2"	0-XXX	GPM	FM / 1	
I-12-01	FE 372		Flow Element	Magnetic	40_91_02.03_1.01A	4X	2"	0-XXX	GPM	FM / 1	
I-12-01	FIT 371		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	2"	0-XXX	GPM	FM / 1	
I-12-01	FIT 372		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	2"	0-XXX	GPM	FM / 1	
I-12-01	PI 361		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	2"	0-XXX	PSI	PG / 13	
I-12-01	PI 362		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	2"	0-XXX	PSI	PG / 13	
I-12-02	DPIT 365		Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	

DWG # P&ID	Tag No.	DESCRIPTION	Type	Specification Section	Min. NEMA Rating	Size	SP/ Range	Units	DWG. DET. Reference	Notes
I-12-02	DPIT 366	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-12-02	DPIT 367	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-12-02	DPIT 368	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-12-02	FE 372	Flow Element	Magnetic	40_91_02.03_1.01A	4X	2"	0-XXX	GPM	FM / 1	
I-12-02	FIT 372	Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	2"	0-XXX	GPM	FM / 1	
I-12-02	PI 363	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	2"	0-XXX	PSI	PG / 13	
I-12-02	PI 364	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	2"	0-XXX	PSI	PG / 13	
I-12-03	LE 951	Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-12-03	LE 952	Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-12-03	LIT 951	Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-12-03	LIT 952	Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-12-03	PI 961	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	1/2" IN 2"	0-XXX	PSI	PG / 13	
I-12-03	PI 962	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	1/2" IN 2"	0-XXX	PSI	PG / 13	
I-12-03	PI 963	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	1/2" IN 2"	0-XXX	PSI	PG / 13	
I-12-04	LE 953	Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-12-04	LE 954	Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-12-04	LIT 953	Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-12-04	LIT 954	Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-12-04	LIT 941	(Weight) Level Indicating Transmitter	Load Cell Scale	40_91_02.05_1.01D	4X	-	-	-	Floor Mount	
I-12-04	LSH 955	Level Switch	Float	40_91_02.05_1.01C	4X	-	-	-	FS / 11	x
I-12-04	PI 964	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	1/2" IN 2"	0-XXX	PSI	PG / 13	
I-12-04	PI 965	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	1/2" IN 2"	0-XXX	PSI	PG / 13	
I-12-04	PI 971	Rotameter with Flow Control	Per. Mfg.	-	4X	-	0-XXX	FT	Per Mfg.	
I-12-04	PI 966	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-12-05	LSH 651	Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-12-05	LSH 652	Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-12-05	LSH 653	Level Switch	Float	40_91_02.05_1.01C	4X	-	-	-	FS / 11	x
I-12-05	PI 653	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-12-05	PI 161	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-12-05	PI 162	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-12-05	PIT 161	Pressure Indicating Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	PT / 7	
I-12-05	PSL 654	Pressure Switch	Diaphragm	40_91_02.07_1.01C	4X	-	20-200	PSI	PS / 6	
I-13-01	AE 182	Sensor	ORP	40_91_02.01_1.01C	4X	-	-1500 - 1500	mV	Civil Detail	
I-13-01	AE 181	Sensor	pH	40_91_02.01_1.01B	4X	-	0-14	pH	Civil Detail	
I-13-01	AIT 181	Analyzer Transmitter	Multiparameter	40_91_02.01_1.01A	4X	-	-	-	Pipe or Wall Mount	
I-13-01	DPIT 261	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-13-01	DPIT 262	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-13-01	FE 171	Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-01	FIT 171	Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-01	LSH 901	Level Switch	Float	40_91_02.05_1.01C	4X	-	-	-	FS / 11	x
I-13-01	PI 163	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	

DWG # P&ID	Tag No.	DESCRIPTION	Type	Specification Section	Min. NEMA Rating	Size	SP/ Range	Units	DWG. DET. Reference	Notes
I-13-01	PI 900	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-13-02	DPIT 361	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Pipe Mount	
I-13-02	DPIT 362	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Pipe Mount	
I-13-02	DPIT 363	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Pipe Mount	
I-13-02	FE 371	Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-02	FE 372	Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-02	FE 373	Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-02	FE 374	Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-02	FIT 371	Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-02	FIT 372	Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-02	FIT 373	Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-02	FIT 374	Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-03	LE 850	Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-13-03	LE 852	Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-13-03	LIT 850	Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-13-03	LIT 852	Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-13-03	PI 863	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-13-03	PI 862	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-13-04	LE 851	Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-13-04	LIT 851	Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-13-04	LSH 852	Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-13-04	LSL 852	Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-13-04	PI 861	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-13-05	FE 671	Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-05	FIT 671	Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-05	LE 654	Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-13-05	LIT 654	Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-13-05	PI 661	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-13-06	AE 581	Sensor	ORP	40_91_02.01_1.01C	4X	-	-1500 - 1500	mV	Civil Detail	
I-13-06	AIT 581	Analyzer Transmitter	Multiparameter	40_91_02.01_1.01A	4X	-	-	-	Pipe or Wall Mount	
I-13-06	DPIT 461	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-13-06	DPIT 462	Differential Pressure Transmitter	Diaphragm	40_91_02.07_1.01A	4X	-	0-XXX	PSI	Per Filter Mfg.	
I-13-06	FE 576	Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-06	FE 575	Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-06	FIT 576	Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-06	FIT 575	Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-13-06	LE 556	Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-13-06	LIT 556	Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-13-06	LSH 554	Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-13-06	LSL 554	Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-13-06	PI 561	Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	

DWG # P&ID	Tag No.		DESCRIPTION	Type	Specification Section	Min. NEMA Rating	Size	SP/ Range	Units	DWG. DET. Reference	Notes
I-13-06	PI 563		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-14-01	AE 481	A	Sensor	pH	40_91_02.01_1.01B	4X	-	0-14	pH	Civil Detail	
I-14-01	AE 481	B	Sensor	Conductivity	40_91_02.01_1.01E	4X	-	10 - 20k	uS	Civil Detail	
I-14-01	AE 482		Sensor	Turbidity	40_91_02.01_1.01D	4X	-	0 - 4000	FNU	Civil Detail	
I-14-01	AIT 481		Analyzer Transmitter	Multiparameter	40_91_02.01_1.01A	4X	-	-	-	Pipe or Wall Mount	
I-14-01	FE 472		Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-14-01	FE 471		Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-14-01	FIT 472		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-14-01	FIT 471		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-14-01	LE 452		Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-14-01	LE 454		Level Element	Sonic	40_91_02.05_1.01A	4X	-	-	-	USL / 12	x
I-14-01	LIT 452		Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-14-01	LIT 454		Level Indicating Transmitter	Sonic	40_91_02.05_1.01A	4X	-	0-XXX	FT	USL / 12	
I-14-01	LSH 459		Level Switch	Float	40_91_02.05_1.01C	4X	-	-	-	FS / 11	x
I-14-01	LSH 451		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-14-01	LSH 453		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-14-01	LSL 451		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-14-01	LSL 453		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-14-01	PI 463		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-14-01	PI 461		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-14-01	PI 462		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-14-02	AE 581	A	Sensor	pH	40_91_02.01_1.01B	4X	-	0-14	pH	Civil Detail	
I-14-02	AE 581	B	Sensor	Conductivity	40_91_02.01_1.01E	4X	-	10 - 20k	uS	Civil Detail	
I-14-02	AIT 581		Analyzer Transmitter	Multiparameter	40_91_02.01_1.01A	4X	-	-	-	Pipe or Wall Mount	
I-14-02	FE 571		Flow Element	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-14-02	FE 572		Flow Element	Magnetic	40_91_02.03_1.01A	4X	2"	0-XXX	GPM	FM / 1	
I-14-02	FIT 571		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X		0-XXX	GPM	FM / 1	
I-14-02	FIT 572		Flow Indicating Transmitter	Magnetic	40_91_02.03_1.01A	4X	2"	0-XXX	GPM	FM / 1	
I-14-02	LI 553		Level Gauge	Gauge							
I-14-02	LSH 551		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-14-02	LSH 555		Level Switch	Float	40_91_02.05_1.01C	4X	-	-	-	FS / 11	x
I-14-02	LSH 554		Level Switch	Float	40_91_02.05_1.01C	4X	-	-	-	FS / 11	x
I-14-02	LSL 551		Level Switch	Float	40_91_02.05_1.01C	-	-	-	-	FS / 8	x
I-14-02	LT 552		Level Transmitter	Submersible	40_91_02.05_1.01B	-	-	0-250	FT	LT / 9	Cable as required per plan
I-14-02	PI 561		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	
I-14-02	PI 562		Pressure Gauge	Bourdon Tube	40_91_02.07_1.01B	4X	-	0-XXX	PSI	PG / 13	

SECTION 40 91 01
PLC & HMI APPLICATIONS PROGRAMMING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Programming of the PLC (Programmable Logic Controller) and HMI (Human Machine Interface) also referred to as OIT (Operator Interface Panel) or OI (Operator Interface) to control the treatment system functions.

1.02 REFERENCES

A. Electrical Specifications (Electrical General).

B. Electrical Specifications (Packaged Equipment Control Panels).

C. Project Drawings including P&ID and wiring schematics.

1.03 QUALIFICATIONS

A. Services furnished under this specification shall be performed by qualified programmers meeting requirements specified in Electrical Specifications (Electrical General, Qualifications).

1.04 SECTION INCLUDES

A. Control descriptions for Programmable Logic Controller (PLC) and HMI (Human Machine Interface).

B. Applications Programming for Programmable Logic Controller (PLC) and HMI (Human Machine Interface) is by Owner Representative (Application Programmer). The programming description in Articles Applications Program Code and Control Strategies of this section is provided for Contractor reference.

C. The System Integrator shall configure the PLC, HMI, and communications equipment to facilitate testing as defined in Electrical Specifications (Factory and Field Testing).

D. Related work as specified in Electrical Specifications (Electrical General).

1.05 SUBMITTAL REQUIREMENTS

A. No submittals pertaining to this section are required.

B. Provide submittals per Electrical Specifications (Electrical General, Submittal Requirements).

C. Submit software operations manual including the following as a minimum:

1. Program Code: Program code demonstrating function in compliance with descriptions herein.
2. Setpoint listing with description.
3. Program Description: Provide written description of program operation. Description shall cover all aspects of normal operation and alarm shutdowns. Describe all alarms and their effect on operation. Describe alarms that require manual reset.
4. Register Cross Reference Listing:
    a. The listing shall be in table format and include all program constants and variable registers with their functions.
    b. The listing shall show (block and rung number) where the register is used within the program code.
5. Configuration and Set-up:
    a. The configuration of the processor and hardware selections shall be summarized.
    b. The configuration of the communication ports shall be shown.
6. Data Tables: Print data tables with initial register values shown.
7. Special Files: Include any special files that are particular to the manufacturer. All files pertinent to programming or configuration shall be submitted.

D. Submit software documentation demonstrating understanding of control software requirements and compliance with Portability and Maintainability requirements specified in this Section.

1. Submit HMI graphic layout and PLC program listing with cross-references for approval 4 weeks prior to factory test.
2. Provide two sets of HMI graphic screens and PLC applications programs on compact disks, in native file format with each software submittal and at the end of the project for as-programmed final documentation for O&M manuals. Each disk shall have a typed label clearly stating the contents, date, filenames, and submittal (i.e., initial or as-programmed final).

3. A hard copy listings of HMI graphic screens and PLC applications programs (with comments) shall be printed with standard laser print 8-1/2 by 11 inch paper and supplied with the initial submittal and for as-programmed final documentation for O&M manuals. Copy and binding method shall not cut off any parts of ladder logic and comments. Print shall be sized so that the complete ladder logic run fits on one sheet, rungs extending to multiple sheets will not be accepted and will be returned without review.

1.06 PROGRAMMING METHODS

A. Design and code programs per the following:

1. Clearly comment each rung of ladder logic code. Include module headers detailing the purpose of the module, programmer name, date of last revision, revision history, and description of sequence of events.
2. Comment for each block of code explaining purpose of program block.
3. Code shall use the P&ID device names as the prefix to the names or tagnames throughout the ladder logic. Reference tag formation below. If PLC does not use tagnames as data reference, then provide tagname in symbol name or in comment areas at minimum.
4. Data arrays may be used in tagname aliases for communication data transfers.
5. Provide ladder file for each type of program logic. The following are types that should be used, as applicable and at minimum.
    a. Analog input scaling.
    b. Analog output scaling.
    c. Analog alarms.
    d. Digital alarms.
    e. PLC clock, midnight and today/yesterday control.
    f. Flow totalizations.
    g. Equipment runtimes.
    h. Equipment starts.
    i. Communications.
    j. Each individual piece of controlled equipment (digital control).
    k. Each individual piece of controlled equipment (analog control).
    l. Each individual process system (digital control).
    m. Each individual process system (analog control).
    n. Miscellaneous systems.

B. All custom software, including diagnostic, configuration and applications programming software shall become the sole property of the Owner for their use on this and future Owner projects.

C. No software or documentation shall be labeled proprietary.

D. Provide complete hardware and original manufacturer software manuals describing how to use the configuration software.

E. Provide two disks copies and two hard copies of all as-installed programs at the end of the project.

F. Furnish and maintain 16 GB (minimum) USB RAM stick on site and within control panel so that latest program files are always available and up-to-date. Upon conclusion of each downloaded program change, the USB RAM stick shall be updated.

1.07 APPLICATIONS PROGRAMMER

A. All programming shall be performed by an application programmer with prior experience on similar PLC & HMI projects. The Engineer will judge if the application programmer assigned to this project is adequate for the task. If the programming performed is deemed inadequate by Engineer, then the System Integrator shall replace the application programmer for one with more experience and skill to meet these requirements.

PART 2 PRODUCTS

2.01 APPLICATIONS PROGRAMMING SOFTWARE

A. Provide applications programming software, in new/unused condition, and in the original packaging to the Owner for their use.

B. The software shall be of latest revision available at time of delivery to the Owner and the same revision number as that used by the Contractor to program the PLC. If the revision numbers of the software provided in the box and that used for programming are different, the Contractor shall make whatever changes are necessary to make the applications program compatible with the applications software provided.

C. Two copies of the following software shall be provided under this contract.

1. GE; Proficy Machine Edition with hard key not software key (Rev. 7 or newer to be confirmed by PG&E) or approved equal.
2. GE; Cimplicity, or approved equal.
3. Latest revision of programming software for the PLC suitable for installation on a Windows PC. Revision shall be as available at time of bid.

D. The Contractor is responsible for obtaining correct revision of PLC & HMI configuration software, manuals and licensing necessary to program and configure the PLC & HMI. Contractor shall coordinate the proper version of software prior to the start of PLC programming. Programming software version shall be compatible and consistent with installed base at other Owner stations.

E. The Contractor is responsible for obtaining PLC & HMI configuration software to program and configure the PLC & HMI for testing purposes.

2.02 APPLICATIONS PROGRAM CODE

A. The Application Programmer will provide, install and test (with Contractor assistance) application programming. The descriptions provided herein are not final and may have modifications made to them during construction that may change the nature of operation.

B. The descriptions are provided to give the Contractor an insight as to the level of testing effort that will be required in the later stages of the project. Minor modifications should be expected and will not constitute a change in project testing assistance scope unless those modifications cause significant additional testing time or materials by Contractor. Significant time shall be defined as 4 hours and only time or materials related to program modifications since bid may be accounted.

C. Provide applications programs in the PLC to execute the control strategies as described herein, as shown on Contract Drawings, and as can be reasonably determined from the overall project scope. The Contractor shall provide application program code that performs to the intent of the descriptions and any additional supporting program code for a fully operational processor and system.

D. Provide comments in the PLC code sufficient to guide the end user in understanding the control algorithms and the flow of the program logic, subject to PG&E approval and acceptance.

E. The Contractor shall provide the PLC & HMI completely configured and programmed for the monitoring and control of the facility. Work shall be completed in a timely manner such that all other parts of the contract may proceed un-inhibited. There shall be no expectation that any program logic or configuration will be performed by others.

F. The control strategies for the PLC & HMI are intended as guidelines for the System Integrator to use to program the PLC. The descriptions are intended to be general in nature and do not contain all details to program a fully functional and robust PLC logic program. Many details concerning programming methods and procedures are the responsibility of the qualified Contractor to design and implement. The descriptions are written for best transference of intent may not be the best way to code the program. Errors and omissions in details shall be the Contractor's responsibility to infill and correct. The Contractor shall meet the intent of the strategies specified, making modifications as necessary to provide an operational system.

G. The program code will minimize any "hard-coded" constants that would effectively require a program change to modify the value. All function blocks shall contain variable registers only when applicable.

2.03 CONTROL STRATEGIES

A. General Requirements:

1. The following requirements (General and Specific) are intended to be used as a guideline for application programming of the PLC. They are the major functions and are not intended to be completely comprehensive of all requirements of the station operation and do not attempt to cover all necessary program routines for an operational system. Additional features, functions and registers will be required for an operational system.
2. The following general program functions shall be provided:
    a. Enable/disable toggle bits and variable time delays for all alarms.
    b. Analog input noise filtering - software or firmware.
    c. SCADA Field LOR switch is Local /Off / Remote. LOR (Local-Off-Remote) controls for all equipment controlled by the PLC. These control buttons shall also be accessible via the HMI(s). Any reset after failure requires LOR switch to go to "OFF" (locally) prior to Reset Acceptance. SCADA Remote manual operation does include system interlocks.
    d. Time of day clock synchronization with SCADA system. PLC shall have registers defined for SCADA system clock write. The PLC shall have code written to recognize that the register(s) have been written to, stop the real time clock, set the clock, and restart it, with the value in the register(s). Date and time of day shall be set.
    e. Resettable and non-resettable operation hour meters for all equipment and resettable starts counters for all equipment.

f. Scaling to engineering values of all variables. Minimum of three significant digits required.
   1) Level in 1/10th feet or inches.
   2) Pressure in 1/10th psi.
   3) Flow in GPM.
   4) Flow totalization
      a) Total non-resettable flow displayed in MGD with 9999999.999 presentation layout.
      b) Total resettable flow displayed in MGD with 9999999.999 presentation layout.
      c) Total yesterday flow displayed in KGAL with 99999.9 presentation layout.
      d) All registers shall roll over to zero automatically.
   5) Speed in Percent and Equivalent Units, i.e., Hz, RPM: Motor current in 1/10 amps. Convert current input to power (in KW) where shown on Drawings. Assume voltage to be 480 and power factor to be 0.85.

g. Data Register Types:
   1) Any register that requires precision past the decimal shall be floating point type.
   2) Integer registers may be used where decimal precision is not required.
   3) Double Integer registers shall be used for flow totalizers.
   4) Boolean registers shall be used for all statuses and on/off controls.

h. All set point registers, enable/disable toggle bits and settable variable time delays shall be adjustable from the HMI direct to program data table.

i. Provide communications messaging as required to share data information and interlocks between PLCs. Message structure shall be fail safe as to keep overflows or other improper operation from occurring.

j. A power fail shall reset all routines.

k. Pumps and equipment shall have backspin delays and power fail sequential re-start delay routines.

l. All powered equipment and devices shall have assigned unique permissives by PG&E for purposes of generator load shedding.

m. Programming code shall have automatic error checking and proper initialization to prevent illegal operations such as negative values being placed in timer presets or mathematical out of range functions which could cause a processor fault.

n. PLC shall be programmed so that, in the event of a power interruption, the equipment controlled shall resume normal

operation without requiring a manual reset unless otherwise shown.

o. Set Points:
   1) Minimum required set points for Lead/Lag pumping scenario where applicable.
      a) Lead Pump start level.
      b) Lag Pump start level.
      c) Lead Pump stop level.
      d) Lag Pump stop level.
      e) Pump Start delay time.
      f) Pump Stop delay time.
      g) Backspin delay time.
      h) Sequential Start delay time.
      i) Pump rotation selection (0=auto rotate, 1=P1 Lead, 2=P2 Lead).
   2) Additional minimum required set points for Lead/Lag pumping scenario when variable speed control is used.
      a) Minimum Lead Pump speed to start Lag Pump.
      b) Minimum Lag Pump speed to stop Lag Pump.
      c) Maximum Pump Speed.
      d) Minimum Pump Speed.

3. Tag Formation:
   a. Tags are created from the P&ID device names. A complete tag is generated by starting with a STATION ID or location as indicated on the P&ID drawings for the originating PLC. (example Plant PLC – PLC1, Remote PLC – RT1, etc.).
   b. The device TAG ROOT is generated by taking the P&ID device name (example PMP-210) and stripping all but the first letter including any dashes, etc., then adding a leading zero to the numeric portion, thus becoming (P0210). Common prefixes for tag roots are listed here.

Tag Prefix	Description
A	Analytical Instrumentation (pH, ORP, Temp, etc.)
F	Flow, Filter
FS	Flow Switch
L	Level
LS	Level Switch
M	Motor, Mixer

Tag Prefix	Description
P	Pump, Pressure
PS	Pressure Switch
V	Valve

c. The TAG SUFFIX is created from the PLC I/O designator on the P&ID drawing by stripping out the numeric portion. Thus, for example, the run input designator YN210R becomes just YNR.

d. The full tag name is now formed by concatenating the STATION ID with the TAG ROOT and the TAG SUFFIX. So in this example the complete tag name is PLC1 plus P0210 plus YNR or PLC1P0210YNR for pump #210 running input on the plant PLC.

e. All other tags associated with a device are then generated by concatenating the appropriate suffix to the end of the TAG ROOT. Common suffixes are listed here. Others may also be developed.

Tag Suffix	Description
UAF	PLC input device Fault
HNA	PLC input device in Auto
YNR	PLC input device Run
ZNO	PLC input device Opened
ZNC	PLC input device Closed
AL	PLC input utility power fail
BL	PLC input UPS power fail
F	PLC input generator fail
FL	PLC input generator fuel leak
ZNE	PLC input ATS in emergency position
ZNN	PLC input ATS in normal position
AI	PLC input raw analog input
	Scaled Input Analog value (NO SUFFIX)
XCS	PLC output device start command
XCT	PLC output device stop command
XCO	PLC output device open command
XCC	PLC output device close command

Tag Suffix	Description
AO	PLC output raw analog output
SC	Scaled output analog value speed command
ZC	Scaled output analog value position command
XFA	Transducer Fail
HHA	High Lockout Alarm
HA	High Alarm
HW	High Warning
LW	Low Warning
LA	Low Alarm
LLA	Low Lockout Alarm
A	Alarm
FA	Fail Alarm
ED	Enable / Disable Toggle
RST	Reset toggle
SP	Alarm Set Point
CSP	Control Set Point
DSP	Delay Set Point
HHSP	High Alarm Set Point (lockout)
HSP	High Warning Set Point
LSP	Low Warning Set Point
LLSP	Low Alarm Set Point (lockout)
RSP	Reset Set Point
T	Alarm Timer
TMR	Control Timer
CTR	Counter
MS	Device Mode Select
MSS	Device Mode Select Start / Stop
NA	Device Not Available

Tag Suffix	Description
REQ	Device required
CALLATO	Device Call in Auto
ABRT	Process Abort
INIT	Process Initiate
EN	Process Enabled
REQRD	Process Required
HRS	Non-resettable run time hours
RHRS	Resettable run time hours
S	Non-resettable run time starts
RS	Resettable run time starts
THRS	Today's run time hours
TS	Today's run time starts
YHRS	Yesterday's run time hours
YS	Yesterday's run time starts
NRTOT	Non-resettable totalization
RTOT	Resettable totalization
TTOT	Today's totalization
YTOT	Yesterday's totalization

f. Tags required for designating parameters associated with a group of devices or a sub system (example PID parameters for a group of pumps) would be formed by using the numeric "0200" in the TAG ROOT. The tag root would be P0200 in this case showing these parameters apply to all the pumps in the group (P0201 – P0299).

g. Each tag type will have a unique sheet within an excel database. Database to be included with completed software submittal.

PLC	Tag Base	Tag Name	Alias For	Rack	Slot	Input / Output	Data Type	Format
Alarm Tag								
PLC1	FxxxLA	PLC1FxxxLA					BOOL	Decimal

PLC	Tag Base	Tag Name	Alias For	Rack	Slot	Input / Output	Data Type	Format
En/Dis Tag								
PLC1	FxxxLAED	PLC1FxxxLAED					BOOL	Decimal
Delay Time Tag								
PLC1	FxxxLADSP	PLC1FxxxLADSP					INT	Decimal
Timer Tag								
PLC1	FxxxLAT	PLC1FxxxLAT					TIMER	Decimal
Set Point Tag								
PLC1	FxxxLASP	PLC1FxxxLACSP					REAL	Float
Digital IN Tag								
PLC1	FxxxDI	PLC1FxxxDI	Local:10:I.Data.1	A	10	1	BOOL	Decimal
Digital OUT Tag								
PLC1	FxxxDO	PLC1FxxxDO	Local:21:O.Data.12	B	21	12	BOOL	Decimal
Analog IN Tag								
PLC1	PxxxAI	PLC1FxxxAI	Local:1:I.Ch1Data	A	1	1	INT	Decimal
Scaled IN Tag								
PLC1	Pxxx	PLC1Fxxx					REAL	Float
Analog OUT Tag								
PLC1	PxxxAO	PLC1FxxxAO	Local:6:O.Ch2Data	1	6	2	BOOL	Decimal
Scaled OUT Tag								
PLC1	PxxxSP	PLC1FxxxSP					REAL	Float

PLC	Description	On State	Off State	Min EU	Max EU	Eng. Units
Alarm Tag						
PLC1	Generic Tag Alarm	Alarm	Null			
En/Dis Tag						
PLC1	Generic Tag Alarm Enable / Disable	Disable	Enable			
Delay Time Tag						
PLC1	Generic Tag Alarm Delay Set Point			0	9999	Seconds
Timer Tag						
PLC1	Generic Tag Alarm Delay Timer			0	9999	Seconds

PLC	Description	On State	Off State	Min EU	Max EU	Eng. Units
Set Point Tag						
PLC1	Generic Tag Alarm Set Point					GPM
Digital IN Tag						
PLC1	Generic Digital Input Tag	On	Off			
Digital OUT Tag						
PLC1	Generic Digital Output Tag	On	Off			
Analog IN Tag						
PLC1	Generic Analog Input Tag			4000	20000	
Scaled IN Tag						
PLC1	Generic Scaled Analog Input Tag			0	100	%
Analog OUT Tag						
PLC1	Generic Analog Output Tag			4000	20000	
Scaled OUT Tag						
PLC1	Generic Scaled Analog Output Tag			0	100	%

4. Analog Scaling:
   a. All analog values shall be adjusted (if necessary) prior to scaling for required offsets due to hardware / firmware conditions.
   b. All analog input values shall be scaled into real world engineering units and presented in REAL (floating point) format for use by SCADA(HMI) and the OI(s).
   c. All analog output values shall be scaled from real world engineering units into INT (decimal) format to control current or voltage output from an analog output device.
5. Alarms General:
   a. Common alarms. Provide all applicable alarms per device based on available P&ID inputs and outputs.
      1) Motor power or amperage alarms shall be disabled when the motor is not running.
      2) If a device is called to start or move and the associated run status does not confirm start or move after a time delay then post a device “Run fail” alarm. (*YNRFA)
      3) Not in Auto Alarm: All devices (valves, gates, pumps) with auto switch monitoring shall have associated “Not in auto” alarms. (*HNAFA)

4) Moisture / Temperature Alarms: All submersible pumps shall have “Moisture” and “Over temperature” alarms. (*SMFA and *SOTFA)
5) Seal Water Fail Alarm: All sludge type pumps shall have “Seal water fail” alarms. (*SWFA)
6) Pressure Alarm: All sludge type pumps shall have “Inlet and Outlet pressure” alarms. (*IPFA and *OPFA)
7) Temperature Alarm: All sludge type pumps shall have a pump body “Over Temp” alarm. (*OTFA)
8) Differential Pressure Alarm: All filters shall have “Differential pressure” alarms. (*DPFA)
9) Low Oil Alarm: All lubricated mechanical devices (gearboxes, etc.) shall have a “Low oil” alarm. *LOFA)
10) Vibration Alarm: All moving mechanical devices (gearboxes, aerators, pumps, etc.) shall have a “Vibration” alarm. (*VFA).
11) Over Torque Alarm: All geared mechanical devices (clarifiers etc.) shall have an “Over torque” alarm. (*OTQFA)
12) VFD Fault: All VFDs shall have a common fault alarm as a minimum. Further breakdown of alarms shall be provided based on data available from the VFD. All VFDs shall have a manual reset available from the OI(s) and SCADA (HMI). (*UAFA)
13) Flow, Level, Pressure, Analytical and Other Analog Alarms: All analog values will have at a minimum an associated alarm structure as defined in Article Control Strategies, Paragraph A.5.b.5 below.
14) All digital alarm values will have at a minimum an associated alarm structure as defined in Article Control Strategies, Paragraph A.5.c.3 below.

b. Analog Alarms:
1) If an analog value is above/below the associated set point, and the associated time delay has exceeded the time delay set point, then the alarm shall be generated / annunciated.
2) Transducer out of range alarms. If the scaled value of the analog input exceeds 21 mA or falls below 3.5 mA, an out of range alarm shall be triggered for that input.
3) The alarm shall automatically reset unless it is designated as “latch”. A latching alarm requires either a reset set point for hysteresis or a manual reset.

4) The low flow alarms (and pressure alarms if applicable) shall only be enabled when the associated pump or system is running.
5) Example analog alarm display structure (Units per alarm type). ENABLE / DISABLE shall be a toggle switch. DELAY to be editable timer base value for associated alarm delay timer. Other alarm rows to contain editable alarm set point value with REAL (floating point) data type. LATCH to be either reset set point value for reset of alarm or manual reset toggle (blank if alarm is not latching).

Description	Status	En / Dis	Delay	Set Point	Latch
Transducer Fail High Alarm	ALARM	Enable	10 sec.	xxx.x GPM	
High Lockout Alarm	OK	Enable	10 sec.	xxx.x GPM	xxx.x GPM
High Alarm	OK	Enable	5 Sec.	xxx.x GPM	
High Warning	ALARM	Enable	5 Sec.	xxx.x GPM	
Low Warning	OK	Enable	5 Sec.	xxx.x GPM	
Low Alarm	OK	Enable	5 sec.	xxx.x GPM	
Low Lockout Alarm	OK	Disable	5 Sec.	xxx.x GPM	xxx.x GPM
Transducer Fail Low Alarm	OK	Disable	5 Sec.	xxx.x GPM	

c. Digital Alarms:
1) If the digital alarm state is TRUE and the associated time delay timer has exceeded the time delay set point, then the alarm shall be generated / annunciated.
2) The alarm shall automatically reset unless it is designated as “latch”. A latching alarm requires a manual reset.
3) Example digital alarm Structure. ENABLE / DISABLE to be a toggle switch. DELAY to be editable timer base value for associated alarm delay timer. LATCH to be a manual reset toggle (blank if alarm is not latching).

Description	Status	En / Dis	Delay	Latch
Generic Digital Alarm 1	OK	Disable	10 sec.	
Generic Digital Alarm 2	ALARM	Enable	10 sec.	Reset

d. Communications Alarm: The SCADA(HMI) and connected PLC(s) shall monitor for communications between controllers and they shall post an alarm if any PLC fails to respond to message queries.

6. Totalization:
   a. Flow Totalization (Example):
      1) If an analog flow input value (Fxxxx) is positive, then increment the flow totalizers (FxxxxNRTOT, FxxxxRTOT and FxxxxTTOT) for each 1,000 gallons of accumulated flow.
      2) If internal flow reset status (FxxxxRST) is set, then set resettable flow totalizer (FxxxxRTOT) to zero and reset FxxxxRST.
      3) Similar for all flowmeters / totalizers.
   b. Hour Meters (Example):
      1) If Generic Pump #1 running (PxxxxYNR) is set, then start hour timers PxxxxHRS, PxxxxRHRS and PxxxxTHRS.
      2) If internal run time hours reset status (PxxxxRHRSRST) is set, then set resettable run time hours (PxxxxRHRS) to zero and reset PxxxxRHRSRST.
      3) Similar for all device run time hours.
   c. Starts Counters (Example):
      1) If Generic Pump #1 running input (PxxxxYNR) is set or Generic Pump #1 start command (PxxxxXCS) is set (if running input is not available), then increment starts counters PxxxxS, PxxxxRS and PxxxxTS.
      2) If internal starts reset status (PxxxxSRST) is set, then set resettable starts counter (PxxxxRS) to zero and reset PxxxxSRST.
      3) Similar for all device starts.

B. Specific Requirements (Topock):

1. Reminder: Specific requirements, shown herein, are in addition to general programming requirements.

2. Freshwater Wells Pump Start Control:
   a. Loop Number: 000.
   b. P&ID Drawing(s) Referenced: I-02-01.
   c. Description:
      1) The freshwater well pumps provide water to the freshwater tank(s) based on level set point control.
      2) The system can rotate wells, well sites or call each well in a specified order.

d. Equipment Associated:

Device	Tag Root	Description
PMP-010	P0010	HNWR-1A WELL PUMP 1
PMP-020	P0020	SITE B WELL PUMP 1
FIT-071A	F0071	HNWR-1A WELL SITE FLOWMETER
FIT-072A	F0072	HNWR-1A WELL SITE REFUGE FLOWMETER
FIT-071B	F0073	SITE B WELL SITE FLOWMETER
PIT-061A	P0062	HNWR-1A WELL SITE PRESSURE TRANSMITTER
PIT-061B	P0063	SITE B WELL SITE PRESSURE TRANSMITTER
LT-051A	L0051	HNWR-1A WELL LEVEL TRANSMITTER
LT-051B	L0052	SITE B WELL LEVEL TRANSMITTER

e. System Enable (Interlocks):
   1) Remedy freshwater storage tank flow permissive.
   2) Tank inlet valve(s) are open on the freshwater storage tank(s).

f. Equipment Enable per Device with Output:
   1) ROA in auto.
   2) No pump fault alarms.
   3) No flow alarms.
   4) No pressure alarms.
   5) No low well level alarms.

g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
UA010F	HNWR-1A Pump Fault
UA020F	Site B Pump Fault
HN010A	HNWR-1A Pump in Auto
HN020A	Site B Pump in Auto
YN010R	HNWR-1 Pump Run
YN020R	Site B Pump Run
YN010C	HNWR-1A External Call

Digital Input	Description
YN020C	Site B External Call
Digital Output	**Description**
XC010S	HNWR-1A Pump Start
XC020S	Site B Pump Start
Analog Input	**Description**
F0071A	HNWR-1A Total Well Flow
F0072	HNWR-1A Total Refuge Flow
F0071B	Well Site B Total Well Flow
P0061A	HNWR-1A Output Pressure
P0061B	Site B Output Pressure
L0051A	HNWR-1A Well Level
L0051B	Site B Well Level
Analog Output	**Description**
	NONE

2) Specific Set Points: Set points per General Requirements Article 2.03.A.2.p.1 and 2 (if water supply wells to be operated with lead – lag function).

Loop Set Point	Description
	Reference Alarm Set Points

h. Start/Stop:
   1) Well pump will start or stop via setting given by Operator in manual mode.
   2) Well pump will start when issued a start command if the Freshwater storage tank flow permissive is enabled, well level(s) are above low limits, the well is enabled for operation and the ROA is in auto.
   3) Each well may be individually enabled / disabled for operation.

4) Well pump will stop when the start command is removed, Remedy freshwater storage tank flow permissive is disabled, well level goes low, the well is disabled or there is an alarm condition.

i. Alarms:
   1) Pump Fault.
   2) Low / High Flow.
   3) Low / High Pressure.
   4) Low Well Level.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm Tag	Latch	Units
UA010F	HNWR-1A Pump Fault	P0010UAFA	L	
UA020F	Site B Pump Fault	P0020UAFA	L	
HN010A	HNWR-1A Pump Not in Auto	P0010HNAA		
HN020A	Site B Pump Not in Auto	P0020HNAA		
YN010R	HNWR-1A Pump Fail to Start	P0010YNRFA	L	
YN020R	Site B Pump Fail to Start	P0020YNRFA	L	
F0071A	HNWR-1A Flow Transducer Fail	F0071AXFA	L	
F0071A	HNWR-1A High Flow Lockout Alarm	F0071AHHA	L	GPM
F0071A	HNWR-1A High Flow Warning	F0071AHA		GPM
F0071A	HNWR-1A Low Flow Warning	F0071ALA		GPM
F0071A	HNWR-1A Low Flow Lockout Alarm	F0071ALLA	L	GPM
F0072	HNWR-1A Refuge Flow Transducer Fail	F0072XFA	L	
F0072	HNWR-1A High Refuge Flow Alarm	F0072HHA	L	GPM
F0072	HNWR-1A High Refuge Flow Warning	F0072HA		GPM
F0072	HNWR-1A Low Refuge Flow Warning	F0072LA		GPM
F0072	HNWR-1A Low Refuge Flow Alarm	F0072LLA	L	GPM
P0061A	HNWR-1A Pressure Transducer Fail	P0061AXFA	L	
P0061A	HNWR-1A High Pressure Alarm	P0061AHHA	L	PSI

Inputs	Description	Alarm Tag	Latch	Units
P0061A	HNWR-1A High Pressure Warning	P0061AHA		PSI
P0061A	HNWR-1A Low Pressure Warning	P0061ALA		PSI
P0061A	HNWR-1A Low Pressure Alarm	P0061ALLA	L	PSI
L0051A	HNWR-1A Level Transducer Fail	L0051AXFA	L	
L0051A	HNWR-1A Low Level Warning	L0051ALA		Feet
L0051A	HNWR-1A Low Level Alarm	L0051ALLA	L	Feet
F0071B	Site B Flow Transducer Fail	F0071B XFA	L	
F0071B	Site B High Flow Alarm	F0071B HHA	L	GPM
F0071B	Site B High Flow Warning	F0071B HA		GPM
F0071B	Site B Low Flow Warning	F0071B LA		GPM
F0071B	Site B Low Flow Alarm	F0071B LLA	L	GPM
P0061B	Site B Pressure Transducer Fail	P0061BXFA	L	
P0061B	Site B High Pressure Alarm	P0061B HHA	L	PSI
P0061B	Site B High Pressure Warning	P0061B HA		PSI
P0061B	Site B Low Pressure Warning	P0061B LA		PSI
P0061B	Site B Low Pressure Alarm	P0061B LLA	L	PSI
L0051B	Site B Level Transducer Fail	L0051B XFA	L	
L0051B	Site B Low Level Warning	L0051B LA		Feet
L0051B	Site B Low Level Alarm	L0051B LLA	L	Feet

3. Remedy Freshwater Tank Flow and Source Permissives:

a. Loop Number: 100.

b. P&ID Drawing(s) Referenced: I-02-02.

c. Description: Level management for the remedy freshwater tank.

d. Equipment Associated:

Tag	Description
LSH-155	TNK-103 HIGH LEVEL SWITCH
LSL-155	TNK-103 LOW LEVEL SWITCH
LT-156	TNK-103 LEVEL TRANSMITTER

e. System Enable (Interlocks): Permissive from tank that it can accept water.

f. Equipment Enable per Device with Output:
   1) ROA in auto.
   2) Well pump available to provide water.

g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
LA155H	TNK-103 High Level
LA155L	TNK-103 High Level

Digital Output	Description

Analog Input	Description
L0156	Tank TNK-103 Water Level

Analog Output	Description
	NONE

   2) Specific Set Points:

Loop Set Point	Description
L0156CSP	TNK-103 Operating Level
	Reference Alarm Set Points

h. Start/Stop:
   1) Remedy freshwater storage tank flow permissive (L0156EN1) will be enabled when the freshwater storage tank current level is below the operational full level set point.
   2) Remedy freshwater storage tank flow permissive (L0156EN1) will be disabled when the freshwater storage tank current level is above the operational full level set point for the set point delay time or there is a HIGH level switch alarm.
   3) Remedy freshwater storage tank source permissive (L0156EN2) will be enabled when the freshwater storage tank current level is above the low level lockout set point.
   4) Remedy freshwater storage tank source permissive (L0156EN2) will be disabled when the freshwater storage tank current level is below the low level lockout set point for the set point delay time or there is a LOW level switch alarm.

i. Alarms: Tank high / low levels.
j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.
k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
LA155H	TNK-103 Level Switch High Alarm	LS0155HA	L	
LA155L	TNK-103Level Switch Low Alarm	LS0155LA	L	
L0156	TNK-103 Level Transducer Fail	L0156XFA	L	
L0156	TNK-103 High Level Alarm	L0156HHA	L	Feet
L0156	TNK-103 High Level Warning	L0156HA		Feet
L0156	TNK-103 Low Level Warning	L0156LA		Feet
L0156	TNK-103 Low Level Alarm	L0156LLA	L	Feet

Inputs	Description	Control Tag	Latch	Units
L0156	Remedy freshwater Storage Tank Flow Permissive	L0156EN1	L	
L0156	Remedy freshwater Storage Tank Source Permissive	L0156EN2	L	

4. Conditioned Water Storage Tank Farm A Side Flow and Source Permissives:

a. Loop Number: 410.
b. P&ID Drawing(s) Referenced: I-14-01.
c. Description: Level management for the Conditioned Water Storage Tank Farm A side (TNK-401 and TNK-402).
d. Equipment Associated:

Device	Tag Root	Description
LSH-451	LS0451H	TNK-401 HIGH LEVEL SWITCH
LSL-451	LS0451L	TNK-401 LOW LEVEL SWITCH
LIT-452	L0452	TNK-401 LEVEL TRANSMITTER
LSH-453	LS0453H	TNK-402 HIGH LEVEL SWITCH

Device	Tag Root	Description
LSL-453	LS0453L	TNK-402 LOW LEVEL SWITCH
LIT-454	L0554	TNK-402 LEVEL TRANSMITTER

e. System Enable (Interlocks): Conditioned Water Storage Tank A Side Permissives.
f. Equipment Enable per Device with Output: None.
g. I/O and Set points Associated:
1) Physical I/O:

Digital Input	Description
LA451H	TNK-401 High Level
LA451L	TNK-401 Low Level
LA453H	TNK-402 High Level
LA453L	TNK-402 Low Level

Digital Output	Description
	NONE

Analog Input	Description
L0452	Conditioned Water Storage Tank 401 Level
L0454	Conditioned Water Storage Tank 402 Level

Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
L0452CSP1	TNK-401 Operational Level Set Point
L0452CSP2	TNK-401 Flow Permissive Reset Set Point
L0454CSP1	TNK-402 Operational Level Set Point
L0454CSP2	TNK-402 Flow Permissive Reset Set Point
	Reference Alarm Set Points

h. Start/Stop: Flow Permissive.
   1) The Conditioned Water Storage Tank A Side Flow permissive (L0400EN1) will be enabled when at least one current tank level is below the corresponding Operational Level set point for that tank.
   2) If both current tank levels meet or exceed the Operational Level set points for the corresponding tanks for the set point delay times the Conditioned Water Storage Tank A Side Flow permissive will be disabled.
   3) The Conditioned Water Storage Tank A Side Flow permissive will be re-enabled when at least one of the current tank levels drop below the corresponding Flow Permissive Reset set point.
   4) The permissive will be disabled if there is a HIGH level switch alarm in all tanks.

i. Source Permissive:
   1) The Conditioned Water Storage Tank A Side Source permissive (L0400EN2) will be enabled when at least one current tank level is above the corresponding Low Level Lockout set point for that tank.
   2) If both current tank levels are below the Low Lockout Level set points for the corresponding tanks for the set point delay times the Conditioned Water Storage Tank A Side Source permissive will be disabled.
   3) The Conditioned Water Storage Tank A Side Source permissive will be re-enabled when at least one of the current tank levels rise above the corresponding Low Level Lockout set point.
   4) The permissive will be disabled if there is a LOW level switch alarm in all tanks.

j. Alarms: Tank Level.
   1) The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an “L” in the latch column immediately after the alarm tag reference.
   2) All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm Tag	Latch	Units
L0452	TNK-401 Level Transducer Fail	L0452XFA	L	
L0452	TNK-401 High Level Alarm	L0452HHA	L	Feet
L0452	TNK-401 High Level Warning	L0452HA		Feet
L0452	TNK-401 Low Level Warning	L0452LA		Feet
L0452	TNK-401 Low Level Alarm	L0454LLA	L	Feet
LA451H	TNK-401 High Level Switch Alarm	LS0451HHA	L	
LA451L	TNK-401 Low Level Switch Alarm	LS0451LLA	L	
L0454	TNK-402 Level Transducer Fail	L0454XFA	L	
L0454	TNK-402 High Level Alarm	L0454HHA	L	Feet
L0454	TNK-402 High Level Warning	L0454HA		Feet
L0454	TNK-402 Low Level Warning	L0454LA		Feet
L0454	TNK-402 Low Level Alarm	L0454LLA	L	Feet
LA453H	TNK-402 High Level Switch Alarm	LS0453HHA	L	
LA453L	TNK-402 Low Level Switch Alarm	LS0453LLA	L	

Inputs	Description	Control Tag	Latch	Units
L0452,L0454	Conditioned Water Tanks Flow Permissive	L0400EN1	L	
L0452,L0454	Conditioned Water Tanks Source Permissive	L0400EN2	L	

5. Conditioned Water Storage Tank B Side Flow and Source Permissives:

a. Loop Number: 510.
b. P&ID Drawing(s) Referenced: I-14-02.
c. Description: Level management for the Conditioned Water Storage Tank Farm B Side (TNK-510).
d. Equipment Associated:

Device	Tag Root	Description
LSH-551	LS0551H	TNK-510 HIGH LEVEL SWITCH
LSL-551	LS0551L	TNK-510 LOW LEVEL SWITCH
LIT-552	L0552	TNK-510 LEVEL TRANSMITTER

e. System Enable (Interlocks): Conditioned Water Storage Tank B Side Permissives.
f. Equipment Enable per Device with Output: None.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
LA551H	TNK-510 High Level
LA551L	TNK-510 Low Level
Digital Output	**Description**
	NONE
Analog Input	**Description**
L0552	Conditioned Water Storage Tank 510 Level
Analog Output	**Description**
	NONE

   2) Specific Set Points:

Loop Set Point	Description
L0552CSP1	TNK-510 Operational Level Set Point
L0552CSP2	TNK-510 Flow Permissive Reset Set Point
	Reference Alarm Set Points

h. Start/Stop:
   1) Flow Permissive:
      a) The Conditioned Water Storage Tank B Side Flow permissive (L0552EN1) will be enabled when the current tank level is below the Operational Level set point.
      b) If current tank level meets or exceeds the Operational Level set point for the set point delay time the permissive will be disabled.
      c) The permissive will be re-enabled when the current tank levels drop below the Flow Permissive Reset set point.
      d) The permissive will be disabled if there is a HIGH level switch alarm.

2) Source Permissive:
   a) The Conditioned Water Storage Tank B Side Source permissive (L0552EN2) will be enabled when the current tank level is above the Low Level Lockout set point.
   b) If current tank level drops below the Low Level Lockout set point for the set point delay time the permissive will be disabled.
   c) The permissive will be re-enabled when the current tank level rises above the Low Level Lockout set point.
   d) The permissive will be disabled if there is a LOW level switch alarm.

i. Alarms: Tank Level.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm Tag	Latch	Units
L0552	TNK-510 Level Transducer Fail	L0552XFA	L	
L0552	TNK-510 High Level Alarm	L0552HHA	L	Feet
L0552	TNK-510 High Level Warning	L0552HA		Feet
L0552	TNK-510 Low Level Warning	L0552LA		Feet
L0552	TNK-510 Low Level Alarm	L0554LLA	L	Feet
LA551H	TNK-510 High Level Switch Alarm	LS0551HHA	L	
LA551L	TNK-510 Low Level Switch Alarm	LS0551LLA	L	

Inputs	Description	Control Tag	Latch	Units
L0552	Conditioned Water Tank B Side Flow Permissive	L0552EN1	L	
L0552	Conditioned Water Tank B Side Source Permissive	L0552EN2	L	

6. Influent Water Storage Tank Farm Source Permissives:

a. Loop Number: 210.
b. P&ID Drawing(s) Referenced: I-11-01, I-11-02, I-11-03, I-11-04.
c. Description: Level management for the Influent Water Storage Tank Farm (TNK-201, TNK-202, TNK-203 and TNK-204) to be able to provide water to the A side and B side filter systems.
d. Equipment Associated:

Device	Tag Root	Description
LSH-251	LS0251H	TNK-201 HIGH LEVEL SWITCH
LSL-251	LS0251L	TNK-201 LOW LEVEL SWITCH
LIT-252	L0252	TNK-201 LEVEL TRANSMITTER
LSH-253	LS0253H	TNK-202 HIGH LEVEL SWITCH
LSL-253	LS0253L	TNK-202 LOW LEVEL SWITCH
LIT-254	L0254	TNK-202 LEVEL TRANSMITTER
LSH-255	LS0255H	TNK-203 HIGH LEVEL SWITCH
LSL-255	LS0255L	TNK-203 LOW LEVEL SWITCH
LIT-256	L0256	TNK-203LEVEL TRANSMITTER
LSH-257	LS0257H	TNK-204 HIGH LEVEL SWITCH
LSL-257	LS0257L	TNK-204 LOW LEVEL SWITCH
LIT-258	L0258	TNK-204 LEVEL TRANSMITTER

e. System Enable (Interlocks): Influent Water Storage Tank Farm Source Permissive.
f. Equipment Enable per Device with Output: None.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
LA251H	TNK-201 High Level
LA251L	TNK-201 Low Level
LA553H	TNK-202 High Level
LA253L	TNK-202 Low Level
LA255H	TNK-203 High Level

Digital Input	Description
LA255L	TNK-203 Low Level
LA257H	TNK-204 High Level
LA257L	TNK-204 Low Level
Digital Output	Description
	NONE
Analog Input	Description
L0252	Influent Water Storage Tank 201 Level
L0254	Influent Water Storage Tank 202 Level
L0256	Influent Water Storage Tank 203 Level
L0258	Influent Water Storage Tank 204 Level
Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
L0252CSP1	TNK-201 Operational Level Set Point
L0252CSP2	TNK-201 Source Permissive Reset Set Point
L0254CSP1	TNK-202 Operational Level Set Point
L0254CSP2	TNK-202 Source Permissive Reset Set Point
L0256CSP1	TNK-203 Operational Level Set Point
L0256CSP2	TNK-203 Source Permissive Reset Set Point
L0258CSP1	TNK-204 Operational Level Set Point
L0258CSP2	TNK-204 Source Permissive Reset Set Point
T0201EN	Influent TNK-201 State. 0 = ONLINE, 1 = TREATMENT, 2 = OFFLINE

Loop Set Point	Description
T0202EN	Influent TNK-202 State. 0 = ONLINE, 1 = TREATMENT, 2 = OFFLINE
T0203EN	Influent TNK-203 State. 0 = ONLINE, 1 = TREATMENT, 2 = OFFLINE
T0204EN	Influent TNK-204 State. 0 = ONLINE, 1 = TREATMENT, 2 = OFFLINE
	Reference Alarm Set Points

h. Start/Stop:
   1) Each Influent Storage Tank will have the following states:
      a) ONLINE.
      b) TREATMENT.
      c) OFFLINE.
   2) Each influent water storage tank will have its own Influent Water Tank Source Permissive (L0xxxEN1) which will be enabled when the current tank level is above the associated low level set point, the pH adjustment procedure (TREATMENT state) has been completed and the tank is in an ONLINE state.
   3) If a tank is not in an ONLINE state or it is in an ONLINE state but the pH adjustment has not been completed, the Influent Water Tank Source Permissive for that tank will be disabled.
   4) If the current tank level drops below the low level set point for the set point delay time the Influent Water Tank Source Permissive for that tank will be disabled.
   5) The Influent Water Tank Source Permissive for a tank will be disabled if there is a LOW level switch alarm in that tank.
   6) The permissive for a tank will be re-enabled when the current tank level reaches the associated Source Permissive Reset set point for that tank, the pH adjustment procedure has been completed and there is no LOW level switch alarm in that tank and the tank is in an ONLINE state.

i. Alarms: Tank Level.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm Tag	Latch	Units
L0252	TNK-201 Level Transducer Fail	L0252XFA	L	
L0252	TNK-201 High Level Alarm	L0252HHA	L	Feet
L0252	TNK-201 High Level Warning	L0252HA		Feet
L0252	TNK-201 Low Level Warning	L0252LA		Feet
L0252	TNK-201 Low Level Alarm	L0252LLA	L	Feet
LA251H	TNK-201 High Level Switch Alarm	LS0251HHA	L	
LA251L	TNK-201 Low Level Switch Alarm	LS0251LLA	L	
L0254	TNK-202 Level Transducer Fail	L0254XFA	L	
L0254	TNK-202 High Level Alarm	L0254HHA	L	Feet
L0254	TNK-202 High Level Warning	L0254HA		Feet
L0254	TNK-202 Low Level Warning	L0254LA		Feet
L0254	TNK-202 Low Level Alarm	L0254LLA	L	Feet
LA253H	TNK-202 High Level Switch Alarm	LS0253HHA	L	
LA253L	TNK-202 Low Level Switch Alarm	LS0253LLA	L	
L0256	TNK-203 Level Transducer Fail	L0256XFA	L	
L0256	TNK-203 High Level Alarm	L0256HHA	L	Feet
L0256	TNK-203 High Level Warning	L0256HA		Feet
L0256	TNK-203 Low Level Warning	L0256LA		Feet
L0256	TNK-203 Low Level Alarm	L0256LLA	L	Feet
LA255H	TNK-203 High Level Switch Alarm	LS0255HHA	L	
LA255L	TNK-203 Low Level Switch Alarm	LS0255LLA	L	
L0258	TNK-204 Level Transducer Fail	L0258XFA	L	
L0258	TNK-204 High Level Alarm	L0258HHA	L	Feet
L0258	TNK-204 High Level Warning	L0258HA		Feet

Inputs	Description	Alarm Tag	Latch	Units
L0258	TNK-204 Low Level Warning	L0258LA		Feet
L0258	TNK-204 Low Level Alarm	L0258LLA	L	Feet
LA257H	TNK-204 High Level Switch Alarm	LS0257HHA	L	
LA257L	TNK-204 Low Level Switch Alarm	LS0257LLA	L	

Inputs	Description	Control Tag	Latch	Units
L0252	Influent Water Tank 201 Source Permissive	L0252EN1	L	
L0254	Influent Water Tank 202 Source Permissive	L0254EN1	L	
L0256	Influent Water Tank 203 Source Permissive	L0256EN1	L	
L0258	Influent Water Tank 204 Source Permissive	L0258EN1	L	

7. Influent Water Tank Farm Flow Permissives:

a. Loop Number: 211.
b. P&ID Drawing(s) Referenced: I-11-01, I-11-02, I-11-03, I-11-04.
c. Description:
   1) Level management for the Influent Water Storage Tank Farm (TNK-201, TNK-202, TNK-203 and TNK-204) to be able to accept incoming water from the well backwash pumps and conditioned water storage.
d. Equipment Associated: Reference Influent Water Tank level transmitters (LIT-252, LIT-254, LIT-256 and LIT-258) and Influent Water Tank level switches (LSH-251, LSL-251, LSH-253 LSL-253, LSH-255, LSL-255, LSH-257 and LSH-257). (INFLUENT WATER TANK FARM SOURCE PERMISSIVES.)

Device	Tag Root	Description
		NONE ADDITIONAL

e. System Enable (Interlocks): Influent Water Tank Farm Flow Permissive.
f. Equipment Enable per Device with Output: None.

g. I/O and Set points Associated:

1) Physical I/O:

Digital Input	Description
	NONE

Digital Output	Description
	NONE

Analog Input	Description
	NONE ADDITIONAL

Analog Output	Description
	NONE

1) Specific Set points

Loop Set Point	Description
	Reference Alarm Set Points

h. Start/Stop:

1) Each Influent Storage Tank will have the following states:
   a) ONLINE.
   b) TREATMENT.
   c) OFFLINE.
2) Each influent water storage tank will have its own Influent Water Tank Flow Permissive (L0xxxEN2) which will be enabled when the current tank level is below the associated Target Water Level to pH Adjust, the pH adjustment procedure (TREATMENT state) is not in progress and the tank is in an ONLINE state.
3) If a tank is not in an ONLINE state or the tank level has reached the Target Water Level to pH Adjust, the Influent Water Tank Flow Permissive for that tank will be disabled.
4) The Influent Water Tank Flow Permissive for a tank will be disabled if there is a HIGH level switch alarm in that tank.
5) The Influent Water Tank Flow Permissive for a tank will be re-enabled when the current tank level drops below the low level set point for that tank, the pH adjustment procedure has been completed and there is no LOW level switch alarm in that tank and the tank is in an ONLINE state.

i. Alarms: None.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm Tag	Latch	Units
	NONE ADDITIONAL			

Inputs	Description	Control Tag	Latch	Units
L0252	Influent Water Tank 201 Flow Permissive	L0252EN2	L	
L0254	Influent Water Tank 202 Flow Permissive	L0254EN2	L	
L0256	Influent Water Tank 203 Flow Permissive	L0256EN2	L	
L0258	Influent Water Tank 204 Flow Permissive	L0258EN2	L	

8. Conditioned Water Quality Permissives:

a. Loop Number: 410.

b. P&ID Drawing(s) Referenced: I-11-01, I-11-02, I-11-03, I-11-04.

c. Description:

1) Conditioned (filtered) influent water quality is measured with pH, conductivity and turbidity.

2) pH is controlled. Conductivity and turbidity are monitored.

d. Equipment Associated:

Device	Tag Root	Description
AIT-482	A0482	CONDITIONED WATER TURBIDITY A SIDE
AIT-481A	A0481A	CONDITIONED WATER pH A SIDE
AIT-481B	A0481B	CONDITIONED WATER CONDUCTIVITY A SIDE
AIT-581A	A0581A	CONDITIONED WATER pH B SIDE
AIT-581B	A0581B	CONDITIONED WATER CONDUCTIVITY B SIDE

e. System Enable (Interlocks): Conditioned Water Quality Permissives.

f. Equipment Enable per Device with Output: None.

g. I/O and Set points Associated:

1) Physical I/O:

Digital Input	Description
	NONE

Digital Output	Description
	NONE

Analog Input	Description
A0482	Conditioned water turbidity A side
A0481A	Conditioned water pH A side
A0481B	Conditioned water conductivity A side
A0581A	Conditioned water pH B side
A0581B	Conditioned water conductivity B side

Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
A0481ACSP	Conditioned Water pH Set Point A Side
A0581ACSP	Conditioned Water pH Set Point B Side
	Reference Alarm Set Points

h. Start/Stop:

1) Conditioned Water Quality Permissive A Side will be enabled when the measured pH in the A side conditioned water stream is within set point limits.
2) Conditioned Water Quality Permissive A Side will be disabled when the measured pH in the A side conditioned water stream is outside set point limits.
3) Conditioned Water Quality Permissive B Side will be enabled when the measured pH in the B side conditioned water stream is within set point limits.

4) Conditioned Water Quality Permissive B Side will be disabled when the measured pH in the B side conditioned water stream is outside set point limits.
5) Conductivity and Turbidity will be monitored and alarmed but not used for control.

i. Alarms: Analytical values.
j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.
k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm Tag	Latch	Units
A0481A	Conditioned Water pH Transducer Fail	A0481AXFA	L	
A0481A	Conditioned Water pH High Alarm	A0481AHHA		pH
A0481A	Conditioned Water pH High Warning	A0481AHA		pH
A0481A	Conditioned Water pH Low Warning	A0481ALA		pH
A0481A	Conditioned Water pH Low Alarm	A0481ALLA		pH
A0481B	Conditioned Water Conductivity Transducer Fail	A0481BXFA	L	
A0481B	Conditioned Water Conductivity High Alarm	A0481BHHA		uS
A0481B	Conditioned Water Conductivity High Warning	A0481BHA		uS
A0481B	Conditioned Water Conductivity Low Warning	A0481BLA		uS
A0481B	Conditioned Water Conductivity Low Alarm	A0481BLLA		uS
A0482	Conditioned Water Turbidity Transducer Fail	A0482XFA	L	
A0482	Conditioned Water Turbidity High Alarm	A0482HHA		NTU
A0482	Conditioned Water Turbidity High Warning	A0482HA		NTU
A0581A	Conditioned Water pH Transducer Fail	A581AXFA		
A0581A	Conditioned Water pH High Alarm	A581AHHA		pH
A0581A	Conditioned Water pH High Warning	A581AHA		pH
A0581A	Conditioned Water pH Low Warning	A581ALA		pH
A0581A	Conditioned Water pH Low Alarm	A581ALLA		pH
A0581B	Conditioned Water Conductivity Transducer Fail	A581BXFA		
A0581B	Conditioned Water Conductivity High Alarm	A581BHHA		uS

Inputs	Description	Alarm Tag	Latch	Units
A0581B	Conditioned Water Conductivity High Warning	A581BHA		uS
A0581B	Conditioned Water Conductivity Low Warning	A581BLA		uS
A0581B	Conditioned Water Conductivity Low Alarm	A581BLLA		uS

Inputs	Description	Control Tag	Latch	Units
A0481A	Conditioned Water Quality Permissive A Side	A0481AEN	L	
A0581A	Conditioned Water Quality Permissive B Side	A0581AEN	L	

9. Seal Water System Permissive:

a. Loop Number: 120.
b. P&ID Drawing(s) Referenced: I-12-05.
c. Description: The seal water system provides pressurized seal water to the filter feed and influent tank recirculation pumps.
d. Equipment Associated:

Device	Tag Root	Description
PMP-110	P0110	SEAL WATER BOOSTER PUMP
PIT-161	P0161	SEAL WATER PRESSURE TRANSMITTER

e. System Enable (Interlocks): TCS Raw Water storage tanks source permissive enabled.
f. Equipment Enable per Device with Output: No Seal Water System Fault.
g. I/O and Set points Associated:
1) Physical I/O:

Digital Input	Description
UA101F	Seal Water System Fault
YN101R	Seal Water System Running

Digital Output	Description
	NONE

Analog Input	Description
P0161	Seal Water System Pressure

Analog Output	Description
	NONE

2) Set points per General Requirements Section 2.03.A.5.p.4 and 5 (if filter supply pumps are to be operated with lead – lag function).
3) Specific Set Points:

Loop Set Point	Description
	Reference Alarm Set Points

h. Start/Stop:
   1) Seal water system will run automatically to maintain constant seal water pressure per manufacturer's design.
   2) Seal Water Permissive will be enabled if the system is running and there is no fault condition.
i. Alarms:
   1) Pump Fault.
   2) Low / High Flow.
j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.
k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
UA101F	Seal Water System Fault	P0110UAF	L	

Inputs	Description	Control Tag	Latch	Units
UA101F	Seal Water Permissive	P0110EN	L	

10. A Side Filtration System Feed Pumps Start Control:

a. Loop Number: 310.

b. P&ID Drawing(s) Referenced: I-12-01.

c. Description:

1) The filter pump(s) run water from the influent tanks through the A side filter system to the A side conditioned water storage tank farm or bypass to Cooling Tower Blow Down.

2) The system can rotate pumps or call them in a specified order.

d. Equipment Associated:

Device	Tag Root	Description
PMP-310	P0310	FILTER FEED PUMP 1 A SIDE
PMP-320	P0320	FILTER FEED PUMP 2 A SIDE
FIT-371	F0371	FILTERED WATER A SIDE FLOWMETER

e. System Enable (Interlocks):

1) Conditioned Water Storage Tank Farm A side flow permissive enabled.

2) At least one Influent Tank Farm Source permissive enabled.

3) At least one course filter and one fine filter must have differential pressure within limits.

4) Water quality permissive A side enabled.

5) Seal Water Permissive enabled.

f. Equipment Enable per Device with Output:

1) ROA in auto.

2) No pump faults.

3) No flow alarm.

4) No differential pressure alarm.

g. I/O and Set points Associated:

1) Physical I/O:

Digital Input	Description
UA310F	Filter Feed Pump 1 A Side Fault
UA320F	Filter Feed Pump 2 A Side Fault
HN310A	Filter Feed Pump 1 A Side in Auto
HN320A	Filter Feed Pump 2 A Side in Auto
YN310R	Filter Feed Pump 1 A Side Running
YN320R	Filter Feed Pump 2 A Side Running

Digital Output	Description
XC310S	Filter Feed Pump 1 A Side Start
XC320S	Filter Feed Pump 2 A Side Start

Analog Input	Description
P0310	Filter Feed Pump 1 A Side Speed Indicated
P0320	Filter Feed Pump 2 A Side Speed Indicated
F0371	Conditioned Water Flow

Analog Output	Description
P0310SC	Filter Feed Pump 1 A Side Speed Command
P0320SC	Filter Feed Pump 2 A Side Speed Command

2) Set points per General Requirements Section 2.03.A.5.p.4 and 5 (if filter supply pumps are to be operated with lead – lag function).
3) Specific Set points.

Loop Set Point	Description
P0310SC	Filter Feed Pump 1 A Side Manual Speed Command
P0320SC	Filter Feed Pump 2 A Side Manual Speed Command
	Reference Alarm Set Points

h. Start/Stop:
   1) Filter pumps will start or stop via setting given by Operator in manual mode.
   2) Filter pump(s) will start in auto mode if:
      a) Conditioned Water Storage Tank A Side Flow Permissive is enabled.
      b) At least one Influent Tank Farm Source Permissive is enabled and the associated supply valve(s) (XV-211 / XV-212, XV-221 / XV-222, XV-231 / XV-232 or XV-241 / XV-242) are open.
      c) Valves XV-311A/C or XV-321A/C are open AND valves XV-312A/C or XV322A/C are open.

d) Valve XV-411 is open and TNK-401 is permitted to receive water.
e) Valve XV-412 is open and TNK-402 is permitted to receive water.
f) No pump or filter faults.
g) Water Quality Permissive A side is enabled.

3) Filter pump(s) will stop if:
a) Valves XV-311A/C and XV-321A/C are closed OR valves XV-312A/C and XV322A/C are closed.
b) Valve XV-411 and XV-412 are closed.
c) Valves XV-211 / XV-212, XV-221 / XV-222, XV-231 / XV-232 and XV-241 / XV-242 are closed.
d) For either valve XV-411 or XV-412 that is open, the associated tank is not permitted to receive water.
e) Influent Tank Farm Source Permissive is disabled.
f) Pump fault.
g) Both coarse and / or both fine filters have a differential pressure alarm.
h) Conditioned Water Quality Permissive A side is disabled.

i. Alarms:
1) Pump Fault.
2) Low / High Flow.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
UA310F	Filter Feed Pump 1 A Side Fault	P0310UAF	L	
UA320F	Filter Feed Pump 2 A Side Fault	P0320UAF	L	
HN310A	Filter Feed Pump 1 A Side Not in Auto	P0310HNA		
HN320A	Filter Feed Pump 2 A Side Not in Auto	P0320HNA		
YN310R	Filter Feed Pump 1 A Side Fail to Start	P0310YNR	L	
YN320R	Filter Feed Pump 2 A Side Fail to Start	P0320YNR	L	
F0371	Filtered Water A Side Flow Transducer Fail	F0371XFA	L	

Inputs	Description	Alarm	Latch	Units
F0371	Filtered Water A Side High Flow Alarm	F0371HHA	L	GPM
F0371	Filtered Water A Side High Flow Warning	F0371HA		GPM
F0371	Filtered Water A Side Low Flow Warning	F0371LA		GPM
F0371	Filtered Water A Side Low Flow Alarm	F0371LLA	L	GPM

11. B Side Filtration System Feed Pump(s) Start Control:

a. Loop Number: 311.
b. P&ID Drawing(s) Referenced: I-12-02.
c. Description:
   1) The filter pump(s) run water from the influent tanks through the B side filter system to the B side conditioned water storage tank (TNK-510).
   2) The system can rotate pumps or call them in a specified order.
d. Equipment Associated:

Device	Tag Root	Description
PMP-330	P0330	FILTER FEED PUMP 1 B SIDE
PMP-340	P0340	FILTER FEED PUMP 2 B SIDE
FIT-372	F0372	FILTERED WATER B SIDE FLOWMETER

e. System Enable (Interlocks):
   1) Conditioned Water Storage Tank B side flow permissive enabled.
   2) At least one Influent Tank Farm Source permissive enabled.
   3) At least one course filter and one fine filter must have differential pressure within limits.
   4) Seal Water Permissive enabled.
f. Equipment Enable per Device with Output:
   1) ROA in auto.
   2) No pump faults.
   3) No flow alarm.
   4) No differential pressure alarm.

g. I/O and Set points Associated:

1) Physical I/O:

Digital Input	Description
UA330F	Filter Feed Pump 1 B Side Fault
UA340F	Filter Feed Pump 2 B Side Fault
HN330A	Filter Feed Pump 1 B Side in Auto
HN340A	Filter Feed Pump 2 B Side in Auto
YN330R	Filter Feed Pump 1 B Side Running
YN340R	Filter Feed Pump 2 B Side Running
Digital Output	**Description**
XC330S	Filter Feed Pump 1 B Side Start
XC340S	Filter Feed Pump 2 B Side Start
Analog Input	**Description**
P0330	Filter Feed Pump 1 B Side Speed Indicated
P0340	Filter Feed Pump 2 B Side Speed Indicated
F0372	Conditioned Water B Side Flow
Analog Output	**Description**
P0330SC	Filter Feed Pump 1 B Side Speed Command
P0340SC	Filter Feed Pump 2 B Side Speed Command

2) Set points per General Requirements Article 2.03.A.5.p.4 and 5 (if filter supply pumps are to be operated with lead – lag function).

3) Specific Set Points:

Loop Set Point	Description
P0330SC	Filter Feed Pump 1 B Side Manual Speed Command
P0340SC	Filter Feed Pump 2 B Side Manual Speed Command

Loop Set Point	Description
	Reference Alarm Set Points

h. Start/Stop:
   1) Filter pumps will start or stop via setting given by Operator in manual mode.
   2) Filter pump(s) will start in auto mode if:
      a) Conditioned Water Storage Tank B Side Flow Permissive is enabled.
      b) At least one Influent Tank Farm Source Permissive is enabled and the associated supply valve (XV-211 / XV-212, XV-221 / XV-222, XV-231 / XV-232 or XV-241 / XV-242) is open.
      c) Valves XV-331A/C or XV-341A/C are open AND valves XV-332A/C or XV342A/C are open.
      d) No pump or filter faults.
   3) Filter pump(s) will stop if:
      a) Valves XV-331A/C and XV-341A/C are closed OR valves XV-332A/C and XV342A/C are closed.
      b) Conditioned Water Storage Tank B Side Flow Permissive is disabled.
      c) Influent Tank Farm Source Permissives are disabled.
      d) Pump fault.
      e) Valves XV-211 / XV-212, XV-221 / XV-222, XV-231 / XV-232 and XV-241 / XV-242 are closed.
      f) Both coarse and / or both fine filters have a differential pressure alarm.

i. Alarms:
   1) Pump Fault.
   2) Low / High Flow.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an “L” in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
UA330F	Filter Feed Pump 1 B Side Fault	P0330UAF	L	
UA340F	Filter Feed Pump 2 B Side Fault	P0340UAF	L	
HN330A	Filter Feed Pump 1 B Side Not in Auto	P0330HNA		
HN340A	Filter Feed Pump 2 B Side Not in Auto	P0340HNA		
YN330R	Filter Feed Pump 1 B Side Fail to Start	P0330YNR	L	
YN340R	Filter Feed Pump 2 B Side Fail to Start	P0340YNR	L	
F0372	Filtered Water B Side Flow Transducer Fail	F0372XFA	L	
F0372	Filtered Water B Side High Flow Alarm	F0372HHA	L	GPM
F0372	Filtered Water B Side High Flow Warning	F0372HA		GPM
F0372	Filtered Water B Side Low Flow Warning	F0372LA		GPM
F0372	Filtered Water B Side Low Flow Alarm	F0372LLA	L	GPM

12. A Side Filter System Pneumatic Valve(s) Open/Close Control:

a. Loop Number: 312.
b. P&ID Drawing(s) Referenced: I-12-01.
c. Description:
   1) Valves control flow path of water from the filter feed pumps through the coarse and fine filters.
   2) Pneumatic acting spring return actuated valves.
   3) Valves will provide automatic switching between coarse and fine filters when high differential pressure occurs across either a coarse or fine filter.
d. Equipment Associated:

Device	Tag Root	Description
XV-311A	V0311A	COARSE FILTER 1A ISOLATION VALVE
XV-311C	V0311C	COARSE FILTER 1A ISOLATION VALVE
XV-321A	V0321A	COARSE FILTER 2A ISOLATION VALVE
XV-321C	V0321C	COARSE FILTER 2A ISOLATION VALVE
XV-312A	V0312A	FINE FILTER 1B ISOLATION VALVE
XV-312C	V0312C	FINE FILTER 1B ISOLATION VALVE
XV-322A	V0322A	FINE FILTER 2B ISOLATION VALVE
XV-322C	V0322C	FINE FILTER 2B ISOLATION VALVE

Device	Tag Root	Description
DPIT-361	DP0361	FILTER 1A DP TRANSMITTER
DPIT-362	DP0362	FILTER 1B DP TRANSMITTER
DPIT-363	DP0363	FILTER 2A DP TRANSMITTER
DPIT-364	DP0364	FILTER 2B DP TRANSMITTER

e. System Enable (Interlocks): At least one coarse filter and one fine filter must have differential pressure within limits.
f. Equipment Enable per Device with Output: ROA in auto.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
HN311AA	Filter 1A Isolation Valve in Auto
ZN311AO	Filter 1A Isolation Valve Opened
ZN311AC	Filter 1A Isolation Valve Closed
HN311CA	Filter 1A Isolation Valve in Auto
ZN311CO	Filter 1A Isolation Valve Opened
ZN311CC	Filter 1A Isolation Valve Closed
HN321AA	Filter 2A Isolation Valve in Auto
ZN321AO	Filter 2A Isolation Valve Opened
ZN321AC	Filter 2A Isolation Valve Closed
HN321CA	Filter 2A Isolation Valve in Auto
ZN321CO	Filter 2A Isolation Valve Opened
ZN321CC	Filter 2A Isolation Valve Closed
HN312AA	Filter 1B Selection Valve in Auto
ZN312AO	Filter 1B Isolation Valve in Auto
ZN312AC	Filter 1B Isolation Valve Opened
HN312CA	Filter 1B Isolation Valve Closed
ZN312CO	Filter 1B Isolation Valve in Auto
ZN312CC	Filter 1B Isolation Valve Opened
HN322AA	Filter 2B Selection Valve in Auto

Digital Input	Description
ZN322AO	Filter 2B Isolation Valve in Auto
ZN322AC	Filter 2B Isolation Valve Opened
HN322CA	Filter 2B Isolation Valve Closed
ZN322CO	Filter 2B Isolation Valve in Auto
ZN322CC	Filter 2B Isolation Valve Opened

Digital Output	Description
XC311AO	Filter 1A Selection Valve Open Command
XC311CO	Filter 1A Selection Valve Open Command
XC321AO	Filter 1B Selection Valve Open Command
XC321CO	Filter 1B Selection Valve Open Command
XC312AO	Filter 2A Selection Valve Open Command
XC312CO	Filter 2A Selection Valve Open Command
XC322AO	Filter 2B Selection Valve Open Command
XC322CO	Filter 2B Selection Valve Open Command

Analog Input	Description
DP0361	Filter 1A Differential Pressure
DP0362	Filter 1B Differential Pressure
DP0363	Filter 2A Differential Pressure
DP0364	Filter 1B Differential Pressure

Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
	Reference Alarm Set Points

h. Open/Close:

1) Valve will open or close via setting given by Operator in manual mode.

2) Filter Isolation valves will operate in pairs to either select a filter for service or isolate a filter from service.
3) When filter 1A is selected for service valves XV-311A and XV311C will be open. These valves will be closed at all other times.
4) When filter 1B is selected for service valves XV-321A and XV321C will be open. These valves will be closed at all other times.
5) When filter 2A is selected for service valves XV-312A and XV312C will be open. These valves will be closed at all other times.
6) When filter 2B is selected for service valves XV-322A and XV322C will be open. These valves will be closed at all other times.
7) A high differential pressure alarm for any filter will close the corresponding filter isolation valves and lockout the filter from use until filter is serviced. Manual reset required for lockout.
8) When a filter is locked out from service for any reason (high DP, alarm, etc.) flow will automatically be re-routed to the stand by filter either coarse or fine.

i. Alarms:
1) Filter Differential Pressure.
2) Fail to Open.
3) Fail to Close.
4) Valve Not in Auto.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
HN311AA	Filter 1A Isolation Valve Not in Auto Alarm	V0311AHNAA		
ZN311AO	Filter 1A Isolation Valve Fail to Open Alarm	V0311AZNOA	L	
ZN311AC	Filter 1A Isolation Valve Fail to Close Alarm	V0311AZNCA	L	
HN311CA	Filter 1A Isolation Valve Not in Auto Alarm	V0311CHNAA		
ZN311CO	Filter 1A Isolation Valve Fail to Open Alarm	V0311CZNOA	L	

Inputs	Description	Alarm	Latch	Units
ZN311CC	Filter 1A Isolation Valve Fail to Close Alarm	V0311CZNCA	L	
HN321AA	Filter 1B Isolation Valve Not in Auto Alarm	V0321AHNAA		
ZN321AO	Filter 1B Isolation Valve Fail to Open Alarm	V0321AZNOA	L	
ZN321AC	Filter 1B Isolation Valve Fail to Close Alarm	V0321AZNCA	L	
HN321CA	Filter 1B Isolation Valve Not in Auto Alarm	V0321CHNAA		
ZN321CO	Filter 1B Isolation Valve Fail to Open Alarm	V0321CZNOA	L	
ZN321CC	Filter 1B Isolation Valve Fail to Close Alarm	V0321CZNCA	L	
HN312AA	Filter 2A Isolation Valve Not in Auto Alarm	V0312AHNAA		
ZN312AO	Filter 2A Isolation Valve Fail to Open Alarm	V0312AZNOA	L	
ZN312AC	Filter 2A Isolation Valve Fail to Close Alarm	V0312AZNCA	L	
HN312CA	Filter 2A Isolation Valve Not in Auto Alarm	V0312CHNAA		
ZN312CO	Filter 2A Isolation Valve Fail to Open Alarm	V0312CZNOA	L	
ZN312CC	Filter 2A Isolation Valve Fail to Close Alarm	V0312CZNCA	L	
HN322AA	Filter 2B Isolation Valve Not in Auto Alarm	V0322AHNAA		
ZN322AO	Filter 2B Isolation Valve Fail to Open Alarm	V0322AZNOA	L	
ZN322AC	Filter 2B Isolation Valve Fail to Close Alarm	V0322AZNCA	L	
HN322CA	Filter 2B Isolation Valve Not in Auto Alarm	V0322CHNAA		
ZN322CO	Filter 2B Isolation Valve Fail to Open Alarm	V0322CZNOA	L	
ZN322CC	Filter 2B Isolation Valve Fail to Close Alarm	V0322CZNCA	L	
DP0361	PIT-361 Differential Pressure Transducer Fail	DP0361XFA		
DP0361	PIT-361 High Differential Pressure Alarm	DP0361HHA	L	PSI
DP0361	PIT-361 High Differential Pressure Warning	DP0361HA		PSI
DP0361	PIT-361 Low Differential Pressure Warning	DP0361LA		PSI
DP0361	PIT-361 Low Differential Pressure Alarm	DP0361LLA	L	PSI
DP0362	PIT-362 Differential Pressure Transducer Fail	DP0362XFA		
DP0362	PIT-362 High Differential Pressure Alarm	DP0362HHA	L	PSI
DP0362	PIT-362 High Differential Pressure Warning	DP0362HA		PSI
DP0362	PIT-362 Low Differential Pressure Warning	DP0362LA		PSI
DP0362	PIT-362 Low Differential Pressure Alarm	DP0362LLA	L	PSI
DP0363	PIT-363Differential Pressure Transducer Fail	DP0363XFA		
DP0363	PIT-363 High Differential Pressure Alarm	DP0363HHA	L	PSI

Inputs	Description	Alarm	Latch	Units
DP0363	PIT-363 High Differential Pressure Warning	DP0363HA		PSI
DP0363	PIT-363 Low Differential Pressure Warning	DP0363LA		PSI
DP0363	PIT-363 Low Differential Pressure Alarm	DP0363LLA	L	PSI
DP0364	PIT-364 Differential Pressure Transducer Fail	DP0364XFA		
DP0364	PIT-364 High Differential Pressure Alarm	DP0364HHA	L	PSI
DP0364	PIT-364 High Differential Pressure Warning	DP0364HA		PSI
DP0364	PIT-364 Low Differential Pressure Warning	DP0364LA		PSI
DP0364	PIT-364 Low Differential Pressure Alarm	DP0364LLA	L	PSI

13. B Side Filter System Pneumatic Valve(s) Open/Close Control:

a. Loop Number: 313.
b. P&ID Drawing(s) Referenced: I-12-02.
c. Description:
   1) Valves control flow path of water from the filter feed pumps through the coarse and fine filters.
   2) Pneumatic acting spring return actuated valves.
   3) Valves will provide automatic switching between coarse and fine filters when high differential pressure occurs across either a coarse or fine filter.
d. Equipment Associated:

Device	Tag Root	Description
XV-331A	V0331A	COARSE FILTER 1A ISOLATION VALVE
XV-331C	V0331C	COARSE FILTER 1A ISOLATION VALVE
XV-341A	V0341A	COARSE FILTER 2A ISOLATION VALVE
XV-341C	V0341C	COARSE FILTER 2A ISOLATION VALVE
XV-332A	V0332A	FINE FILTER 1B ISOLATION VALVE
XV-332C	V0332C	FINE FILTER 1B ISOLATION VALVE
XV-342A	V0342A	FINE FILTER 2B ISOLATION VALVE
XV-342C	V0342C	FINE FILTER 2B ISOLATION VALVE
DPIT-365	DP0365	FILTER 1A DP TRANSMITTER
DPIT-366	DP0366	FILTER 1B DP TRANSMITTER
DPIT-367	DP0367	FILTER 2A DP TRANSMITTER

Device	Tag Root	Description
DPIT-368	DP0368	FILTER 2B DP TRANSMITTER

e. System Enable (Interlocks): At least one coarse filter and one fine filter must have differential pressure within limits.
f. Equipment Enable per Device with Output: ROA in auto.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
HN331AA	Filter 1A Isolation Valve in Auto
ZN331AO	Filter 1A Isolation Valve Opened
ZN331AC	Filter 1A Isolation Valve Closed
HN331CA	Filter 1A Isolation Valve in Auto
ZN331CO	Filter 1A Isolation Valve Opened
ZN331CC	Filter 1A Isolation Valve Closed
HN341AA	Filter 2A Isolation Valve in Auto
ZN341AO	Filter 2A Isolation Valve Opened
ZN341AC	Filter 2A Isolation Valve Closed
HN341CA	Filter 2A Isolation Valve in Auto
ZN341CO	Filter 2A Isolation Valve Opened
ZN341CC	Filter 2A Isolation Valve Closed
HN332AA	Filter 1B Selection Valve in Auto
ZN332AO	Filter 1B Isolation Valve in Auto
ZN332AC	Filter 1B Isolation Valve Opened
HN332CA	Filter 1B Isolation Valve Closed
ZN332CO	Filter 1B Isolation Valve in Auto
ZN332CC	Filter 1B Isolation Valve Opened
HN342AA	Filter 2B Selection Valve in Auto
ZN342AO	Filter 2B Isolation Valve in Auto
ZN342AC	Filter 2B Isolation Valve Opened
HN342CA	Filter 2B Isolation Valve Closed

Digital Input	Description
ZN342CO	Filter 2B Isolation Valve in Auto
ZN342CC	Filter 2B Isolation Valve Opened
Digital Output	**Description**
XC331AO	Filter 1A Selection Valve Open Command
XC331CO	Filter 1A Selection Valve Open Command
XC341AO	Filter 1B Selection Valve Open Command
XC341CO	Filter 1B Selection Valve Open Command
XC332AO	Filter 2A Selection Valve Open Command
XC332CO	Filter 2A Selection Valve Open Command
XC342AO	Filter 2B Selection Valve Open Command
XC342CO	Filter 2B Selection Valve Open Command
Analog Input	**Description**
DP0365	Filter 1A Differential Pressure
DP0366	Filter 1B Differential Pressure
DP0367	Filter 2A Differential Pressure
DP0368	Filter 1B Differential Pressure
Analog Output	**Description**
	NONE

2) Specific Set Points:

Loop Set Point	Description
	Reference Alarm Set Points

h. Open/Close:
   1) Valve will open or close via setting given by Operator in manual mode.
   2) Filter Isolation valves will operate in pairs to either select a filter for service or isolate a filter from service.
   3) When filter 1A is selected for service valves XV-331A and XV331C will be open. These valves will be closed at all other times.

4) When filter 1B is selected for service valves XV-341A and XV341C will be open. These valves will be closed at all other times.
5) When filter 2A is selected for service valves XV-332A and XV332C will be open. These valves will be closed at all other times.
6) When filter 2B is selected for service valves XV-342A and XV342C will be open. These valves will be closed at all other times.
7) A high differential pressure alarm for any filter will close the corresponding filter isolation valves and lockout the filter from use until filter is serviced. Manual reset required for lockout.
8) When a filter is locked out from service for any reason (high DP, alarm, etc.) flow will automatically be re-routed to the stand by filter either coarse or fine.

i. Alarms:
1) Filter Differential Pressure.
2) Fail to Open.
3) Fail to Close.
4) Valve Not in Auto.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
HN331AA	Filter 1A Isolation Valve Not in Auto Alarm	V0331AHNAA		
ZN331AO	Filter 1A Isolation Valve Fail to Open Alarm	V0331AZNOA	L	
ZN331AC	Filter 1A Isolation Valve Fail to Close Alarm	V0331AZNCA	L	
HN331CA	Filter 1A Isolation Valve Not in Auto Alarm	V0331CHNAA		
ZN331CO	Filter 1A Isolation Valve Fail to Open Alarm	V0331CZNOA	L	
ZN331CC	Filter 1A Isolation Valve Fail to Close Alarm	V0331CZNCA	L	
HN341AA	Filter 1B Isolation Valve Not in Auto Alarm	V0341AHNAA		
ZN341AO	Filter 1B Isolation Valve Fail to Open Alarm	V0341AZNOA	L	

Inputs	Description	Alarm	Latch	Units
ZN341AC	Filter 1B Isolation Valve Fail to Close Alarm	V0341AZNCA	L	
HN341CA	Filter 1B Isolation Valve Not in Auto Alarm	V0341CHNAA		
ZN341CO	Filter 1B Isolation Valve Fail to Open Alarm	V0341CZNOA	L	
ZN321CC	Filter 1B Isolation Valve Fail to Close Alarm	V0341CZNCA	L	
HN332AA	Filter 2A Isolation Valve Not in Auto Alarm	V0332AHNAA		
ZN332AO	Filter 2A Isolation Valve Fail to Open Alarm	V0332AZNOA	L	
ZN332AC	Filter 2A Isolation Valve Fail to Close Alarm	V0332AZNCA	L	
HN332CA	Filter 2A Isolation Valve Not in Auto Alarm	V0332CHNAA		
ZN332CO	Filter 2A Isolation Valve Fail to Open Alarm	V0332CZNOA	L	
ZN332CC	Filter 2A Isolation Valve Fail to Close Alarm	V0332CZNCA	L	
HN342AA	Filter 2B Isolation Valve Not in Auto Alarm	V0342AHNAA		
ZN342AO	Filter 2B Isolation Valve Fail to Open Alarm	V0342AZNOA	L	
ZN342AC	Filter 2B Isolation Valve Fail to Close Alarm	V0342AZNCA	L	
HN342CA	Filter 2B Isolation Valve Not in Auto Alarm	V0342CHNAA		
ZN342CO	Filter 2B Isolation Valve Fail to Open Alarm	V0342CZNOA	L	
ZN342CC	Filter 2B Isolation Valve Fail to Close Alarm	V0342CZNCA	L	
DP0365	PIT-365 Differential Pressure Transducer Fail	DP0365XFA		
DP0365	PIT-365 High Differential Pressure Alarm	DP0365HHA	L	PSI
DP0365	PIT-365 High Differential Pressure Warning	DP0365HA		PSI
DP0365	PIT-365 Low Differential Pressure Warning	DP0365LA		PSI
DP0365	PIT-365 Low Differential Pressure Alarm	DP0365LLA	L	PSI
DP0366	PIT-366 Differential Pressure Transducer Fail	DP0366XFA		
DP0366	PIT-366 High Differential Pressure Alarm	DP0366HHA	L	PSI
DP0366	PIT-366 High Differential Pressure Warning	DP0366HA		PSI
DP0366	PIT-366 Low Differential Pressure Warning	DP0366LA		PSI
DP0366	PIT-366 Low Differential Pressure Alarm	DP0366LLA	L	PSI
DP0367	PIT-367Differential Pressure Transducer Fail	DP0367XFA		
DP0367	PIT-367 High Differential Pressure Alarm	DP0367HHA	L	PSI
DP0367	PIT-367 High Differential Pressure Warning	DP0367HA		PSI
DP0367	PIT-367 Low Differential Pressure Warning	DP0367LA		PSI
DP0367	PIT-367 Low Differential Pressure Alarm	DP0367LLA	L	PSI

Inputs	Description	Alarm	Latch	Units
DP0368	PIT-368 Differential Pressure Transducer Fail	DP0368XFA		
DP0368	PIT-368 High Differential Pressure Alarm	DP0368HHA	L	PSI
DP0368	PIT-368 High Differential Pressure Warning	DP0368HA		PSI
DP0368	PIT-368 Low Differential Pressure Warning	DP0368LA		PSI
DP0368	PIT-368 Low Differential Pressure Alarm	DP0368LLA	L	PSI

14. A Side Conditioned Water Transfer Pump(s) Start Control:

a. Loop Number: 411.

b. P&ID Drawing(s) Referenced: I-14-01.

c. Description:

1) The transfer pump(s) pump from the A Side Conditioned Water Storage Tanks to the conditioned water frac tank TNK-720 (primary destination) or the secondary destinations (TCS Wastewater Tank and Conditioned Water Storage Tank TNK-510).

2) The system can rotate pumps or call them in a specified order.

d. Equipment Associated:

Device	Tag Root	Description
PMP-405	P0405	CONDITIONED WATER TRANSFER PUMP 2
PMP-406	P0406	CONDITIONED WATER TRANSFER PUMP 1
LSH-459	LS459H	SECONDARY SUMP LEVEL SWITCH
FIT-471	F0471	CONDITIONED WATER FLOWMETER

e. System Enable (Interlocks): Outlet valves XV-415 and XV-416 are open.

f. Equipment Enable per Device with Output:

1) ROA in auto.

2) Conditioned Water Storage Tank A Side Source Permissive enabled.

3) Conditioned Water Storage Tank B Side Flow Permissive enabled and XV-416 is open.

4) Conditioned Water Frac Tank Flow Permissive enabled, XV-416 and XV-514 are open.

5) No pump faults.

6) No flow alarms.

g. I/O and Set points Associated:

1) Physical I/O:

Digital Input	Description
UA405F	Conditioned Water Transfer Pump 1 Fault
UA406F	Conditioned Water Transfer Pump 2 Fault
HN405A	Conditioned Water Transfer Pump 1 in Auto
HN406A	Conditioned Water Transfer Pump 2 in Auto
YN405R	Conditioned Water Transfer Pump 1 Running
YN406R	Conditioned Water Transfer Pump 2 Running
LA459H	Secondary Sump Level Switch

Digital Output	Description
XC330S	Conditioned Water Transfer Pump 1 Start
XC340S	Conditioned Water Transfer Pump 2 Start

Analog Input	Description
F0471	Conditioned Water Flow

Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
	Reference Alarm Set Points

h. Start/Stop:

1) Pumps will start or stop via setting given by Operator in manual mode.
2) Transfer pump(s) will start in auto mode if:
   a) Conditioned Water Storage Tank A Side Source Permissive is enabled and b, c or d (below) are true.
   b) Conditioned Water Storage Tank B Side Flow Permissive is enabled and XV-416 is open.

c) Conditioned Water Frac Tank Flow Permissive is enabled and XV-416 is open.
d) TCS Wastewater Tank Flow Permissive is enabled and XV-415 is open.

3) Transfer pump(s) will stop if:
a) Conditioned Water Storage Tank A Side Source Permissive is disabled.
b) Conditioned Water Storage Tank B Side Flow Permissive, Conditioned Water Frac Tank Flow Permissive and TCS Wastewater Tank Flow Permissive are disabled.
c) XV-415 and XV-416 are closed.
d) Pump Fault.

4) Conditioned Water Frac Tank Flow Permissive will be generated by controller operating the Frac Tank.
5) Transfer pumps will be operated with selection for auto-rotation or manual selection of lead pump.

i. Alarms:
1) Pump Fault.
2) High / Low Flow.
3) Secondary Containment Level.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
UA405F	PMP-405 Pump Fault	P405UAF	L	
UA406F	PMP-406 Pump Fault	P406UAF	L	
HN405A	PMP-405 Pump Not in Auto	P405HNA		
HN406A	PMP-406 Pump Not in Auto	P406HNA		
YN405R	PMP-405 Pump Fail to Start	P405YNR	L	
YN406R	PMP-406 Pump Fail to Start	P406YNR	L	
F0471	FIT-471 Flow Transducer Fail	F471XFA	L	
F0471	FIT-471 High Flow Alarm	F471HHA	L	GPM

Inputs	Description	Alarm	Latch	Units
F0471	FIT-471 High Flow Warning	F471HA		GPM
F0471	FIT-471 Low Flow Warning	F471LA		GPM
F0471	FIT-471 Low Flow Alarm	F471LLA	L	GPM
LS459H	LSH-459 High Level Alarm	LS459HA		

15. A Side Conditioned Water Storage And Distribution Pneumatic Valve(s) Open/Close Control:

a. Loop Number: 412.
b. P&ID Drawing(s) Referenced: I-14-01.
c. Description:
   1) Valves controlling storage and delivery of A Side conditioned water.
   2) Pneumatic cylinder double acting actuated valve.
d. Equipment Associated:

Device	Tag Root	Description
XV-411	V0411	CONDITIONED WATER STORAGE TANK 1 FILL VALVE
XV-412	V0412	CONDITIONED WATER STORAGE TANK 2 FILL VALVE
XV-415	V0415	CONDITIONED WATER TO B SIDE VALVE
XV-416	V0416	CONDITIONED WATER TO TCS WASTEWATER TANK VALVE

e. System Enable (Interlocks): None.
f. Equipment Enable per Device with Output:
   1) ROA in auto.
   2) Conditioned Water Storage Tank B Side Flow permissive.
   3) Conditioned Water Frac Tank Flow Permissive (from Frac Tank Controller).
   4) TCS Wastewater Tank Flow Permissive.

g. I/O and Set points Associated:

1) Physical I/O:

Digital Input	Description
HN411A	Conditioned Water Storage Tank 1 Fill Valve in Auto
ZN411O	Conditioned Water Storage Tank 1 Fill Valve Opened
ZN411C	Conditioned Water Storage Tank 1 Fill Valve Closed
HN412A	Conditioned Water Storage Tank 2 Fill Valve in Auto
ZN412O	Conditioned Water Storage Tank 2 Fill Valve Opened
ZN412C	Conditioned Water Storage Tank 2 Fill Valve Closed
HN415A	Conditioned Water to Side B Valve in Auto
ZN415O	Conditioned Water to Side B Valve Opened
ZN415C	Conditioned Water to Side B Valve Closed
HN416A	Conditioned Water to TCS Waste Tank Valve in Auto
ZN416O	Conditioned Water to TCS Waste Tank Valve Opened
ZN416C	Conditioned Water to TCS Waste Tank Valve Closed
Digital Output	**Description**
XC411O	Conditioned Water Storage Tank 1 Fill Valve Open Command
XC412O	Conditioned Water Storage Tank 2 Fill Valve Open Command
XC415O	Conditioned Water Water to Side B Valve Open Command
XC416O	Conditioned Water Water to TCS Waste Tank Valve Open Command

Analog Input	Description
	NONE

Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
	Reference Alarm Set Points

h. Start/Stop:
   1) Valve will open or close via setting given by Operator when in manual mode.
   2) XV-411 and XV-412 will open when their associated conditioned water storage tank (TNK-401 and TNK-402) is below Operational Level Set Point (L0452CSP1 and L0454CSP1).
   3) XV-411 and XV-412 will close when their associated conditioned water storage tank level is at or above operational level set point (L0452CSP1 and L0454CSP1).
   4) XV-415 will open when there is a request to pump to the TCS wastewater tank. XV-415 will close when this request is not present or the TCS wastewater tank meets set point full level.
   5) XV-416 will open when there is a request to pump conditioned water to the B side storage tank (TNK-510) or for general use on the B side. XV-416 will close when this request is not present.

i. Alarms: Open / Close Fail.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an “L” in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
HN411A	TNK-401 Tank Fill Valve Not in Auto Alarm	V0411HNAA		
ZN411O	TNK-401 Tank Fill Valve Fail to Open Alarm	V0411ZNOA	L	
ZN411C	TNK-401 Tank Fill Valve Fail to Close Alarm	V0411ZNCA	L	
HN412A	TNK-402 Tank Fill Valve Not in Auto Alarm	V0412HNAA		
ZN412O	TNK-402 Tank Fill Valve Fail to Open Alarm	V0412ZNOA	L	
ZN412C	TNK-402 Tank Fill Valve Fail to Close Alarm	V0412ZNCA	L	
HN415A	TCS Waste Select Valve Not in Auto Alarm	V0415HNAA		
ZN415O	TCS Waste Select Valve Fail to Open Alarm	V0415ZNOA	L	
ZN415C	TCS Waste Select Valve Fail to Close Alarm	V0415ZNCA	L	
HN416A	B Side Select Valve Not in Auto Alarm	V0416HNAA		
ZN416O	B Side Select Valve Fail to Open Alarm	V0416ZNOA	L	
ZN416C	B Side Select Valve Fail to Close Alarm	V0416ZNCA	L	

16. TCS Truck Fill Pump Start Control:

a. Loop Number: 510.
b. P&ID Drawing(s) Referenced: I-14-02.
c. Description: The truck fill pump will pump up to the TCS truck tanker based on set point control or hand operation.
d. Equipment Associated:

Device	Tag Root	Description
PMP-501	P0501	TCS TRUCK FILL PUMP
LSH-555	LS0555H	TCS TRUCK FILL SUMP HIGH LEVEL SWITCH
LSH-554	LS0554H	TCS TRUCK TANKER HIGH LEVEL SWITCH
HCS-502	H0502S	FILL TCS TRUCK TANKER START SWITCH
HCP-502	H0502P	FILL TCS TRUCK TANKER STOP SWITCH

e. System Enable (Interlocks):
   1) TCS Fill Station (HCS-502) must give command to start.
   2) Conditioned Water Storage Tank B side Flow Permissive.
f. Equipment Enable per Device with Output:
   1) ROA in auto.
   2) No fail alarms.
   3) No level alarms.

g. I/O and Set Points Associated:

1) Physical I/O:

Digital Input	Description
LS0555H	TCS Truck Fill Sump High Level
LS0554H	TCS Truck Tanker High Level
H0502S	Fill TCS Truck Tanker Start Switch
H0502P	Fill TCS Truck Tanker Stop Switch
UA501F	TCS Truck Fill Pump Fault
HN501A	TCS Truck Fill Pump in Auto
YN501R	TCS Truck Fill Pump Running

Digital Output	Description
XC0501S	TCS Truck Fill Pump Start Command

Analog Input	Description
	NONE

Analog Output	Description
	NONE

h. Specific Set Points:

Loop Set Point	Description
L0552VSP	Desired Volume for TCS Truck Transfer SP
	Reference Alarm Set Points

i. Start/Stop:

1) TCS Truck Fill pump will start when given the start command by the TCS Fill Station from HCS-502 if the Conditioned Water Storage Tank Side B Source Permissive is enabled.
2) TCS Truck Fill pump will stop if stop command is given by TCS Fill Station from HCP-502, high level set point is reached on the truck tanker, Conditioned Water Storage Tank Side B Source Permissive is disabled, the requested set point volume has been transferred from TNK-510 to the truck tanker, or the secondary sump level switch detects high level.

j. Alarms:
   1) Pump fault.
   2) High level in tanker.
   3) Low level in conditioned water tank.
   4) Secondary containment sump liquid level high.
   5) The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.
   6) All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
UA501F	PMP-501 Pump Fault	P0501UAF	L	
HN501A	PMP-501 Pump Not in Auto	P0501NA		
YN501R	PMP-501 Pump Fail to Start	P0501YNR	L	
LSH554	TCS Truck Tanker Level Switch High Alarm	LS0554HA		
LSH555	Secondary Sump Level Switch High Alarm	LS0555HA		

17. Caustic Feed Pump Start Control (Influent Tanks):

a. Loop Number: 910.
b. P&ID Drawing(s) Referenced: I-12-03.
c. Description: Caustic Feed Pump Transfers Caustic from the bulk caustic tank to the Influent Water Tanks.
d. Equipment Associated:

Device	Tag Root	Description
PMP-911	P0911	CAUSTIC FEED PUMP 1
LIT-951	L0951	CAUSTIC STORAGE TANK LEVEL TRANSMITTER

e. System Enable (Interlocks):
   1) Caustic Tank Source Permissive.
   2) Caustic Flow Request for Influent Water Permissive.
f. Equipment Enable per Device with Output: ROA in auto.

g. I/O and Set points Associated:

1) Physical I/O:

Digital Input	Description
	NONE

Digital Output	Description
XC0911S	Caustic Feed Pump 1 Start Command

Analog Input	Description
L0951	Caustic Storage Tank Level

Analog Output	Description
P0911SC	Caustic Feed Pump 1 Speed Command

2) Specific Set Points:

Loop Set Point	Description
P0911CSP	Caustic Feed Pump 1 Manual Speed Command
L0951CSP	Caustic Storage Tank Operating Level

h. Start/Stop:

1) Caustic Feed pump will start or stop via setting given by Operator in manual mode.
2) Caustic pump will start if Caustic Tank Source Permissive is enabled and Caustic Flow Request for Influent Water is enabled.
3) Caustic Feed pump(s) will stop if Caustic Tank Source Permissive is disabled or Caustic Flow Request for Influent Water is disabled.
4) Caustic Feed pump will run at requested Caustic Feed Pump Speed.
5) Caustic Tank Source Permissive will be enabled if the Caustic Storage Tank level is above the Caustic Storage Tank low level lockout set point.
6) Caustic Tank Source Permissive will be disabled if the Caustic Storage Tank level drops below the Caustic Storage Tank low level lockout set point.

i. Alarms: Caustic tank level.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.
k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
L0951	TNK-910 Level Transducer Fail	L0951XFA		
L0951	TNK-910 High Level Alarm	L0951HAH		Feet
L0951	TNK-910 High Level Warning	L0951HA		Feet
L0951	TNK-910 Low Level Warning	L0951LA		Feet
L0951	TNK-910 Low Level Alarm	L0951LAL		Feet

18. Caustic Feed Pump Start Control (Conditioned Water Storage Tanks):

a. Loop Number: 911.
b. P&ID Drawing(s) Referenced: I-12-03.
c. Description: Caustic Feed Pump Transfers Caustic from the bulk caustic tank to the A side Conditioned Water Storage Tanks.
d. Equipment Associated: Reference LIT-951 caustic tank level transmitter (CAUSTIC FEED PUMP START CONTROL INFLUENT TANKS).

Device	Tag Root	Description
PMP-912	P0912	CAUSTIC FEED PUMP 2

e. System Enable (Interlocks):
   1) Caustic Tank Source Permissive.
   2) Caustic Flow Request from Conditioned Water Permissive.
f. Equipment Enable per Device with Output: ROA in Auto.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
	NONE

Digital Output	Description
XC0912S	Caustic Feed Pump 2 Start Command

Analog Input	Description
L0951	Caustic Supply Tank Level

Analog Output	Description
P0912SC	Caustic Feed Pump 2 Speed Command

2) Specific Set Points:

Loop Set Point	Description
P912SC	Caustic Feed Pump 2 Manual Speed Command

h. Start/Stop:
   1) Caustic Feed Pump will start or stop via setting given by Operator in manual mode.
   2) Caustic pump will start if Caustic Tank Source Permissive is enabled and Caustic Flow Request from Conditioned Water is enabled.
   3) Caustic Feed pump will stop if Caustic Tank Source Permissive is disabled or Caustic Flow Request from Conditioned Water is disabled.
   4) Caustic Feed pump will run at requested Caustic Feed Pump Speed.

i. Alarms: Reference caustic tank level alarms (CAUSTIC FEED PUMP START CONTROL INFLUENT TANKS).

19. Acid Feed Pump Start Control (Influent Tanks):

a. Loop Number: 912.
b. P&ID Drawing(s) Referenced: I-12-04.
c. Description: Acid Feed Pump transfers acid from the bulk acid tank to the Influent Water Tanks.
d. Equipment Associated:
   1) Reference influent tanks analytical instrumentation (ACID AND CAUSTIC FEED REQUEST PERMISSIVES).

Device	Tag Root	Description
PMP-931	P0931	ACID FEED PUMP 1
LIT-953	L0953	ACID STORAGE TANK LEVEL TRANSMITTER

e. System Enable (Interlocks):
   1) Acid Tank Source Permissive.
   2) Acid Flow Request for Influent Water Permissive.

f. Equipment Enable per Device with Output: ROA in auto.

g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
	NONE

Digital Output	Description
XC0931S	Acid Feed Pump 1 Start Command

Analog Input	Description
L0953	Acid Storage Tank Level

Analog Output	Description
P0931SC	Acid Feed Pump 1 Speed Command

   2) Specific Set Points:

Loop Set Point	Description
P0931CSP	Acid Feed Pump 1 Manual Speed Command
L0953CSP	TNK-930 Operating Level

h. Start/Stop:
   1) Acid Feed Pump will start or stop via setting given by Operator in manual mode.
   2) Acid pump will start if Acid Tank Source Permissive is enabled and Acid Flow Request for Influent Water is enabled.
   3) Acid Feed pump(s) will stop if Acid Tank Source Permissive is disabled or Acid Flow Request for Influent Water is disabled.

4) Acid Feed pump will run at requested Acid Feed Pump Speed.
5) Acid Tank Source Permissive will be enabled if the Acid Storage Tank level is above the Acid Storage Tank low level lockout set point.
6) Acid Tank Source Permissive will be disabled if the Acid Storage Tank level drops below the Acid Storage Tank low level lockout set point.

i. Alarms:
1) Acid storage tank level.
2) Reference influent tank water analytical instrument alarms (ACID AND CAUSTIC FEED REQUEST PERMISSIVES).

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLA, LA, HA, HHA, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
L0953	TNK-930 Level Transducer Fail	L0953XFA	L	
L0953	TNK-930 High Level Alarm	L0953HHA	L	Feet
L0953	TNK-930 High Level Warning	L0953HA		Feet
L0953	TNK-930 Low Level Warning	L0953LA		Feet
L0953	TNK-930 Low Level Alarm	L0953LLA	L	Feet

20. Acid Feed Pump Start Control (Conditioned Water Storage Tanks):

a. Loop Number: 913.
b. P&ID Drawing(s) Referenced: I-12-04.
c. Description: Acid Feed Pump transfers acid from the bulk acid tank to the A side Conditioned water flow stream.

d. Equipment Associated: Reference LIT-953 acid tank level transmitter (ACID FEED PUMP(S) START CONTROL (INFLUENT TANKS):

Device	Tag Root	Description
PMP-932	P0932	ACID FEED PUMP 2

e. System Enable (Interlocks):
   1) Acid Tank Source Permissive.
   2) Acid Flow Request for Conditioned Water Permissive.

f. Equipment Enable per Device with Output: ROA in Auto.

g. I/O and Set Points Associated:
   1) Physical I/O:

Digital Input	Description
	NONE

Digital Output	Description
XC0932S	Acid Feed Pump 2 Start Command

Analog Input	Description
L0951	Acid Supply Tank Level

Analog Output	Description
P0932SC	Acid Feed Pump 2 Speed Command

   2) Specific Set Points:

Loop Set Point	Description
P0932CSP	Acid Feed Pump 2 Manual Speed Command

h. Start/Stop:
   1) Acid Feed Pump will start or stop via setting given by Operator in manual mode.
   2) Acid pump will start if Acid Tank Source Permissive is enabled and Acid Flow Request for Conditioned Water is enabled.
   3) Acid Feed pump will stop if Acid Tank Source Permissive is disabled or Acid Flow Request for Conditioned Water is disabled.

4) Acid Feed pump will run at requested Acid Feed Pump Speed.

i. Alarms: Reference acid tank level alarms (ACID FEED PUMP(S) START CONTROL INFLUENT TANKS).

21. Acid, Caustic and Coagulant Feed Request Permissives:

a. Loop Number: 914.

b. P&ID Drawing(s) Referenced: I-12-03.

c. Description: Acid, Caustic and Coagulant Feed Requests will be generated for the Influent Water Tanks and the Conditioned Water Flow Stream A Side.

d. Equipment Associated:

1) Reference AIT-481A pH Transmitter, AIT-481B Conductivity Transmitter and AIT-482 Turbidity Transmitter for the A Side Conditioned Water Stream (CONDITIONED WATER QUALITY PERMISSIVES).

2) Reference LIT-252 Level Transmitter, LIT-254 Level Transmitter, LIT-256 Level Transmitter and LIT-258 Level Transmitter for the Influent Water Storage Tanks (INFLUENT WATER STORAGE TANK FARM SOURCE PERMISSIVES).

Device	Tag Root	Description
AIT-281A	A0281A	INFLUENT TANK 1 pH TRANSMITTER
AIT-281B	A0281B	INFLUENT TANK 1 CONDUCTIVITY TRANSMITTER
AIT-282	A0282	INFLUENT TANK 1 TURBIDITY TRANSMITTER
AIT-283A	A0283A	INFLUENT TANK 2 pH TRANSMITTER
AIT-283B	A0283B	INFLUENT TANK 2 CONDUCTIVITY TRANSMITTER
AIT-284	A0284	INFLUENT TANK 2 TURBIDITY TRANSMITTER
AIT-285A	A0285A	INFLUENT TANK 3 pH TRANSMITTER
AIT-285B	A0285B	INFLUENT TANK 3 CONDUCTIVITY TRANSMITTER
AIT-286	A0286	INFLUENT TANK 3 TURBIDITY TRANSMITTER
AIT-287A	A0287A	INFLUENT TANK 4 pH TRANSMITTER
AIT-287B	A0287B	INFLUENT TANK 4 CONDUCTIVITY TRANSMITTER
AIT-288	A0288	INFLUENT TANK 4 TURBIDITY TRANSMITTER

e. System Enable (Interlocks):
   1) Caustic Storage Tank level above low set point.
   2) Acid Storage Tank level above low level set point.

f. Equipment Enable per Device with Output:
   1) Caustic Flow Request for Influent Water enabled.
   2) Acid Flow Request for Influent Water enabled.
   3) Caustic Flow Request for Conditioned Water enabled.
   4) Acid Flow Request for Conditioned Water enabled.

g. I/O and Set Points Associated:
   1) Physical I/O:

Digital Input	Description
	NONE

Digital Output	Description
	NONE

Analog Input	Description
L0252	Influent Tank 1 Level
L0254	Influent Tank 2 Level
L0256	Influent Tank 3 Level
L0258	Influent Tank 4 Level
A0481A	Conditioned Water A Side pH
A0481B	Conditioned Water A Side Conductivity
A0482	Conditioned Water A Side Turbidity
A0281A	Influent Tank 1 pH
A0281B	Influent Tank 1 Conductivity
A0282	Influent Tank 1 Turbidity
A0283A	Influent Tank 2 pH
A0283B	Influent Tank 2Conductivity
A0284	Influent Tank 2 Turbidity
A0285A	Influent Tank 3 pH
A0285B	Influent Tank 3 Conductivity
A0286	Influent Tank 3 Turbidity
A0287A	Influent Tank 4 pH

A0287B	Influent Tank 4 Conductivity
A0288	Influent Tank 4 Turbidity

Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
A0281ADSP1	Pre-Treatment Delay Time Influent Tank 1
A0283ADSP1	Pre-Treatment Delay Time Influent Tank 2
A0285ADSP1	Pre-Treatment Delay Time Influent Tank 3
A0287ADSP1	Pre-Treatment Delay Time Influent Tank 4
A0281ADSP2	Chemical Dosing Time Influent Tank 1
A0283ADSP2	Chemical Dosing Time Influent Tank 2
A0285ADSP2	Chemical Dosing Time Influent Tank 3
A0287ADSP2	Chemical Dosing Time Influent Tank 4
A0281ADSP3	Post-Treatment Delay Time Influent Tank 1
A0283ADSP3	Post-Treatment Delay Time Influent Tank 2
A0285ADSP3	Post-Treatment Delay Time Influent Tank 3
A0287ADSP3	Post-Treatment Delay Time Influent Tank 4
L0252CSP3	Target Water Level to pH Adjust Influent Tank 1
L0254CSP3	Target Water Level to pH Adjust Influent Tank 2
L0256CSP3	Target Water Level to pH Adjust Influent Tank 3
L0258CSP3	Target Water Level to pH Adjust Influent Tank 4
A0281ACSP1	Target pH Level for Influent Tank 1
A0283ACSP1	Target pH Level for Influent Tank 2
A0285ACSP1	Target pH Level for Influent Tank 3
A0287ACSP1	Target pH Level for Influent Tank 4
A0481ACSP1	Target pH Level for Conditioned Water
A0281ACSP2	Stop pH Level for Caustic In Influent Tank 1
A0283ACSP2	Stop pH Level for Caustic In Influent Tank 2

Loop Set Point	Description
A0285ACSP2	Stop pH Level for Caustic In Influent Tank 3
A0287ACSP2	Stop pH Level for Caustic In Influent Tank 4
A0481ACSP2	Stop pH Level for Caustic In Conditioned Water
A0281ACSP3	Stop pH Level for Acid In Influent Tank 1
A0283ACSP3	Stop pH Level for Acid In Influent Tank 2
A0285ACSP3	Stop pH Level for Acid In Influent Tank 3
A0287ACSP3	Stop pH Level for Acid In Influent Tank 4
A0481ACSP3	Stop pH Level for Acid In Conditioned Water
A0280CSP1	Desired Coagulant Concentration Set Point (ppm)

h. Start/Stop:
   1) Influent Tanks will be chemically adjusted individually in a batch mode basis based on an adjustment recipe.
   2) When an influent tank is placed in TREATMENT state the pH adjustment procedure will start.
   3) pH adjustment for Influent Water will be performed as follows:
      a) Tank will be placed in TREATMENT state either manually by an Operator or automatically by tank fill level meeting Target Water Level to pH Adjust set point.
      b) Influent Tank Recirculation Pump will recirculate the tank water for a set amount of time. This is the pre-treatment recirculation period.
      c) pH value will be measured when the pre-treatment recirculation period completes.
      d) Total water volume in the Influent Tank will be computed based on the current value of the tank level.
      e) If the pH is above the Stop pH Level for Caustic in Influent Tank, acid will be added to the water.
      f) If the pH is below the Stop pH Level for Acid in Influent Tank, caustic will be added to the water.
      g) If the pH is between these two stop levels no pH adjustment is necessary.
      h) If pH adjustment is necessary the total amount of either acid or caustic will be calculated from the volume of water to be treated, the Target pH level for

the Influent Tank, the current pH level in the Influent Tank, the nonlinear offset set points (if any) necessary to compensate for buffering capacity of the water to be treated and the respective acid or caustic concentrations coming from the acid and caustic feed systems.

i) The acid or caustic feed system feed rates and total amount of acid or caustic required for the pH adjustment of the batch will determine the total chemical dosing time.

j) Influent Tank Recirculation Pump will recirculate the tank water for the chemical dosing amount of time. This is the treatment recirculation period.

k) If caustic is required the Caustic Flow Request for Influent Water will be enabled for the time required to perform the pH adjustment.

l) If acid is required the Acid Flow Request for Influent Water will be enabled for the time required to perform the pH adjustment.

m) When the chemical dosing time is complete the respective chemical flow requests will be disabled.

n) Influent Tank Recirculation Pump will recirculate the tank water for set point amount of time. This is the post-treatment recirculation period.

o) pH value will be measured when the post-treatment recirculation period completes to verify pH adjustment was successful.

4) Based on total batch volume to be treated, the coagulant concentration in the coagulant bulk source tank and the desired final coagulant concentration in the batch, Coagulant will be added to the batch to meet the desired set point concentration.

5) Coagulant Flow Request for Influent Water will be enabled while coagulant is required for treating an influent water batch.

6) Coagulant will be added to the recirculation flow in parallel with the pH adjustment chemistry (if needed).

7) Conditioned Water will be pH adjusted on a continuous basis in the flow stream.

8) pH adjustment for Conditioned Water will be performed as follows.

a) pH will be measured continuously in the Conditioned Water flow stream.

b) If the pH is above the Stop pH Level for Caustic in Conditioned Water, acid will be added to the water.
c) If the pH is below the Stop pH Level for Acid in Conditioned Water, caustic will be added to the water.
d) If the pH is between these two stop levels no pH adjustment is necessary.
e) If caustic is required the Caustic Flow Request for Conditioned Water will be enabled.
f) If acid is required the Acid Flow Request for Conditioned Water will be enabled.
g) When either flow request is enabled the corresponding chemical feed system supply pump will run at the requested pace.

9) Acid and Caustic feed system supply pumps for conditioned water will be speed controlled to pump chemical at control set point pump speed. Pump speed will be PID loop generated from input reference measured Conditioned Water pH and Target pH Level for Conditioned Water Set Point.
10) PID loop to be tuned for optimum performance, minimizing overshoot and oscillation.

i. Alarms: Analytical data ranges.
j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an “L” in the latch column immediately after the alarm tag reference.
k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.
l. Reference analytical alarms for AIT-481A pH Transmitter, AIT-481B Conductivity Transmitter and AIT-482 Turbidity Transmitter for the A Side Conditioned Water Stream (CONDITIONED WATER QUALITY PERMISSIVES).
m. Reference level alarms for LIT-252 Level Transmitter, LIT-254 Level Transmitter and LIT-256 Level Transmitter and LIT-258 Level Transmitter for the Influent Water Tanks (INFLUENT WATER STORAGE TANK FARM SOURCE PERMISSIVES).

Inputs	Description	Alarm	Latch	Units
A0281A	Influent Tank 1 pH Transducer Fail	A0281AXFA	L	
A0281A	Influent Tank 1 pH High Alarm	A0281AHHA	L	pH
A0281A	Influent Tank 1 pH High Warning	A0281AHA		pH
A0281A	Influent Tank 1 pH Low Warning	A0281ALA		pH
A0281A	Influent Tank 1 pH Low Alarm	A0281ALLA	L	pH
A0281B	Influent Tank 1 Conductivity Transducer Fail	A0281BXFA	L	
A0281B	Influent Tank 1 Conductivity High Alarm	A0281BHHA	L	uS
A0281B	Influent Tank 1 Conductivity High Warning	A0281BHA		uS
A0281B	Influent Tank 1 Conductivity Low Warning	A0281BLA		uS
A0281B	Influent Tank 1 Conductivity Low Alarm	A0281BLLA	L	uS
A0282	Influent Tank 1 Turbidity Transducer Fail	A0282XFA	L	
A0282	Influent Tank 1 Turbidity High Alarm	A0282HHA	L	NTU
A0282	Influent Tank 1 Turbidity High Warning	A0282HA		NTU
A0283A	Influent Tank 2 pH Transducer Fail	A0283AXFA	L	
A0283A	Influent Tank 2 pH High Alarm	A0283AHHA	L	pH
A0283A	Influent Tank 2 pH High Warning	A0283AHA		pH
A0283A	Influent Tank 2 pH Low Warning	A0283ALA		pH
A0283A	Influent Tank 2 pH Low Alarm	A0283ALLA	L	pH
A0283B	Influent Tank 2 Conductivity Transducer Fail	A0283BXFA	L	
A0283B	Influent Tank 2 Conductivity High Alarm	A0283BHHA	L	uS
A0283B	Influent Tank 2 Conductivity High Warning	A0283BHA		uS
A0283B	Influent Tank 2 Conductivity Low Warning	A0283BLA		uS
A0283B	Influent Tank 2 Conductivity Low Alarm	A0283BLLA	L	uS
A0284	Influent Tank 2 Turbidity Transducer Fail	A0284XFA	L	
A0284	Influent Tank 2 Turbidity High Alarm	A0284HHA	L	NTU
A0284	Influent Tank 2 Turbidity High Warning	A0284HA		NTU
A0285A	Influent Tank 3 pH Transducer Fail	A0285AXFA	L	
A0285A	Influent Tank 3 pH High Alarm	A0285AHHA	L	pH
A0285A	Influent Tank 3 pH High Warning	A0285AHA		pH
A0285A	Influent Tank 3 pH Low Warning	A0285ALA		pH
A0285A	Influent Tank 3 pH Low Alarm	A0285ALLA	L	pH

Inputs	Description	Alarm	Latch	Units
A0285B	Influent Tank 3 Conductivity Transducer Fail	A0285BXFA	L	
A0285B	Influent Tank 3 Conductivity High Alarm	A0285BHHA	L	uS
A0281B	Influent Tank 3 Conductivity High Warning	A0285BHA		uS
A0285B	Influent Tank 3 Conductivity Low Warning	A0285BLA		uS
A0285B	Influent Tank 3 Conductivity Low Alarm	A0285BLLA	L	uS
A0286	Influent Tank 3 Turbidity Transducer Fail	A0286XFA	L	
A0286	Influent Tank 3 Turbidity High Alarm	A0286HHA	L	NTU
A0286	Influent Tank 3 Turbidity High Warning	A0286HA		NTU
A0287A	Influent Tank 4 pH Transducer Fail	A0287AXFA	L	
A0287A	Influent Tank 4 pH High Alarm	A0287AHHA	L	pH
A0287A	Influent Tank 4 pH High Warning	A0287AHA		pH
A0287A	Influent Tank 4 pH Low Warning	A0287ALA		pH
A0287A	Influent Tank 4 pH Low Alarm	A0287ALLA	L	pH
A0287B	Influent Tank 4 Conductivity Transducer Fail	A0287BXFA	L	
A0287B	Influent Tank 4 Conductivity High Alarm	A0287BHHA	L	uS
A0287B	Influent Tank 4 Conductivity High Warning	A0287BHA		uS
A0287B	Influent Tank 4 Conductivity Low Warning	A0287BLA		uS
A0287B	Influent Tank 4 Conductivity Low Alarm	A0287BLLA	L	uS
A0288	Influent Tank 4 Turbidity Transducer Fail	A0288XFA	L	
A0288	Influent Tank 4 Turbidity High Alarm	A0288HHA	L	NTU
A0288	Influent Tank 4 Turbidity High Warning	A0288HA		NTU

Inputs	Description	Tag
A0280	Caustic Flow Request for Influent Water	A0280EN1
A0280	Acid Flow Request for Influent Water	A0280EN2
A0280	Caustic Flow Request for Conditioned Water	A0280EN3
A0280	Acid Flow Request for Conditioned Water	A0280EN4
A0280	Coagulant Flow Request for Influent Water	A0280EN5

22. Coagulant Feed Pump(s) Start Control:

a. Loop Number: 915.
b. P&ID Drawing(s) Referenced: I-12-03.
c. Description: Coagulant Feed Pump(s) transfer coagulant from the Coagulant Bulk Tank to the Influent Water Tanks.
d. Equipment Associated: Reference influent tanks analytical instrumentation (ACID, CAUSTIC AND COAGULANT FEED REQUEST PERMISSIVES).

Device	Tag Root	Description
PMP-921	P0921	COAGULANT FEED PUMP 1
PMP-922	P0921	COAGULANT FEED PUMP 2
LIT-952	L0952	COAGULANT TANK LEVEL TRANSMITTER

e. System Enable (Interlocks): Coagulant Storage Tank above low set point.
f. Equipment Enable per Device with Output: Influent Tanks 1, 2, 3 or 4 request for coagulant.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
	NONE

Digital Output	Description
XC0921S	Coagulant Feed Pump 1 Start Command
XC0922S	Coagulant Feed Pump 2 Start Command

Analog Input	Description
L0952	Coagulant Supply Tank Level

Analog Output	Description
P0921SC	Coagulant Feed Pump 1 Speed Command
P0922SC	Coagulant Feed Pump 2 Speed Command

2) Specific Set Points:

Loop Set Point	Description
P0921CSP	Coagulant Feed Pump 1 Manual Speed Command
P0922CSP	Coagulant Feed Pump 2 Manual Speed Command
L0952CSP	Coagulant Storage Tank Operating Level

h. Start/Stop:
   1) Coagulant Feed Pumps will start or stop via setting given by Operator in manual mode.
   2) Coagulant Feed Pumps will start if there is a Coagulant Flow Request for Influent Water.
   3) Coagulant Feed Pump(s) will stop if the Coagulant Flow Request for Influent Water is removed.

i. Alarms:
   1) Coagulant tank level.
   2) Reference influent tank water analytical instrument alarms (ACID, CAUSTIC AND COAGULANT FEED REQUEST PERMISSIVES).

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLA, LA, HA, HHA, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
L0952	TNK-920 Level Transducer Fail	L0952XFA	L	
L0952	TNK-920 High Level Alarm	L0952HHA	L	Feet
L0952	TNK-920 High Level Warning	L0952HA		Feet
L0952	TNK-920 Low Level Warning	L0952LA		Feet
L0952	TNK-920 Low Level Alarm	L0952LLA	L	Feet

23. Dewatering Aid Feed System Start Control:

a. Loop Number: 916.
b. P&ID Drawing(s) Referenced: I-12-04.
c. Description:
   1) Flocculent Feed Pump transfers Flocculent from the Flocculent Storage Tank to the liquid phase separator inlet flow.
   2) Polymer product Pump transfers polymer from the polymer product drum to the raw water inlet mixing line.
d. Equipment Associated:

Device	Tag Root	Description
PMP-942	P0942	POLYMER PUMP
PMP-945	P0945	FLOCCULANT (DEWATERING) FEED PUMP
LIT-954	L0954	FLOCCULANT TANK LEVEL TRANSMITTER
LIT-956	L0956	POLYMER PRODUCT DRUM LEVEL TRANSMITTER
LSH-955	LS0955H	SUMP HIGH LEVEL SWITCH

e. System Enable (Interlocks):
   1) Permissive from liquid phase separator to inject flocculent into inlet water stream.
   2) Flocculent Storage Tank above low set point.
f. Equipment Enable per Device with Output:
   1) Polymer Product Drum above low set point.
   2) ROA in Auto.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
LA955H	Sump High Level
Digital Output	**Description**
XC0942S	Polymer Feed Pump Start Command
XC0945S	Flocculent Feed Pump Start Command
Analog Input	**Description**
L0956	Polymer Product Drum Level
L0954	Flocculent Storage Tank Level

Analog Output	Description
P0942SC	Polymer Feed Pump Speed Command
P0945SC	Flocculent Feed Pump Speed Command

2) Specific Set Points:

Loop Set Point	Description
P0942CSP	Polymer Feed Pump Manual Speed Cmd SP
P0945CSP1	Flocculent Feed Pump Manual Speed Cmd SP
P0945CSP2	Flocculent Feed Concentration
L0954CSP	Flocculent Storage Tank Operating Level

h. Start/Stop:
   1) Polymer feed pump will start or stop via setting given by Operator in manual mode.
   2) Flocculent feed pump will start or stop via setting given by Operator in manual mode.
   3) Flocculent feed pump will start if the liquid phase separation system requests Flocculent. Flocculent will be requested whenever the solids transfer pump is running.
   4) Flocculent feed pump speed will be calculated based on desired Flocculent Feed Concentration set point P0945CSP2, flow rate of material through the liquid phase separator solids feed pump, PMP*601 (this will be entered as a set point value estimate if there is no flowmeter inline giving this flow), Flocculent source concentration and Flocculent feed pump flow rate versus pump speed.
   5) Polymer supply pump will start if there is a request for raw polymer to blend a new batch of raw Flocculent feed stock.

i. Alarms:
   1) Flocculent Storage Tank level.
   2) Polymer product drum level.
   3) Secondary Sump level.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an “L” in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLA, LA, HA, HHA, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
LS0956H	Secondary Sump High Level Alarm	LS0956HA	L	
L0954	Flocculent Storage Tank Level Transducer Fail	L0954XFA	L	
L0954	Flocculent Storage Tank High Level Alarm	L0954HHA	L	Feet
L0954	Flocculent Storage Tank High Level Warning	L0954HA		Feet
L0954	Flocculent Storage Tank Low Level Warning	L0954LA		Feet
L0954	Flocculent Storage Tank Low Level Alarm	L0954LLA	L	Feet
L0956	Polymer Product Drum Level Transducer Fail	L0955XFA	L	
L0956	Polymer Product Drum High Level Alarm	L0955HHA	L	Feet
L0956	Polymer Product Drum High Level Warning	L0955HA		Feet
L0956	Polymer Product Drum Low Level Warning	L0955LA		Feet
L0956	Polymer Product Drum Low Level Alarm	L0955LLA	L	Feet

24. Liquid Phase Separator Level Monitoring:

a. Loop Number: 610.
b. P&ID Drawing(s) Referenced: I-12-05.
c. Description: Level switches monitor HIGH level in the liquid separators and the secondary sump.
d. Equipment Associated:

Device	Tag Root	Description
LSH-651	LS0651H	LIQUID PHASE SEPARATOR 1 HIGH LEVEL SWITCH
LSH-652	LS0652H	LIQUID PHASE SEPARATOR 2 HIGH LEVEL SWITCH
LSH-653	LS0653H	SUMP HIGH LEVEL SWITCH
AV-601	V0601	SOLIDS TRANSFER PUMP AIR SUPPLY VALVE

e. System Enable (Interlocks):
   1) High Level Switch Lockout.
   2) Flocculent Source enabled.
f. Equipment Enable per Device with Output: ROA in Auto.

g. I/O and Set points Associated:

1) Physical I/O:

Digital Input	Description
ZN601O	Solids Transfer Pump Air Valve Opened
HN601A	Solids Transfer Pump 1 Air Valve in Auto
ZN601C	Solids Transfer Pump Air Valve Closed
LA651H	Liquid Phase Separator 1 High Level
LA652H	Liquid Phase Separator 2 High Level
LA653H	Sump High Level

Digital Output	Description
XC601O	Backwash Recycle Pump Air Valve Open

Analog Input	Description
	NONE

Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
V0631DSP1	Open Time for Air Supply Valve
V0631DSP2	Interval Time between Open Times for Air Supply Valve

h. Start/Stop:

1) Level switches will be monitored for high levels in the liquid separators and secondary sump.
2) Solids Pump Air Supply Valve will open or close via setting given by Operator in manual mode.
3) Solids Pump Air Supply Valve will open for set point duration of time at a set point time interval.
4) Solids Pump Air Supply Valve will close at the completion of the set point run time duration or High level alarm in the Liquid Phase Separators.
5) Cycle will repeat upon completion of set point time interval between run periods.

i. Alarms:
   1) Separator High Level.
   2) Secondary Sump Level.
   3) Open / Close Fail.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLA, LA, HA, HHA, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
HN601A	Pump Air Supply Valve Not in Auto	V0601HNAA		
ZN601O	Pump Air Supply Valve Fail to Open	V0601ZNOA	L	
ZN601C	Pump Air Supply Valve Fail to Close	V0601ZNCA	L	
LS0651H	Liquid Phase Separator 1 High Level Alarm	LS0651HA	L	
LS0652H	Liquid Phase Separator 2 High Level Alarm	LS0652HA	L	
LS0653H	Secondary Sump High Level Alarm	LS0653HA	L	

25. Influent Tanks Recirculation Pumps Control:

a. Loop Number: 210.

b. P&ID Drawing(s) Referenced: I-11-01, I-11-02, I-11-03, I-11-04.

c. Description: Recirculation pumps turn over the water in the Influent tanks to promote mixing during pH adjustment of the water or coagulant addition.

d. Equipment Associated:

Device	Tag Root	Description
PMP-201	P0201	INFLUENT TANK 1 RECIRCULATION PUMP
PMP-202	P0202	INFLUENT TANK 2 RECIRCULATION PUMP
PMP-203	P0203	INFLUENT TANK 3 RECIRCULATION PUMP
PMP-204	P0204	INFLUENT TANK 4 RECIRCULATION PUMP

e. System Enable (Interlocks):
   1) Influent Water Storage Tank in TREATMENT state.
   2) Seal Water Permissive enabled.

f. Equipment Enable per Device with Output: ROA in Auto.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
UA201F	Influent Tank 1 Recirculation Pump Fault
UA202F	Influent Tank 2 Recirculation Pump Fault
UA203F	Influent Tank 3 Recirculation Pump Fault
UA204F	Influent Tank 4 Recirculation Pump Fault
HN201A	Influent Tank 1 Recirculation Pump in Auto
HN204A	Influent Tank 2 Recirculation Pump in Auto
HN203A	Influent Tank 3 Recirculation Pump in Auto
HN204A	Influent Tank 4 Recirculation Pump in Auto
YN201R	Influent Tank 1 Recirculation Pump Run
YN202R	Influent Tank 2 Recirculation Pump Run
YN203R	Influent Tank 3 Recirculation Pump Run
YN204R	Influent Tank 4 Recirculation Pump Run

Digital Output	Description
XC201S	Influent Tank 1 Recirculation Pump Start
XC202S	Influent Tank 2 Recirculation Pump Start
XC203S	Influent Tank 3 Recirculation Pump Start
XC204S	Influent Tank 4 Recirculation Pump Start

Analog Input	Description
	NONE

Analog Output	Description
	NONE

   2) Specific Set Points:

Loop Set Point	Description
	NONE

h. Start/Stop:
   1) Influent Water Tank Recirculation Pumps will start or stop via setting given by Operator in manual mode.
   2) Influent Water Tank Recirculation Pumps will start when the corresponding Influent Water Storage Tank is in TREATMENT state.
   3) Influent Water Tank Recirculation Pumps will stop when the corresponding Influent Water Storage Tank is not in TREATMENT state, the Influent Water Storage Tank has a low level lockout or there is a pump fault.

i. Alarms: Pump Fault.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLA, LA, HA, HHA, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
UA201F	Influent Tank 1 Recirculation Pump Fault	P0201UAF	L	
UA202F	Influent Tank 2 Recirculation Pump Fault	P0202UAF	L	
UA203F	Influent Tank 3 Recirculation Pump Fault	P0203UAF	L	
UA204F	Influent Tank 4 Recirculation Pump Fault	P0204UAF	L	
HN201A	Influent Tank 1 Recirculation Pump Not in Auto	P0201HNA		
HN202A	Influent Tank 2 Recirculation Pump Not in Auto	P0202HNA		
HN203A	Influent Tank 3 Recirculation Pump Not in Auto	P0203HNA		
HN204A	Influent Tank 4 Recirculation Pump Not in Auto	P0204HNA		
YN201R	Influent Tank 1 Recirculation Pump Fail to Start	P0201YNR	L	
YN202R	Influent Tank 2 Recirculation Pump Fail to Start	P0202YNR	L	
YN203R	Influent Tank 3 Recirculation Pump Fail to Start	P0203YNR	L	
YN204R	Influent Tank 4 Recirculation Pump Fail to Start	P0204YNR	L	

26. Influent Tanks Water Inlet Valve Control and Flow Monitoring:

a. Loop Number: 211.
b. P&ID Drawing(s) Referenced: I-11-01, I-11-02, I-11-03, I-11-04.
c. Description: Inlet valves allow the water coming from the extraction wells to enter the Influent Water Storage Tanks.
d. Equipment Associated:

Device	Tag Root	Description
XV-217	V0217	INFLUENT TANK 1 WATER INLET VALVE
XV-227	V0227	INFLUENT TANK 2 WATER INLET VALVE
XV-237	V0237	INFLUENT TANK 3 WATER INLET VALVE
XV-247	V0247	INFLUENT TANK 4 WATER INLET VALVE
FIT-078	F0078	TOTAL INFLUENT FLOW FLOWMETER

e. System Enable (Interlocks): The Influent Water Tank Flow Permissive.
f. Equipment Enable per Device with Output: ROA in Auto.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
ZN217O	Influent Tank 1 Inlet Valve Opened
ZN217C	Influent Tank 1 Inlet Valve Closed
ZN227O	Influent Tank 2 Inlet Valve Opened
ZN227C	Influent Tank 2 Inlet Valve Closed
ZN237O	Influent Tank 3 Inlet Valve Opened
ZN237C	Influent Tank 3 Inlet Valve Closed
ZN247O	Influent Tank 4 Inlet Valve Opened
ZN247C	Influent Tank 4 Inlet Valve Closed

Digital Output	Description
XC217O	Influent Tank 1 Inlet Valve Open Command
XC227O	Influent Tank 2 Inlet Valve Open Command

XC237O	Influent Tank 3 Inlet Valve Open Command
XC247O	Influent Tank 4 Inlet Valve Open Command
Analog Input	Description
F0078	Total Incoming Influent Water Flow
Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
	Reference Alarm Set Points

h. Start/Stop:
   1) Influent Water Tank water inlet valves will open or close via setting given by Operator in manual mode.
   2) Influent Water Tank water inlet valves will open when the corresponding Influent Water Tank Flow Permissive is enabled.
   3) Influent Water Tank water inlet valves will close when the corresponding Influent Water Tank Flow Permissive is disabled or the Influent Water Storage Tank has a high level lockout.
   4) Total Influent Water flow will be monitored by the Total Influent Flow flowmeter.

i. Alarms: Open / Close Fault.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an “L” in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLA, LA, HA, HHA, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
F0078	Total Incoming Influent Flow Transducer Fail	F078XFA	L	
F0078	Total Incoming Influent High Flow Alarm	F078HHA	L	GPM
F0078	Total Incoming Influent High Flow Warning	F078HA		GPM
F0078	Total Incoming Influent Low Flow Warning	F078LA		GPM
F0078	Total Incoming Influent Low Flow Alarm	F078LLA	L	GPM
ZN217O	Influent Tank 1 Inlet Valve Fail to Open Alarm	V0217ZNOA	L	
ZN217C	Influent Tank 1 Inlet Valve Fail to Close Alarm	V0217ZNCA	L	
ZN227O	Influent Tank 2 Inlet Valve Fail to Open Alarm	V0227ZNOA	L	
ZN227C	Influent Tank 2 Inlet Valve Fail to Close Alarm	V0227ZNCA	L	
ZN237O	Influent Tank 3 Inlet Valve Fail to Open Alarm	V0237ZNOA	L	
ZN237C	Influent Tank 3 Inlet Valve Fail to Close Alarm	V0237ZNCA	L	
ZN247O	Influent Tank 4 Inlet Valve Fail to Open Alarm	V0247ZNOA	L	
ZN247C	Influent Tank 4 Inlet Valve Fail to Close Alarm	V0247ZNCA	L	

27. Influent Tanks Recirculation Loop Chemical Valves Control:

a. Loop Number: 212.
b. P&ID Drawing(s) Referenced: I-11-01, I-11-02, I-11-03, I-11-04.
c. Description: Chemical inlet valves allow caustic, acid and coagulant to enter the recirculation loops of the Influent Water Storage Tanks on demand.
d. Equipment Associated:

Device	Tag Root	Description
XV-213	V0213	INFLUENT TANK 1 CAUSTIC INLET VALVE
XV-223	V0223	INFLUENT TANK 2 CAUSTIC INLET VALVE
XV-233	V0233	INFLUENT TANK 3 CAUSTIC INLET VALVE
XV-243	V0243	INFLUENT TANK 4 CAUSTIC INLET VALVE
XV-214	V0214	INFLUENT TANK 1 ACID INLET VALVE
XV-224	V0224	INFLUENT TANK 2 ACID INLET VALVE
XV-234	V0234	INFLUENT TANK 3 ACID INLET VALVE
XV-244	V0244	INFLUENT TANK 4 ACID INLET VALVE
XV-215	V0215	INFLUENT TANK 1 COAGULANT INLET VALVE

Device	Tag Root	Description
XV-225	V0225	INFLUENT TANK 2 COAGULANT INLET VALVE
XV-235	V0235	INFLUENT TANK 3 COAGULANT INLET VALVE
XV-245	V0245	INFLUENT TANK 4 COAGULANT INLET VALVE

e. System Enable (Interlocks): The Influent Water Tank Flow Permissive.
f. Equipment Enable per Device with Output: ROA in Auto.
g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
HN213A	Influent Tank 1 Caustic Inlet Valve in Auto
ZN213O	Influent Tank 1 Caustic Inlet Valve Opened
ZN213C	Influent Tank 1 Caustic Inlet Valve Closed
HN223A	Influent Tank 2 Caustic Inlet Valve in Auto
ZN223O	Influent Tank 2 Caustic Inlet Valve Opened
ZN223C	Influent Tank 2 Caustic Inlet Valve Closed
HN233A	Influent Tank 3 Caustic Inlet Valve in Auto
ZN233O	Influent Tank 3 Caustic Inlet Valve Opened
ZN233C	Influent Tank 3 Caustic Inlet Valve Closed
HN233A	Influent Tank 4 Caustic Inlet Valve in Auto
ZN243O	Influent Tank 4 Caustic Inlet Valve Opened
ZN243C	Influent Tank 4 Caustic Inlet Valve Closed
HN214A	Influent Tank 1 Acid Inlet Valve in Auto
ZN214O	Influent Tank 1 Acid Inlet Valve Opened
ZN214C	Influent Tank 1 Acid Inlet Valve Closed
HN224A	Influent Tank 2 Acid Inlet Valve in Auto
ZN224O	Influent Tank 2 Acid Inlet Valve Opened
ZN224C	Influent Tank 2 Acid Inlet Valve Closed
HN234A	Influent Tank 3 Acid Inlet Valve in Auto
ZN234O	Influent Tank 3 Acid Inlet Valve Opened

Digital Input	Description
ZN234C	Influent Tank 3 Acid Inlet Valve Closed
HN244A	Influent Tank 4 Acid Inlet Valve in Auto
ZN244O	Influent Tank 4 Acid Inlet Valve Opened
ZN244C	Influent Tank 4 Acid Inlet Valve Closed
HN215A	Influent Tank 1 Coagulant Inlet Valve in Auto
ZN215O	Influent Tank 1 Coagulant Inlet Valve Opened
ZN215C	Influent Tank 1 Coagulant Inlet Valve Closed
HN225A	Influent Tank 2 Coagulant Inlet Valve in Auto
ZN225O	Influent Tank 2 Coagulant Inlet Valve Opened
ZN225C	Influent Tank 2 Coagulant Inlet Valve Closed
HN235A	Influent Tank 3 Coagulant Inlet Valve in Auto
ZN235O	Influent Tank 3 Coagulant Inlet Valve Opened
ZN235C	Influent Tank 3 Coagulant Inlet Valve Closed
HN245A	Influent Tank 4 Coagulant Inlet Valve in Auto
ZN245O	Influent Tank 4 Coagulant Inlet Valve Opened
ZN245C	Influent Tank 4 Coagulant Inlet Valve Closed
Digital Output	Description
XC213O	Influent Tank 1 Caustic Inlet Valve Open Command
XC223O	Influent Tank 2 Caustic Inlet Valve Open Command
XC233O	Influent Tank 3 Caustic Inlet Valve Open Command
XC243O	Influent Tank 4 Caustic Inlet Valve Open Command
XC214O	Influent Tank 1 Acid Inlet Valve Open Command
XC224O	Influent Tank 2 Acid Inlet Valve Open Command
XC234O	Influent Tank 3 Acid Inlet Valve Open

Digital Input	Description
	Command
XC244O	Influent Tank 4 Acid Inlet Valve Open Command
XC217O	Influent Tank 1 Coagulant Inlet Valve Open Command
XC227O	Influent Tank 2 Coagulant Inlet Valve Open Command
XC237O	Influent Tank 3 Coagulant Inlet Valve Open Command
XC247O	Influent Tank 4 Coagulant Inlet Valve Open Command

Analog Input	Description
	NONE

Analog Output	Description
	NONE

2) Specific Set Points:

Loop Set Point	Description
	Reference Alarm Set Points

h. Start/Stop:
   1) Influent Water Tank chemical supply valves (caustic, acid and coagulant) will open or close via setting given by Operator in manual mode.
   2) Influent Water Tank Caustic inlet valve will open when the corresponding influent water tank Caustic Flow Request for Influent Water is enabled.
   3) Influent Water Tank Caustic inlet valve will close when the corresponding influent water tank Caustic Flow Request for Influent Water is disabled.
   4) Influent Water Tank Acid inlet valve will open when the corresponding influent water tank Acid Flow Request for Influent Water is enabled.

5) Influent Water Tank Acid inlet valve will close when the corresponding influent water tank Acid Flow Request for Influent Water is disabled.
6) Influent Water Tank Coagulant inlet valve will open when the corresponding influent water tank Coagulant Flow Request for Influent Water is enabled.
7) Influent Water Tank Coagulant inlet valve will close when the corresponding influent water tank Coagulant Flow Request for Influent Water is disabled.

i. Alarms: Open / Close Fault.
j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an "L" in the latch column immediately after the alarm tag reference.
k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLA, LA, HA, HHA, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm	Latch	Units
HN213A	Influent Tank 1 Caustic Inlet Valve Not in Auto Alarm	V0213HNAA		
ZN213O	Influent Tank 1 Caustic Inlet Valve Fail to Open Alarm	V0213ZNOA	L	
ZN213C	Influent Tank 1 Caustic Inlet Valve Fail to Close Alarm	V0213ZNCA	L	
HN223A	Influent Tank 2 Caustic Inlet Valve Not in Auto Alarm	V0223HNAA		
ZN223O	Influent Tank 2 Caustic Inlet Valve Fail to Open Alarm	V0223ZNOA	L	
ZN223C	Influent Tank 2 Caustic Inlet Valve Fail to Close Alarm	V0223ZNCA	L	
HN233A	Influent Tank 3 Caustic Inlet Valve Not in Auto Alarm	V0233HNAA		
ZN233O	Influent Tank 3 Caustic Inlet Valve Fail to Open Alarm	V0233ZNOA	L	
ZN233C	Influent Tank 3 Caustic Inlet Valve Fail to Close Alarm	V0233ZNCA	L	
HN243A	Influent Tank 4 Caustic Inlet Valve Not in Auto Alarm	V0243HNAA		
ZN243O	Influent Tank 4 Caustic Inlet Valve Fail to Open Alarm	V0243ZNOA	L	

Inputs	Description	Alarm	Latch	Units
ZN243C	Influent Tank 4 Caustic Inlet Valve Fail to Close Alarm	V0243ZNCA	L	
HN214A	Influent Tank 1 Acid Inlet Valve Not in Auto Alarm	V0214HNAA		
ZN214O	Influent Tank 1 Acid Inlet Valve Fail to Open Alarm	V0214ZNOA	L	
ZN214C	Influent Tank 1 Acid Inlet Valve Fail to Close Alarm	V0214ZNCA	L	
HN224A	Influent Tank 2 Acid Inlet Valve Not in Auto Alarm	V0224HNAA		
ZN224O	Influent Tank 2 Acid Inlet Valve Fail to Open Alarm	V0224ZNOA	L	
ZN224C	Influent Tank 2 Acid Inlet Valve Fail to Close Alarm	V0224ZNCA	L	
HN234A	Influent Tank 3 Acid Inlet Valve Not in Auto Alarm	V0234HNAA		
ZN234O	Influent Tank 3 Acid Inlet Valve Fail to Open Alarm	V0234ZNOA	L	
ZN234C	Influent Tank 3 Acid Inlet Valve Fail to Close Alarm	V0234ZNCA	L	
HN244A	Influent Tank 4 Acid Inlet Valve Not in Auto Alarm	V0244HNAA		
ZN244O	Influent Tank 4 Acid Inlet Valve Fail to Open Alarm	V0244ZNOA	L	
ZN244C	Influent Tank 4 Acid Inlet Valve Fail to Close Alarm	V0244ZNCA	L	
HN215A	Influent Tank 1 Coagulant Inlet Valve Not in Auto Alarm	V0215HNAA		
ZN215O	Influent Tank 1 Coagulant Inlet Valve Fail to Open Alarm	V0215ZNOA	L	
ZN215C	Influent Tank 1 Coagulant Inlet Valve Fail to Close Alarm	V0215ZNCA	L	
HN225A	Influent Tank 2 Coagulant Inlet Valve Not in Auto Alarm	V0225HNAA		
ZN225O	Influent Tank 2 Coagulant Inlet Valve Fail to Open Alarm	V0225ZNOA	L	
ZN225C	Influent Tank 2 Coagulant Inlet Valve Fail to Close Alarm	V0225ZNCA	L	
HN235A	Influent Tank 3 Coagulant Inlet Valve Not in Auto Alarm	V0235HNAA		
ZN235O	Influent Tank 3 Coagulant Inlet Valve Fail to	V0235ZNOA	L	

Inputs	Description	Alarm	Latch	Units
	Open Alarm			
ZN235C	Influent Tank 3 Coagulant Inlet Valve Fail to Close Alarm	V0235ZNCA	L	
HN245A	Influent Tank 4 Coagulant Inlet Valve Not in Auto Alarm	V0245HNAA		
ZN245O	Influent Tank 4 Coagulant Inlet Valve Fail to Open Alarm	V0245ZNOA	L	
ZN245C	Influent Tank 4 Coagulant Inlet Valve Fail to Close Alarm	V0245ZNCA	L	

28. Injection Well Control:

a. Loop Number: 010.
b. P&ID Drawing(s) Referenced: I-02-03.
c. Description:
   1) The injection well puts freshwater into the ground.
   2) Periodic backwashing pulls remedy produced water from the well.
d. Equipment Associated:

Device	Tag Root	Description
PMP-001	P0001	INJECTION WELL BACKWASH PUMP
PMP-101	P0101	SECONDARY CONTAINMENT PUMP 1
PMP-102	P0102	SECONDARY CONTAINMENT PUMP 2
FIT-071	F0071	FRESHWATER FLOWMETER
FIT-072	F0072	REMEDY PRODUCED WATER FLOWMETER
PIT-061	P0061	FRESHWATER PRESSURE TRANSMITTER
PIT-062	P0062	WELL HEAD PRESSURE TRANSMITTER
LT-052	L0052	INJECTION WELL LEVEL TRANSMITTER
LT-054	L0054	SECONDARY CONTAINMENT LEVEL TRANSMITTER
LSH-051	LS0051H	METER AND VALVE VAULT HIGH LEVEL SWITCH
LSH-053	LS0053H	INJECTION WELL HIGH LEVEL SWITCH
FV-011	V0011	FRESHWATER SHUTOFF VALVE
FCV-012	P0012	HYDRAULIC FLOW CONTROL VALVE
FV-013	V0013	BACKWASH SHUTOFF VALVE

e. System Enable (Interlocks):
   1) Freshwater Flow Permissive.
   2) Influent Water Storage Tank Farm Flow Permissive.

f. Equipment Enable per Device with Output:
   1) ROA in auto.
   2) No pump faults.
   3) No flow alarms.
   4) No Pressure alarms.
   5) No Level alarms.

g. I/O and Set points Associated:
   1) Physical I/O:

Digital Input	Description
UA001F	Injection Well Backwash Pump 1 Fault
HN001A	Injection Well Backwash Pump 1 in Auto
YN001R	Injection Well Backwash Pump 1 Run
UA101F	Containment Pump 1 Fault
UA102F	Containment Pump 2 Fault
HN101A	Containment Pump 1 in Auto
HN102A	Containment Pump 2 in Auto
YN101R	Containment Pump 1 Run
YN102R	Containment Pump 2 Run
HN012A	Hydraulic Pump in Auto
YN012R	Hydraulic Pump Run
ZN013O	Backwash Shutoff Valve Opened
ZN013C	Backwash Shutoff Valve Closed
HN013A	Backwash Shutoff Valve in Auto
ZN011O	Freshwater Shutoff Valve Opened
ZN011C	Freshwater Shutoff Valve Closed
HN011A	Freshwater Shutoff Valve in Auto
LA051H	Meter and Valve Vault High Level
LA053H	Injection Well High Level

Digital Output	Description
XC001S	Injection Well Backwash Pump Start
XC101S	Containment Pump 1 Start
XC102S	Containment Pump 2 Start
XC013O	Backwash Shutoff Valve Open Command
XC013C	Backwash Shutoff Valve Close Command
XC011O	Freshwater Shutoff Valve Open Command
XC011C	Freshwater Shutoff Valve Close Command
XC012R	Hydraulic Pump Start
XC012O	Hydraulic Flow Control Valve Open Command
XC012C	Hydraulic Flow Control Valve Close Command

Analog Input	Description
F0071	Freshwater Flow
F0072	Remedy Produced Water Flow
P0061	Freshwater Pressure
P0062	Well Head Pressure
L0052	Injection Well Level
L0054	Secondary Containment Level

Analog Output	Description
	NONE

2) Specific Set Points: Applicable set points per General Requirements Article 2.03.A.2.p.1 and 2. (Secondary Containment pumps to be operated with auto-rotation function.)

Loop Set Point	Description
P0001DSP	Injection Well Backwash Run Time Set Point
L0054CSP	Secondary Containment Operational Level Set Point
	Reference Alarm Set Points

h. Start/Stop:
   1) Injection Well Backwash pump will start or stop via setting given by Operator in manual mode.
   2) Injection Well Backwash pump will be called to run periodically to backwash the injection well. Pump run time will be by timed set point control. The pump will start when issued a start command if:
      a) Influent Water Storage Tank Farm Flow Permissive is enabled.
      b) Well Head Pressure within set point limits (time delay from pump start).
      c) Remedy Produced Flow with in set point limits (time delay from pump start).
      d) No pump faults.
      e) ROA in auto.
   3) Injection Well Backwash pump will stop if any of the following are true:
      a) Influent Water Storage Tank Farm Flow Permissive is disabled.
      b) Pump fault or pump disabled.
      c) Well Head Pressure outside set point limits (time delay from pump start).
      d) Remedy Produced Flow outside set point limits (time delay from pump start).
      e) Start signal removed.
   4) Secondary Containment pump will start or stop via setting given by Operator in manual mode.
   5) Each Secondary Containment pump may be individually enabled / disabled for operation.
   6) Secondary Containment pumps to be operated with auto-rotation function.
   7) Secondary Containment pump will start when issued a start command based on secondary containment level control set point if:
      a) Influent Water Storage Tank Farm Flow Permissive is enabled.
      b) No pump faults.
      c) ROA in auto.
   8) Secondary Containment pump will stop if any of the following are true:
      a) Influent Water Storage Tank Farm Flow Permissive is disabled.

b) Secondary containment sump below low set point level.
c) Pump fault or pump disabled.
d) Remedy Produced Flow outside set point limits (time delay from pump start).
e) Start signal removed.

9) Hydraulic pump will start or stop via setting given by Operator in manual mode.
10) Hydraulic pump will start when issued a start command to generate oil pressure for flow control valve operation.
11) Hydraulic pump will stop when start command is removed.
12) Hydraulic flow control valve will open or close via settings given by Operator in manual mode.
13) Hydraulic flow control valve will open or close via commands issued from PLC in Remote mode.
14) Hydraulic flow control valve will be open when water is being injected into the well and closed during backwash operation.
15) Hydraulic flow control valve can be operated at any time to adjust open percentage from completely open to completely closed.
16) The backwash shutoff valve will be closed whenever fresh water is to be injected into the well. The valve will be opened whenever the Well Backwash Pump is called to run.
17) The fresh water shutoff valve will be opened whenever fresh water is to be injected into the well. The valve will be closed whenever the Well Backwash Pump is called to run.

i. Alarms:
1) Pump Fault.
2) Valve Fail.
3) Low / High Flow.
4) Low / High Pressure.
5) High Level.

j. The following table summarizes the alarms required and associated tag references for this loop. If an alarm requires to be latched, it is shown with an “L” in the latch column immediately after the alarm tag reference.

k. All Alarm Associated Tags: Enable/disable toggle (ED), alarm delay set point (DSP), alarm set point (LLSP, LSP, HSP, HHSP, etc.), alarm delay timer (T), alarm reset set point (RSP) and manual reset (RST) may also be required for each alarm.

Inputs	Description	Alarm Tag	Latch	Units
UA001F	Injection Well Backwash Pump Fault	P0001UAFA	L	
HN001A	Injection Well Backwash Pump Not in Auto	P0001HNAA		
YN001R	Injection Well Backwash Pump Fail to Start	P0001YNRFA	L	
UA101F	Containment Sump Pump 1 Fault	P0101UAFA	L	
UA102F	Containment Sump Pump 2 Fault	P0102UAFA	L	
HN101A	Containment Sump Pump 1 Not in Auto	P0101HNAA		
HN102A	Containment Sump Pump 2 Not in Auto	P0102HNAA		
YN101R	Containment Sump Pump 1 Fail to Start	P0101YNRFA	L	
YN102R	Containment Sump Pump 2 Fail to Start	P0102YNRFA	L	
HN012A	Hydraulic Pump Not in Auto	P0012HNAA		
YN012R	Hydraulic Pump Fail to Start	P0012YNRFA	L	
XC013O	Backwash Shutoff Valve Fail to Open Alarm	V0012ZNOA	L	
XC013C	Backwash Shutoff Valve Fail to Close Alarm	V0012ZNCA	L	
HN013A	Backwash Shutoff Valve Not in Auto	V0012HNAA		
XC011O	Freshwater Shutoff Valve Fail to Open Alarm	V0011ZNOA	L	
XC011C	Freshwater Shutoff Valve Fail to Close Alarm	V0011ZNCA	L	
HN011A	Freshwater Shutoff Valve Not in Auto	V0011HNAA		
LS0051H	Meter / Valve Vault High Level Alarm	LS0051HA	L	
LS0053H	Containment Sump High Level Alarm	LS0053HA	L	
P0061	Freshwater Pressure Transducer Fail	P0061XFA	L	
P0061	Freshwater High Pressure Alarm	P0061HHA	L	PSI
P0061	Freshwater High Pressure Warning	P0061HA		PSI
P0061	Freshwater Low Pressure Warning	P0061LA		PSI
P0061	Freshwater Low Pressure Alarm	P0061LLA	L	PSI
P0062	Remedy Pressure Transducer Fail	P0062XFA	L	
P0062	Remedy High Pressure Alarm	P0062HHA	L	PSI
P0062	Remedy High Pressure Warning	P0062HA		PSI
P0062	Remedy Low Pressure Warning	P0062LA		PSI

Inputs	Description	Alarm Tag	Latch	Units
P0062	Remedy Low Pressure Alarm	P0062LLA	L	PSI
L0052	Injection Well Level Transducer Fail	L0052XFA	L	
L0052	Injection Well High Level Alarm	L0052HHA	L	Feet
L0052	Injection Well High Level Warning	L0052HA		Feet
L0052	Injection Well Low Level Warning	L0052LA		Feet
L0052	Injection Well Low Level Alarm	L0052LLA	L	Feet
L0054	Containment Sump Level Transducer Fail	L0054XFA	L	
L0054	Containment Sump High Level Alarm	L0054HHA	L	Feet
L0054	Containment Sump High Level Warning	L0054HA		Feet
L0054	Containment Sump Low Level Warning	L0054LA		Feet
L0054	Containment Sump Low Level Alarm	L0054LLA	L	Feet
F0071	Freshwater Flow Transducer Fail	F0071XFA	L	
F0071	Freshwater High Flow Alarm	F0071HHA	L	GPM
F0071	Freshwater High Flow Warning	F0071HA		GPM
F0071	Freshwater Low Flow Warning	F0071LA		GPM
F0071	Freshwater Low Flow Alarm	F0071LLA	L	GPM
F0072	Remedy Produced Flow Transducer Fail	F0072XFA	L	
F0072	Remedy Produced High Flow Alarm	F0072HHA	L	GPM
F0072	Remedy Produced High Flow Warning	F0072HA		GPM
F0072	Remedy Produced Low Flow Warning	F0072LA		GPM
F0072	Remedy Produced Low Flow Alarm	F0072LLA	L	GPM

2.04 HUMAN MACHINE INTERFACE (HMI) AND SCADA

A. The following general information shall be provided on the HMI display for all ladder logic program control strategies:

1. Display all analog values on the HMI graphics with bargraph and analog readout along with its associated alarm setpoints arranged next to bargraph in ascending order (i.e., low alarm setpoints at bottom and high alarm setpoints near the top).
2. Graphic screen(s) shall display station main parameters in process flow format similar to that shown on the P&ID diagrams.
3. OI shall display all station parameters, setpoints, statuses and outputs, regardless if the registers are linked to physical I/O or not.

4. All HMI shall display all wells and systems. Complete control and status shall be available at all OI no matter the location of the OI.
5. Setup control parameter screen listing all setpoint registers. All settable values shall be changeable from the HMI screens.
6. Alarm summary screens listing all alarms.
7. Flashing Alarm Indication.
8. Acknowledge button to acknowledge alarms displayed on HMI.
9. All values shall be displayed with engineering units.
10. Analog values shall be displayed with the resolution as described above.
11. Display indicating a new alarm regardless of the screen currently displayed.
12. Menu screen with jump buttons to all screens.
13. Jump button displayed on all screens to go to a menu screen.
14. Jump button displayed on all screens to go to the last screen.
15. Text accompanying any changes in color display (i.e., green – "RUN", red – "OFF", etc.).
16. Setup Color Convention to be Used:
    a. Background Colors:
        1) Window: Black.
        2) Changeable Variable Points: Pale Yellow.
        3) Nonchangeable Variable Points: Light Blue.
    b. Control Switch Colors (ROA):
        1) Hand: Red.
        2) Off: Grey.
        3) Auto: Green.
    c. Pump and Equipment Colors:
        1) Run: Green.
        2) Off: Red.
        3) Fail: Gold.
        4) Ready/Available: White.
    d. Water Valve Colors:
        1) Closed: Red.
        2) Modulating: Purple.
        3) Open: Green.
        4) Undetermined: Grey.
    e. Circuit Breaker Colors:
        1) Closed: Green.
        2) Open: Red.
    f. Relay Logic Colors:
        1) Closed Relay Contact: Green.
        2) Open Relay Contact: Red.

PART 3 EXECUTION

3.01 SOFTWARE DEVELOPMENT

A. The programming, setup and configuration of the PLC & HMI shall be done by the Application Programmer (not in Contractor Scope).

END OF SECTION

SECTION 40 91 02.01
I&C ANALYTICAL MEASUREMENT COMPONENTS

PART 1 GENERAL

1.01 COMPONENT SPECIFICATIONS

A. Multi-parameter Analyzer Transmitter:

1. General:
   a. Function: Indicate and transmit analytical parameters of process fluid.
2. Performance:
   a. Analyzer/Transmitter:
      1) 2/4/8 measuring channels for up to 8 Memosens analytical sensors.
      2) Operating Temperature: 0 degree F to plus 140 degrees F.
      3) Operating Humidity: 0 to 95 percent relative humidity, noncondensing.
3. Analyzer/Transmitter:
   a. Display: Graphic dot matrix, LCD, with back lighting.
   b. Signal Interface:
      1) Analog Outputs: Up to 8 isolated 4 to 20 mA DC.
      2) Discrete Outputs:
         a) Process Alarms: Three SPST, normally open.
         b) Sensor/Analyzer and Process Fault Alarm: SPDT.
         c) Contact Rating: 120 volts, 5 amps, resistive.
   c. Enclosure.
      1) Type: NEMA 4X.
      2) Dimensions: 9 inches by 7.5 inches by 6 inches, nominal.
      3) Suitable for panel, 2-inch pipe, or wall mounting.
      4) Suitable for use in Class 1, Div 2, Groups A, B, C, and D environment.
   d. Power: 115V ac, 50/60 Hz, unless otherwise noted.
4. Interconnecting Cable: Manufacturer specified. Length as required.
5. Accessories:
   a. Junction Box: If noted.
      1) NEMA 4X box for cable extension.
6. Manufacturer and Product: Endress and Hauser, Model Liquiline Multiparameter Transmitter CM442, CM444, CM448.

B. pH Element:

1. General:
   a. Function: Measure pH of noted process fluid.
   b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.
2. Performance:
   a. Element:
      1) Range: 0 to 14 pH.
      2) Operating Temperature: 32 to 230 degrees F.
      3) Operating Pressure: 0 to 145 psig max at 176 degrees F.
   b. Analyzer/Transmitter:
      1) Range: 0 to 14 pH units.
      2) Accuracy: Plus or minus 0.01 pH units.
      3) Repeatability: Plus or minus 0.01 pH units.
      4) Stability: Plus or minus 0.01 pH units per month, noncumulative.
      5) Operating Temperature: 0 to plus 140 degrees F.
      6) Operating Humidity: 0 to 95 percent relative humidity, non-condensing.
3. Element:
   a. Process Connection: 1-inch MNPT.
   b. Connector Cable: Watertight sensor-to-cable connector that eliminates rewiring and cable twisting.
   c. Process Fluid: As noted.
   d. Wetted Materials: Compatible with process fluid.
   e. No field-replaceable parts, unless otherwise noted.
   f. Integral Preamplifier: Required, unless otherwise noted.
   g. Mounting/Process Connections: As shown on Drawings or as noted from among the following:
      1) Submersion:
         a) Sensor handrail assembly.
         b) Handrail mounting kit.
      2) Flow-through:
         a) 3/4-inch NPT tee.
         b) 1-inch NPT tee.
         c) 1-1/2-inch NPT tee.
      3) Low-flow cell assembly.
      4) Insertion.
4. Interconnecting Cable: Manufacturer specified. Length as required.
5. Expendables (for each unit provided):
   a. Chemicals: 1 pint each of buffer solution for pH 4, pH 7, and pH 9.

6. Accessories:
   a. Junction Box: If noted.
      1) NEMA 4X box for cable extension.
7. Manufacturer and Product: Endress and Hauser; Model Orbipac CPF81D pH electrode.

C. ORP Element:

1. General:
   a. Function: Measure ORP of noted process fluid.
   b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.
2. Performance:
   a. Element:
      1) Range: Minus 1,500 mV to plus 1,500 mV.
      2) Operating Temperature: 32 to 176 degrees F.
      3) Operating Pressure: 0 psig to 145 psig max at 176 degrees F.
   b. Analyzer/Transmitter:
      1) Range: Minus 1,500 mV to plus 1,500 mV.
      2) Accuracy: Plus or minus 1 mV.
      3) Repeatability: Plus or minus 1 mV.
      4) Stability: Plus or minus 1 mV per month, noncumulative.
      5) Operating Temperature: 0 to plus 140 degrees F.
      6) Operating Humidity: 0 to 95 percent relative humidity, noncondensing.
3. Element:
   a. Process Connection: 1-inch MNPT.
   b. Connector Cable: Watertight sensor-to-cable connector that eliminates rewiring and cable twisting.
   c. Process Fluid: As noted.
   d. Wetted Materials: Compatible with process fluid.
   e. No field-replaceable parts, unless otherwise noted.
   f. Minimum Conductivity: 50 micro S/cm nominal.
   g. Integral Preamplifier: Required, unless otherwise noted.
   h. Mounting/Process Connections: As shown on Drawings or as noted from among the following:
      1) Submersion:
         a) Sensor handrail assembly.
         b) Handrail mounting kit.
      2) Flow-through:
         a) 3/4-inch NPT tee.
         b) 1-inch NPT tee.

c) 1-1/2-inch NPT tee.
3) Low-flow cell assembly.
4) Insertion.

4. Interconnecting Cable: Manufacturer specified. Length as required.
5. Expendables (for each unit provided):
   a. Chemicals: 100 mL each of buffer solution for plus 220 mV (pH 7.0) and plus 468 mV (pH 0.1).
6. Accessories:
   a. Junction Box: If noted.
      1) NEMA 4X box for cable extension.
7. Manufacturer and Product: Endress and Hauser; Model Orbipac CPF82D ORP electrode

D. Turbidity Element:

1. General:
   a. Function: Continuously measure a signal proportional to turbidity of process fluid sample stream.
   b. Type: Light scatter detection measurement using a combination of 90-degree scatter and 135-degree photocell detectors.
   c. Parts: Sensor, transmitter, accessories, and expendables.
2. Performance:
   a. Complies with ISO 7027 and EN 27027.
   b. Detection Limits:
      1) Process Range: 0 to 4000 FNU.
      2) 0 – 50 FNU to 0.006 FNU.
   c. Accuracy: Less than 2 percent of reading or plus or minus 0.1 FNU (whichever is larger).
   d. Repeatability: Plus or minus 1 percent of reading.
   e. Required Sample Flow: No minimum flow required.
   f. Operating Temperature: Minus 4 degrees F to 176 degrees F.
3. Element:
   a. Light Source: 860 nm plus or minus 30 nm.
   b. Pressure Range: 7 to 145 psig
4. Interconnecting Cable: Manufacturer specified. Length as required.
5. Accessories and Expendables: Primary calibration kit.
6. Manufacturer and Product: Endress and Hauser; Element Model Turbimax CUS51D.

E. Conductivity Element:

1. General:
   a. Function: Measure conductivity of noted process liquid.

b. Parts: Element, transmitter, interconnecting cable, junction box (if specified), ancillaries and expendables.

2. Performance:
   a. Process Liquid: As noted.
   b. Process Range: 10 uS/cm to 20 mS/cm.
   c. Accuracy: Plus or minus 0.5 percent of measured range.
   d. Maximum Operating Pressure: 232 psig.
   e. Process Temperature Range: Minus 4 degrees F to 275 degrees F.
3. Element:
   a. Type: Conductivity Electrode with automatic temperature compensation.
   b. Electrode Material: Titanium, unless otherwise noted.
   c. Type 316 stainless steel sensor tube.
   d. Other Wetted Parts: PEEK, EPDM, Graphite, Neoprene; manufacturer to confirm compatibility with process liquid.
   e. Probe Constant: k equals 1/cm.
   f. Insertion Length: Compatible with main process pipe.
   g. Process Connection: As noted.
   h. Accessories: As noted.
   i. Mounting Hardware: As recommended by manufacturer for specific application and/or as shown on Drawings.
4. Interconnecting Cable: Manufacturer specified. Length as required.
5. Junction Box (weather proof): If noted.
6. Expendables (for each unit provided): One 16-ounce bottle of 2,000 microS/cm conductivity standardizing solution if appropriate for noted range.
7. Manufacturer: Endress and Hauser; Model Condumax W CLS21D.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 91 02.03
I&C FLOW MEASUREMENT COMPONENTS

PART 1 GENERAL

1.01 COMPONENT SPECIFICATIONS

A. Flow Element and Transmitter, Electromagnetic:

1. General:
   a. Function: Measure, indicate and transmit flow of a conductive process liquid in a full pipe.
   b. Type:
      1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
      2) Full bore meter with magnetic field traversing entire flow-tube cross section.
      3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
   c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
2. Service:
   a. Stream Fluid:
      1) As noted.
      2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
   b. Flow Stream Descriptions: If and as described below.
3. Operating Temperature:
   a. Element:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Storage: 15 to 120 degrees F, typical, unless otherwise noted.

4. Performance:
   a. Flow Range: As noted.
      1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
   b. Accuracy:
      1) Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 0.25 to 30 feet per second.
      2) Lack of straight pipe or obstructions to straight length pipe requirements shall not cause overall flowmeter inaccuracies to exceed more 0.5 percent of actual flowrate over the range of full scale settings from 1 to 30 feet per second.
   c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
   d. Humidity: 0 to 100 percent relative humidity.
5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
   d. Measures bi-directional flow.
6. Process Connections:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise noted.
7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted
8. Flow Element:
   a. Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.
   b. Liner Material:
      1) Teflon, unless otherwise noted.
      2) For potable water service, must have appropriate approvals.
   c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
   d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
   e. Electrode Material: Hastelloy C, unless otherwise noted.
   f. Grounding Ring:
      1) Required, unless otherwise noted.
      2) Quantity: Two, unless otherwise noted.
      3) Material: Type 316 stainless steel, unless otherwise noted.

g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
h. Submergence Rating:
    1) Per Instrument Schedule.
    2) If NEMA 6P/IP68, Continuous submergence rated (up to 30 feet depth).
i. Direct Buried (3 to 10 feet): If noted.
j. Hazardous Area Certification:
    1) Class 1, Division 2, Groups A, B, C, D: If noted.
    2) Class 1, Division 1, Groups A, B, C, D, and FM approved if noted.
    3) Class 1, Division 1, Groups C, D, and FM approved: If noted.

9. Transmitter:
    a. Mounting: Surface (wall), unless otherwise noted.
    b. Display: Required, unless otherwise noted.
        1) Digital LCD display, indicating flow rate and total.
        2) Bi-directional Flow Display: Required, unless otherwise noted.
            a) Forward and reverse flow rate.
            b) Forward, reverse and net totalization.
    c. Parameter Adjustments: By keypad or non-intrusive means.
    d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
    e. Empty Pipe Detection: Drives display and outputs to zero when empty pipe detected.
10. Signal Interface (at Transmitter):
    a. Analog Output:
        1) Isolated 4 to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
        2) Supports Superimposed Digital HART Protocol: If noted.
    b. Discrete Outputs:
        1) Two discrete outputs, typical, rated for up to 30 volts typical.
        2) Programmable as noted for the following typical parameters:
            a) Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.
    c. Discrete Input: If noted.
        1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.
    d. Other: As noted.
11. Cables:
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations.
12. Built-in Diagnostic System:
    a. Features:
        1) Field programmable electronics.

2) Self-diagnostics with troubleshooting codes.
3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
4) Initial flow tube calibration and subsequent calibration checks.

13. Factory Calibration:
    a. Calibrated in an ISO 9001 and NIST certified factory.
    b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
    c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Factory Ready for Future In situ Verifications: If noted. Original meter parameter values available from vendor by request.
15. Accessories:
    a. In situ Verification System: If noted.
        1) Quantity: One complete system provided for the project.
        2) Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
        3) Physical access to the flow-tube not required.
        4) Meet standards established by the National Testing Laboratory.
        5) Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.
        6) Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.
        7) Windows-based software.
    b. Primary Simulation System: If noted.
        1) Quantity: One complete system provided for the project.
        2) Verifies proper operation of the signal converter by simulating the flow meter's output signal.
            a) Generates pulsed dc excitation signal with a reference voltage of 70 mV.
            b) Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.
            c) Switch selectable for forward, reverse and zero flow rate.
        3) Verifies various input and output signals.
16. Manufacturers and Products:
    a. ABB Automation MagMaster (includes Transmitter):
        1) 10D1475 Mini-Mag (size: 1/10 to 4 inches).
        2) MFE (size: 1/2 to 24 inches).
        3) Plus MFF (size: 8 to 84 inches).

b. Emerson Process Management, Rosemount Division:
   1) Model 8705 (flanged) and Model 8711(wafer) flow tubes.
   2) Model 8712 (surface) and Model 8732 (integral) transmitters.
c. Endress & Hauser, Inc. Flow Measuring System:
   1) Promag 50/53H (size: 1/12 to 4 inches).
   2) Promag 50/53P (size: 1/2 to 24 inches).
   3) Promag 50/53W (size: 1 to 78 inches).
d. Invensys Foxboro (includes IMT 25 Series Intelligent Magnetic Flow Transmitter):
   1) 8000A Series Wafer Body (size: 1/16 to 16 inches).
   2) 9100A Series Flanged Body Flow Tubes (size: 1 to 78 inches).
   3) 9200A Series Flanged Body Flow Tubes (size: 8 to 48 inches).
   4) 9300A Series Flanged Body Flow Tubes (size: 8 to 16 inches).
e. Krohne [includes IFC 020K/IFC 090K (integral) or IFC 020F/IFC 090F (remote) signal converter].
   1) Aqua Flux Flowmeter (size: 3/8 to 120 inches).
   2) EnviroMag, IFS 4000 Flowmeter (size: 2 to 60 inches).
   3) IFS 1000 EcoFlux Flowmeter (size: 1/10 to 8 inches).

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 91 02.05
I&C LEVEL MEASUREMENT COMPONENTS

PART 1 GENERAL

1.01 COMPONENT SPECIFICATIONS

A. Level Element and Controller, Ultrasonic:

1. General:
   a. Functions: Continuous, non-contacting level measurement.
   b. Type: Ultrasonic.
   c. Parts: Element, transmitter, interconnecting cable, and accessories as noted.
2. Service:
   a. Application: If and as noted.
   b. Vapor Space Pressure: Atmospheric, unless otherwise noted.
   c. Operating Temperature Range:
      1) Element: Minus 4 to plus 149 degrees F.
      2) Transmitter: Minus 4 to 113 degrees F.
3. Performance:
   a. Range: As noted.
   b. Zero Reference: As noted.
   c. Accuracy: Plus or minus 0.25 percent of maximum range or 6 mm, whichever is greater.
   d. Resolution: 0.1 percent of range or 2 mm, whichever is greater.
   e. Blanking Distance:
      1) Sensor dependent.
      2) 1 foot for 33 feet of range sensor, typical.
4. Element:
   a. Quantity: One, unless otherwise noted.
   b. NEMA 6P waterproof.
   c. Housing: PVDF, unless otherwise noted.
   d. Blind Flanges: If and as noted.
   e. Facing: None, unless otherwise noted.
   f. Integral Flange: If noted.
      1) Face: PTFE, unless otherwise noted.
      2) Size: As noted.
   g. Process Connection:
      1) 1-inch NPT, unless otherwise noted.
      2) Top mounted.

h. Electrical Hazardous Rating:
   1) Class I, Division 1, Groups A, B, C, and D.
   2) Class II, Division 1, Groups E, F, and G.
   3) Intrinsically Safe Approval: If noted.
i. Beam Angle: 3 degrees.
j. Integral temperature compensation.
k. Transmitter:
   1) Mounting: Wall, unless otherwise noted.
   2) Available mounting options include wall, rack, fascia, and panel.
l. Display:
   1) Integral keypad or nonintrusive external programming.
   2) Six digits plus 12-character text, plus bargraph with direction indicators.
   3) Eight digit on-board resettable and nonresettable flow totalizers.
m. Enclosure: NEMA 4X polycarbonate, unless otherwise noted.
   1) Available enclosures include wall (NEMA 4X), fascia (NEMA 12), and panel (NEMA 4X).
n. Power Supply: 115V ac, 50/60-Hz, unless otherwise noted.
o. Analog Output:
   1) Isolated 4 mA to 20 mA dc for load impedance of 0 to 750 ohms.
   2) Quantity: One, unless otherwise noted.
p. Digital Communications:
   1) HART.
   2) Modbus RTU: If noted.
   3) Profibus dP: If noted.
   4) Ethernet: If noted.
q. Discrete Outputs:
   1) Five relay (SPDT) rated for 5 amps continuous at 240V ac.
   2) Assignable and as noted.
r. Features:
   1) Programming Security: Password protected.
   2) Data Integrity: Nonvolatile RAM.
   3) RS232 port suitable for programming connection with personal computer.
   4) Resident configurable software to implement the following functions:
      a) Level.
      b) Volume: Preprogrammed tank shapes for accurate volume measurement for inventory control, plus capability to measure unusual shapes.

c) Pump Control: Control up to five pumps with assigning pumps as fixed, lead/lag, FOFO, ratio, and pump-by-time.

5. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.
6. Accessories:
   a. Submergence Shield: If noted.
   b. Remote Programming: Standard on rack and panel mount units via infra-red communicator.
   c. On-board Programming: Standard on wall and fascia mount unit; includes integral keypad.
   d. Programming Via Personal Computer: If noted, one copy of Ultra PC software per lot of controllers furnished.
   e. Aiming Kit: If needed for installation.
      1) Facilitates aiming transducer in solids.
   f. Transducer Mounting Kit: If needed.
      1) Wall or Floor Mount: As noted.
   g. Data Logging:
      1) Allows reporting and trending of level/flow.
      2) Furnish Data Logging Module and Ultralog Software: If noted.
7. Manufacturer and Product:
   a. Endress & Hauser; Model FMU90 and Sensor.
   b. Siemens; SITRANS L, Model HydroRanger 200 and Sensor.
   c. Pulsar; Ultra Blackbox Series 13X and Sensor.

B. Level Element/Transmitter, Submersible, Water, Wastewater:

1. General:
   a. Function: Measure and transmit signal proportional to level.
   b. Type: Totally submersible pressure sensor (loop powered).
   c. Parts: Sensor, interconnecting cable, other parts as noted.
2. Service:
   a. Fluid: Water, Wastewater, unless otherwise noted.
3. Performance:
   a. Process Range:
      1) As noted.
      2) Provide fixed factory range such that noted process range is between 40 percent and 80 percent of fixed factory range.
   b. Accuracy: 0.25 percent of full scale.
   c. Temperature, Operating: Minus 5 degrees F to plus 140 degrees F.
   d. Overpressure:
      1) Proof: At least 1.5 times full scale.
      2) Burst: At least 4.0 times full scale.

4. Features:
    a. Sensor:
        1) Silicon pressure-sensing element.
        2) External Diaphragm: Flush type, coated with fluoro-polymer.
        3) Titanium or Type 316 stainless steel pressure module assembly, unless otherwise noted.
            a) For Titanium Sensors Only: 5-year corrosion warranty, replace sensor if it fails due to corrosion: If noted.
        4) NEMA 6/IP 68 rating (submersible).
        5) Temperature compensation.
        6) Dimensions, Nominal:
            a) Diameter: 1.2 inches.
            b) Length: 5 inches.
        7) Loop powered, 9 to 30V dc.
    b. Interconnecting Cable:
        1) Length: As required.
        2) Polyurethane sheathed, unless otherwise noted.
        3) Kevlar strain relief cord.
        4) Integral vent tube.
    c. Sensor Termination Enclosure: Required, unless otherwise noted.
        1) Enclosure: NEMA 4X.
        2) Houses such noted items as desiccant vent, filter, microfilter aneroid bellows.
        3) 2-Inch Pipe Mounting Kit: Required, unless otherwise noted.
    d. Accessories:
        1) Aneroid Bellows: If noted.
            a) Bellows shall be suitable for application.
        2) Desiccant module: Required, unless otherwise noted.
        3) Spare Desiccant Modules: If noted.
            a) Quantity: As noted.
        4) Cable Hanger, Kellems Type Grip: Required, unless otherwise noted.
        5) Lightning Protection:
            a) Internal (protects against water lightning strike): If noted.
            b) External (protects 4 to 20 mA dc output): Required, unless otherwise noted.
        6) Anchor Assembly: Required, unless otherwise noted.
            a) Marine anchor, clamps, Type 316 stainless steel cable, length at least 3 feet greater than interconnecting cable.
5. Signal Interface: 4 to 20 mA dc output, for load impedance of 0 to 750 ohms, minimum for 24V dc supply without load adjustment.

6. Certification(s):
   a. Class I, Division 1, Groups A, B, C, and D.
   b. Class II, Groups E, F, and G.
   c. Class III.
7. Manufacturer and Product: (provided that they can furnish the noted options)
   a. Endress and Hauser; FMX-21.
   b. Esterline; KPSI Series 705.
   c. Viatran; Model 690.

C. Level Switch, Non-Mercury:

1. General:
   a. Function: Actuate contact at preset liquid level.
   b. Type:
      1) Direct-acting, stainless steel float with enclosed, encapsulated switch and integral cable.
      2) Mercury free.
2. Service: Liquid, water, wastewater, unless otherwise noted.
3. Performance:
   a. Setpoint as noted.
   b. Differential: 8 inches maximum.
   c. Temperature: 32 degrees F (nonfreezing) to 160 degrees F.
4. Features:
   a. Entire Assembly: Watertight and impact-resistant.
   b. Float:
      1) Material and Size Max.: 5.5-inch diameter polymer-coated, Type 316 stainless steel float.
      2) Buoyancy Max.: 2 pounds.
   c. Cable:
      1) Length as noted or as necessary per mounting requirements.
      2) Plastic-jacketed cable, oil-resistant, and suitable for continuous service.
   d. Mounting: Pipe, unless otherwise noted.
      1) Pipe Mounting:
         a) Cable clamp, suitable for connection to 1-inch pipe.
         b) Pipe-to-wall bracket, suitable for connection to 1-inch pipe.
      2) Anchor Mounting Kit: If noted.
         a) 15-pound vinyl-coated cast-iron anchor.
         b) 1/8-inch, Type 316 stainless steel wire rope.
         c) Stainless steel cable clips.

5. Signal Interface:
    a. Switch Type: Magnetic reed switch.
    b. Switch Contacts:
        1) Isolated, rated at least 0.8 amp continuous at 120V ac.
        2) Contact Type: Either NO or NC, as required by application or as noted; or SPDT (NO and NC).
        3) Lead Wires: 18 AWG, 24-inch length.
6. Accessories: As noted.
7. Manufacturer and Product:
    a. Siemens Water Technologies; Model 9G-EF Direct Acting Float Switch (B100).
    b. Contegra; Model FS90.
    c. GEMS; Model FS-1950.

D. Drum Weigh Scale:

1. General:
    a. Function: Measure the level in a 55 gallon drum using total drum weight.
2. Performance:
    a. Process Range: 0 to 1,000 pounds.
    b. Accuracy: Plus or minus 0.2 pounds.
    c. Operating Temperature Range: 14 to 104 degrees F.
3. Scale:
    a. Type: Load cell based weigh scale.
    b. Load Cell Material: Stainless Steel.
    c. Accessories: 4 to 20 mA analog output.
    d. Mounting Hardware: As recommended by manufacturer for specific application and/or as shown on Drawings.
4. Cable: Length as required to accommodate device locations.
5. Junction Box (weather proof): If noted.
6. Manufacturer and Product: Arlyn Scales; Model 325M with 4 to 20mA output.

E. Data Monitoring and Acquisition System:

1. General:
    a. Functions: Collect, Store and Forward data from multiple sensors in remote locations.
    b. Parts: Elements, transmitter, interconnecting cables, and accessories as noted.
2. Service:
    a. Application: If and as noted.

b. Operating Temperature Range:
   1) Transmitter: Minus 40 degrees C to 60 degrees C.
   2) Humidity: 0 to 95 percent noncondensing.

3. Performance:
   a. Configuration:
      1) Up to 28 analog, 12 digital and 5 serial ports.
      2) 32 bit, 192 MHz Arm-9 Processor with LINUX Operating System.
      3) 256 Mb internal data logging memory expandable to 4 Gb.
      4) Removable MM/SD Card Socket (32 Mb to 8 Gb cards).
      5) 10/100BaseT Ethernet Port.
      6) Two USB Ports.
      7) Two RS-232 Serial Ports.
      8) Two SDI-12 Ports.
      9) Plug in Terminal Strip Connectors.
   b. Transmitter:
      1) Mounting: Panel, unless otherwise noted.
   c. Display:
      1) 5.7 inch 1/4 VGA TFT color touchscreen display.
      2) Programmable through BASIC Interpreter.
   d. Enclosure: NEMA 4X, unless otherwise noted.
      1) Fiberglass Enclosure with Lexan Window.
   e. Power Supply: 10 to 16V dc.
4. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.
   a. Data Logging: Allows reporting and trending of collected data.
5. Manufacturer and Product: Xylem; WaterLog System H-5000, no equal.

F. Multiparameter Water Quality Sonde:

1. General:
   a. Functions: Collects up to four analytical values plus integral pressure for depth.
   b. Type: Various.
   c. Parts: Elements, sonde transmitter, interconnecting cables, and accessories as noted.
2. Service:
   a. Operating Temperature Range:
      1) Element: Minus 5 degrees C to plus 50 degrees C.

3. Elements:
    a. Quantity: Up to four interchangeable, unless otherwise noted. Sensor options include:
        1) Conductivity and Temperature.
        2) Dissolved Oxygen (optical).
        3) fDOM (Fluorescent Dissolved Organic Matter).
        4) pH or pH / ORP.
        5) Depth (Integral to sonde body).
        6) Total Algae.
        7) Turbidity.
    b. NEMA 6P waterproof.
    c. Communications:
        1) Bluetooth wireless technology.
        2) USB Cable.
        3) RS-485.
        4) SDI-12.
    d. Power Supply: 9 to 16.5V dc.
4. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.
5. Manufacturer and Product: Xylem; EXO1 Water Quality Sonde, no equal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 91 02.07
I&C PRESSURE MEASUREMENT COMPONENTS

PART 1 GENERAL

1.01 COMPONENT SPECIFICATIONS

A. Pressure and Differential Pressure Transmitter:

1. General:
   a. Function: Measure pressure or differential pressure.
   b. Transmit signal proportional to either pressure or differential pressure or square root of pressure or differential pressure, as applicable.
   c. Type:
      1) Electronic variable capacitance or silicon strain gauge.
      2) Two-wire transmitter; “smart electronics”.
   d. Parts: Transmitter and accessories.
2. Performance:
   a. Range: As noted.
      1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
   b. Accuracy:
      1) Plus or minus 0.075 percent of span for most gauge pressure factory ranges.
      2) Plus or minus 0.25 percent of span for absolute pressure gauges.
   c. Ambient Operating Temperature: Minus 40 degrees F to plus 185 degrees F, with integral meter.
   d. Process Operating Temperature: Minus 40 degrees F to plus 220 degrees F.
   e. Humidity: 0 to 100 percent relative humidity.
   f. Hazardous Location Certifications:
      1) FM explosion-proof.
      2) Others: As noted.
3. Features:
   a. Linear or square-root output, user-configurable.
   b. Type: Gauge pressure, unless otherwise noted.
   c. Adjustable damping.
   d. LCD indicator, unless otherwise noted.
      1) Display in either percent or engineering units, field configurable.

e. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
   1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
f. Wetted O-Rings: Glass-filled TFE, graphite-filled PTFE, or Viton, unless otherwise noted.
g. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
h. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct/remote Diaphragm Seal: If and as noted.
5. Signal Interface:
   a. 4 to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop resistance with External 24V dc Power Supply: 550 ohms.
   b. 4 to 20 mA dc, no HART Protocol: If noted.
   c. FOUNDATION Fieldbus Protocol: If noted.
   d. Profibus: If noted.
6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
      1) Bracket and Accessories: Type 316 stainless steel bolts, suitable for mounting transmitter to 2-inch pipe.
7. Accessories: If and as noted.
8. Manufacturers and Products:
   a. Gauge Pressure, Absolute Pressure and Differential Pressure Units: Rosemount; Model 3051 series.
   b. Gauge Pressure or Absolute Pressure: Endress and Hauser Cerabar M PMP51.
   c. Differential Pressure: Endress and Hauser Deltabar PMD55 or PMD75.

B. Pressure Gauge:

1. General:
   a. Function: Local pressure indication.
   b. Type: Bourdon tube element.
2. Performance:
   a. Scale Range: As noted.

b. Accuracy: Plus or minus 0.50 percent of full scale.

3. Features:
   a. Dial: 4-1/2-inch diameter.
   b. Pointer Vibration Reduction: Required, unless otherwise noted. Use the following method.
      1) Liquid filled gauge front, unless otherwise noted.
         a) Glycerine fill, unless otherwise noted.
   c. Case Material: Black thermoplastic, unless otherwise noted.
   d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
      1) Stainless steel, unless otherwise noted.
   e. Pointer: Adjustable by removing ring and window.
      1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
   f. Window: Glass or acrylic, unless otherwise noted.
   g. Threaded reinforced polypropylene front ring.
   h. Case Type: Solid front with blow-out back.
4. Process Connections:
   a. Mounting: Lower stem, unless otherwise noted.
   b. Size: 1/2-inch MNPT, unless otherwise noted.
5. Accessories: If and as noted.
   a. Throttling Device: Required, unless otherwise noted.
      1) Type suitable for the intended service.
      2) Install in gauge socket bore.
6. Manufacturers and Products:
   a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!
   b. Ametek U.S. Gauge; Solfrunt Model 19XX/1981Advantatge.
   c. WIKA, Type 2XX.34.

C. Pressure Switch, Adjustable Dead Band:

1. General:
   a. Function: Monitor pressure, activate switch at setpoint, and deactivate switch at reset point.
   b. Type:
      1) Piston-actuated.
      2) Both setpoint and deadband (the differential between setpoint and reset point) adjustable.
2. Performance:
   a. Setpoint:
      1) As noted.
      2) Repeatability: Plus or minus 1 percent of range.

b. Reset Point: As noted.
c. Range: The noted setpoint shall fall between 20 and 80 percent of the range.
d. Deadband: Adjustable within nominally 25 and 85 percent of range.
e. Overpressure Proof Pressure:
    1) Pressure psi Ranges: At least 400 percent of rated maximum static pressure.
    2) Pressure Inches of Water Ranges: 20 psig.
    3) Compound Range: 250 psig.
    4) Vacuum Range: 250 psig.
f. Operating Temperature Range:
    1) Dependent on actuator seal materials.
    2) For Buna-N seal, 0 to 150 degrees F.

3. Features:
    a. Actuator Seal: Buna-N, unless otherwise noted.
    b. Adjustable deadband.
    c. Mounting: Surface, unless otherwise noted.
4. Process Connections:
    a. 1/4-inch NPT female connections, unless otherwise noted.
    b. Materials:
        1) Pressure psi Ranges: Type 316 stainless steel, unless otherwise noted.
        2) Pressure Inches of Water Ranges: Epoxy coated carbon steel, unless otherwise noted.
5. Enclosure: NEMA 4X, unless otherwise noted.
6. Signal Interface:
    a. Contact Type:
        1) SPDT.
        2) Rated for 10 amps minimum at 120V ac.
    b. Hermetically Sealed Switch: If noted.
7. Manufacturers and Products:
    a. Ashcroft; L or P Series.
    b. United Electric; J6 Series.
    c. If NEMA 7, explosion-proof enclosure specified; Ashcroft; P Series only.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 92 05
PROGRAMMABLE LOGIC CONTROLLER AND HUMAN MACHINE INTERFACE

PART 1 GENERAL

1.01 SUMMARY

A. Provide and install Programmable Logic Controller (PLC) and Human Machine Interface (HMI) Hardware and all supporting hardware, wiring and devices as specified in Drawings and Specifications.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. PLC components.
   b. HMI Components.
   c. Wire and cable accessories.
   d. Software.
2. Calculations:
   a. Power Supply for processor and I/O modules.
   b. I/O point count with spare capacity.
   c. Special materials.
3. Drawings:
   a. Power Distribution wiring diagrams.
   b. I/O wiring diagrams.
   c. Communications block diagrams.
   d. Dimensional drawings.

PART 2 PRODUCTS

2.01 PLC COMPONENTS

A. Programmable Logic Controller System:

1. General:
   a. Function: Used for process monitoring and control by emulating functions of conventional panel mounted equipment such as relays, timers, counters, current switches, calculation modules, PID controllers, stepping switches, and drum programmers.

b. Type: Microprocessor based device programmable using ladder logic.
c. Parts: Central processing unit (CPU), power supply, local and remote input/output modules, local and remote base (chassis/rack) controllers, I/O bases (chassis/rack) and factory assembled interconnecting cables. Provide components required to make a complete and totally operational system. Reference PLC system block diagram on Drawings.

2. Environmental:
   a. Temperature: Operating range 32 to 140 degrees F (0 to 60 degrees C); storage range minus 40 to 158 degrees F (0 to 70 degrees C).
   b. Humidity: Operating range 5 to 95 percent noncondensing.
   c. Vibration:
      1) Sinusoidal: IEC 68-2-6, Test Fc; 0.15 mm peak-to-peak, 10-to 57-Hz; 1 g, 57- to 150-Hz.
      2) Random: IEC 68-2-34, Test Fdc; 0.4 g^2/Hz, 80- to 350-Hz, and 3dB/octave rolloff, 80- to 20-Hz and 350- to 2-KHz at 10 min/axis.
   d. Noise: IEC 801, Part 3, Level 3 and Part 4, Level 3; MIL STD-461B.
   e. Isolation: User-side to PLC side 1,500V rms.
3. Central Processing Unit (CPU):
   a. Type: Microprocessor, 32-bit minimum 1 GHz CPU.
   b. Scan Time: Less than 1 ms/K words of relay ladder logic.
   c. PLC Communications:
      1) Communication Ports: Two Serial Ports.
   d. Network Communications: One Ethernet Module.
   e. Remote I/O Communication Links: GE Genius Bus.
   f. Instruction Set:
      1) Timers and Counters: Quantity 1,024 minimum; minimum timer resolution 0.001 seconds; minimum counter count range 0 to 32,000.
      2) Math: Signed integer and floating-point math including add, subtract, multiply, divide, square root, and compare.
      3) Register Operations: Shift registers, bit shift, bit set, bit clear, data move and data format conversion.
      4) Process Loop Control: User configurable direct or reverse acting PID loop control computation with the capability of both AUTO and MANUAL modes of operation, remote access to controller tuning constants; minimum of 64 PID loops.

5) Real Time Clock: Date and time set and compare.

g. Diagnostics:
   1) Indicators: Battery status, PLC status, PLC operation mode, remote I/O communication status.
   2) Status Word: With failure status for PLC battery, scan overrun, communications, I/O, special functions.
   3) Power Up: PLC checks status of PROMs upon powerup; runs self-diagnostics on power-up; periodically runs self-diagnostics while in RUN mode, halts logic processor and sets outputs to configured state if fatal error is detected.
   4) Diagnostic Tables: Tables, displayable by programming computer, that describe nature and location (address) existing faults and errors.

h. Agency Approvals and Standards:
   1) UL listed.
   2) CSA certified.
   3) DIN Standard 41494.
   4) Factory Mutual approved.

4. Random Access Memory (RAM):
   a. Type: CMOS type.
   b. Word Size: 32 bits, minimum.
   c. Battery Backup: 6 months, minimum.
   d. Memory Size: Sufficient to implement all applications software plus 50 percent spare (total 64 MB minimum).
   e. Read only memory (ROM) for controller's operating system and diagnostics.
   f. Memory Protection: Keylock switch.
5. Power Supply: One unit for each input/output base assembly:
   a. Voltage: 120/220 volts (user selectable), 60-Hz input; 85 to 132 volts output.
   b. Mounting: Integral with base.
6. Input/Output: Complete input/output system with a minimum of 1,024 I/O points in up to 8 expansion racks.
   a. Discrete Input Modules:
      1) Voltage: 120 volts, 60-Hz.
      2) Operating Power: 50 watts.
      3) Points per Module: 32 maximum.
      4) LED status indicator for each point.
      5) Isolation: Between input point and PLC, 1,500 volts rms.
   b. Isolated Discrete Output Modules:
      1) Type: Isolated Form C relay.
      2) Voltage: 120 volts, 60-Hz.

3) Isolated Outputs per Module: 8.
4) Load Rating: 2 amps continuous.
5) Operating Power: 2.5 watts.
6) Points Per Module: 16 maximum.
7) LED status indicator and fuse for each point.
8) Isolation: Between PLC and output point, 1,500 volts rms.

c. Analog Input/Output Modules:
1) Voltage: 24V dc.
2) Power: 3 watts.
3) Differential Analog Points Per Module: 8 maximum.
4) Isolation: Between PLC and I/O point and between I/O points, 1,500 volts rms.
5) Analog Input Resolution: 16 bits.
6) Analog Output Resolution: 16 bits.
7) Signal 4 to 20 ma DC.

d. Pulse Input Modules:
1) Input Voltage: 5V or 12 to 24V (user selectable).
2) Input Current: 7 mA at 5V; 7.0 to 1.5 mA at 12 to 24V.
3) Points per Module: 4, maximum.
4) Maximum Input Frequency: 100 KHz in counter mode.
5) Maximum Count Value: 0 to 999,999 (programmable).

7. Remote Input/Output Bases:
a. Supply: Same power supply as described in subparagraph Power Supply, above.
b. Base Controller: One remote I/O adapter module required for each remote base with Ethernet based communications protocols.
c. Distributed I/O with modular design and mix and match capability. Up to 32 module support per communication block.

8. Communication Network:
a. Peer-To-Peer: Ethernet/IP, Modbus for peer to peer PLC communication; support data block transfers of up to 255 16-bit registers per transaction.
b. Network Interface:
1) Communication to Computer Subsystem Computers via Ethernet: Allen-Bradley Ethernet/IP, Modicon Modbus interface and protocol.
c. Remote I/O Interface.

9. Redundancy Requirement (if shown on Drawings):
a. CPU:
1) Redundant (hot backup).
2) Two PLCs share common I/O system.

3) One PLC actively in control of I/O. Memory of backup PLC is continuously updated with current data.
4) Automatic switchover to backup PLC on failure of active PLC.
5) Standby PLC assumes control within 50 milliseconds**.**

b. I/O:
1) All discrete inputs in one group, discrete outputs in another group.
2) Wired to/from PLC I/O modules or racks to/from control panel terminal blocks in all panels (direct connection of field wiring to I/O module or rack is not acceptable).

10. Identification:
a. Nameplates installed above/below each PLC component (CPU, I/O rack, power supply).
b. Label configured I/O points as they have been configured (addressed) in the system, as approved by the Engineer.
11. Manufacturers and Products (No Equals Allowed to Match Existing Equipment):
a. GE PACSystems RX3i.
b. GE VersaMax Micro (with Ethernet).
c. GE PACSystems RSTi.
12. Programming Software:
a. Standard Software:
1) Number of Copies: One.
2) PLC Program Documentation:
a) Online and offline programming and documentation support. User selectable display of documentation information while online or offline.
b) Ladder Logic Documentation: Ladder logic annotation including tag numbers, setpoints calculations and associated variables and ranges, PID loops, and special function descriptions.
c) Discrete Input/Output List and Cross Reference: Character alpha-numeric functional identification printed above the input, output or coil in program listing; cross reference printout indicates all rung numbers where input, output or coil is used in the program; display cross reference online, offline.
d) Data Register List and Cross Reference: Cross reference listing of data registers used and location(s) in the program; display cross reference online, offline.

e) Special Functions: Lists programmed special, location in ladder logic, and programmed values.
f) PID Loops: List of programmed PID loops by loop number or tag number. Description of memory locations and status registers used (on a per loop basis) in the loop; individual loop tuning values.
g) Rung Comments: Rung comments to identify, annotate, and segment the program into subprograms.
h) Special Function Index: Index listing special function program tag numbers, functional description, and program page number.
i) Manufacturer and Product: GE; Proficy Machine Edition (version to be confirmed by PG&E).

13. Human Machine Interface:
    a. Environmental:
        1) Temperature: Operating range 14 to 140 degrees F (minus 10 to 60 degrees C).
        2) NEMA 4, 4X.
    b. Agency Approvals and Standards:
        1) UL listed Class 1, Division 2 (A, B, C, D).
        2) ATEX Class 1, Zone 2.
        3) CE Mark.
    c. Hardware:
        1) Color TFT User Interface Display.
        2) 6, 8, 12 and 15 inch displays available.
        3) 600 by 800 or higher pixel minimum screen resolution.
        4) 64 Mb system memory minimum.
        5) 10/100 Mbps Ethernet Connectivity.
        6) RS232/RS485 Serial Connectivity.
        7) 12/24V dc power supply capability.
        8) Communications: Modbus TCP.
        9) USB V1.1 Compatible.
        10) Compact Flash Type 2.
    d. Manufacturer and Product: GE; QuickPanel View 8”, 12”.
14. Programming Computer:
    a. Hardware:
        1) Type: Laptop, 64-bit, IBM compatible personal computer.
        2) Processor: Intel I7 core.
        3) Clock Speed: 2.0 GHz, minimum.
        4) RAM: 8 Gbyte, minimum.
        5) DVD Drive: Read/Write capable.
        6) Hard Drive: 750 Gbyte, minimum.

7) Display: 1920 by 1200 resolution. Suitable for use in low light situations.
8) USB communications ports; four minimum.
9) Battery pack and charger.
10) Carrying case with shoulder strap, storage pockets and space for battery, charger, power cords, and communications cable.
11) Manufacturers:
    a) Dell.
    b) Toshiba.
    c) Gateway.
    d) Lenovo.

b. Software:
1) Windows 7 Professional operating system.
2) GE Proficy Machine Edition (installed and licensed for full development programming).

15. Equipment Groups:
a. Spares:
1) CPU: One each type used.
2) Spare I/O Cards Installed in I/O racks: For each type of I/O card, quantity = 10 percent of each type and size used, minimum one each.
3) Spare I/O Cards Provided Loose (Shelf Spares): For each type of I/O card, quantity = 10 percent of each type and size used, minimum one each.
4) Power supply one each of each type and size used, minimum one each.
5) Cables:
    a) USB Programming Cable: One.
    b) Ethernet Cable: One.
6) Communication Modules: One each type used.
7) I/O Rack: One each type used.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s printed instructions.

3.02 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each controller.

2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.

B. Performance Test:

1. Conduct on each controller.
2. Perform under actual or approved simulated operating conditions.
3. Test for continuous 12-hour period without malfunction.

END OF SECTION

SECTION 40 95 60
TELEMETRY SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Telemetry Subsystem (TS) is part of the overall PIC. This section specifies TS functional requirements for the interface with the; Computer Subsystem (CS); communication links provided by others; and equipment at remote facilities.

B. Telemetry Subsystem consists of the following:

1. Communication Links:
   a. Between the CS and the RTUs.
   b. Between the CS and the remote peripherals.
2. Remote Telemetry Units (RTU).
3. RTU Test Set(s).

C. Configuration of the Telemetry Subsystem as shown on Drawings.

1.02 REFERENCES

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

1. Alliance for Telecommunications for Industry Solutions (ATIS): O5.1, Specifications and Dimensions (for Wood Poles).
2. American Association of State Highway and Transportation Officials (AASHTO):
   a. T99, Standard Method of Test for the Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
   b. T310, Standard Specification for In-place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
3. American Wood Preservers Association (AWPA).
4. ASTM International:
   a. D1556, Standard Test Method for Density and Unit Weight of Soil In Place by the Sand-Cone Method.
   b. D2167, Standard Test Method for Density and Unit Weight of Soil In Place by the Rubber-Balloon Method.
   c. D2937, Standard Test Method for Density of Soil In Place by the Drive-Cylinder Method.

5. Federal Aviation Administration (FAA).
6. Federal Communications Commission (FCC).
7. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C37.90, Standards for Relays and Relay Systems Associated with Electric Power Apparatus.
8. International Society of Automation (ISA): 50-00.01, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
9. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
10. Rural Utilities Service (RUS): Bulletin 1728F-700, Specification for Wood Poles, Stubs, and Anchor Logs.
11. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
    a. 222-G, Structural Standards for Steel Antenna Supporting Structure and Antennas.
    b. 222-G-1, Structural Standards for Steel Antenna Towers and Antenna Supporting Structure.
    c. 232, Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
    d. 603, Land Mobile FM or PM – Communication Equipment – Measurement and Performance Standards.

1.03 DEFINITIONS

A. Abbreviations:

1. AI: Analog inputs.
2. AO: Analog outputs.
3. DI: Discrete inputs.
4. DO: Discrete outputs.
5. DTMF: Dual tone multiple frequency.
6. FAA: Federal Aviation Administration.
7. FCC: Federal Communication Commission.
8. I/O: Input/output.
9. LED: Light omitting diode.
10. N.C.: Normally open.
11. N.O.: Normally closed.
12. PIC: Process Instrumentation and Control.
13. RTU: Remote Telemetry Units.
14. SCADA: Supervisory control and data acquisition.
15. SPDT: Single-pole double-throw.

16. TS: Telemetry Subsystem.

B. Article Definitions in Section 40 90 00, Instrumentation and Control for Process Systems, apply to this section.

1.04 SUBMITTALS

A. Action Submittals:

1. Overview Block Diagram: Show major assemblies and interrelationships of the TS and CS, including CS/RTU and CS/Remote Peripheral communication links. Diagram similar in content and format as shown on Drawings. Identify each major assembly with the same name and tag numbers as on Overview Equipment List.
2. Overview Description: Comprehensively describe function, operations, and interrelationship of the TS and CS. Emphasize explanation of overview block diagram in minimum of five 8-1/2-inch by 11-inch pages.
3. CS/Remote Peripheral Communication Links Definition: Comprehensive definition of communication protocol and timing. Include a definition for the following:
    a. Link control.
    b. Formats message security.
    c. Effective communication rates.
4. Overview Equipment List: List all TS major assemblies and elements shown in overview block diagram. Include in the list as a minimum:
    a. Reference or tag number.
    b. Name.
    c. Description.
    d. Actual equipment manufacturer and model number.
    e. Quantity.
5. Descriptive Information: Provide for each element of the TS:
    a. Manufacturer’s part and model number with all options clearly defined.
    b. Catalog information.
    c. Performance specifications.
    d. Functional description.
    e. Block diagram.
    f. Input/output definitions.
    g. Installation dimensions and requirements.

6. Assembly Information: For all specifically manufactured equipment, (such as, RTUs, RTU test set, and RTU printed circuit cards) provide the following in addition to material under subparagraph Descriptive Information:
   a. Assembly drawings.
   b. Schematic diagrams.
   c. Bill of Materials.
   d. Power consumption for nominal and worst case.
7. Interconnecting Wiring Diagrams: Show all assemblies of the TS and interconnecting cable and wiring terminations including terminations to interfacing elements and systems. Number all terminations. Label the terminations for circuits that extend beyond assemblies of the TS with circuit names corresponding to Circuit and Raceway Schedule in Division 26. Refer to Article Sequencing and Scheduling.
8. Installation Details: All modifications and details adequately showing the installation of the TS elements and assemblies.
9. Input/Output List: For each I/O point, list the type of I/O point, point ID number, tag number of source or final control equipment, equipment description, RTU number, RTU terminal identification, and RTU location. I/O list sorted in two ways by the following parameters:
   a. Point type, point ID number.
   b. RTU number, point type, point ID number.
10. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing (to be completed).
2. Owner training plan.
3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed), and the following:
   a. Updated versions of the following items as required under paragraph Shop Drawings.
      1) Overview block diagram.
      2) Overview description.
      3) CS/RTU communication link definition.
      4) Radio communication link design.
      5) CS/remote peripheral communication link definition.
      6) Descriptive information.
      7) Assembly information.
      8) Interconnecting wiring diagrams.

9) Input/output list.
10) RTU list.

b. Assembly O&M Manuals: For each size RTU, RTU Test Set, and transceiver:
1) Definition of model numbers and options.
2) Performance specifications.
3) Functional description including theory of operation, configuration, capabilities, controls, and operations.
4) Bill of Materials.
5) Assembly drawings.
6) Block and schematic diagrams.
7) Installation and safety requirements.
8) Maintenance tests and diagnostic procedures.

c. Maintenance Information: For each type of RTU printed circuit board, provide the information listed under subparagraph Assembly O&M Manuals, including original equipment manufacturer's part numbers for all component and modules.

d. List of required and recommended spares, expendables, and test equipment.

4. Statement of Qualification: Maintenance technician.
5. Maintenance service agreement.

1.05 QUALITY ASSURANCE

A. Maintenance Technician Qualifications: Factory training and a minimum of 2 years of experience in the installation and maintenance of RTUs of the types required for this Project.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Design the Telemetry System components for continuous operation in 70 degrees C maximum temperature.

1.07 SEQUENCING AND SCHEDULING

A. Coordinate the external circuit portion of the Interconnecting Wiring Diagrams required in paragraph Shop Drawings with the electrical requirements of Division 26, Electrical.

1.08 MAINTENANCE

A. Maintenance Service Agreement:

1. Preventive Maintenance Program: Visit Owner's Site once every 6 months by qualified maintenance technician to verify operation of the RTUs and calibrate all AI and AO. Visits also include verification and calibration of the RTU Test Set.

PART 2 PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Availability:

1. Subsystem Availability Calculation: Subsystem availability (A) for the TS is defined as average of the individual RTU availabilities (ai) times the nonspecific availability (NA). That is, A = NA*(A1+A2+A3...+An)/n, where n is the number of RTUs. Subsystem availability does not include communication links provided by others.
2. Availability Requirement: TS availability at least 99 percent.
3. Component and Backup Definitions: For purposes of the availability calculations, each RTU and its process I/O is considered an individual component. There are no backup components.

B. Accuracy: The total, worst case, end-to-end, root mean square error for all analog input data handled by TS and CS, not to exceed plus or minus 0.25 percent of full scale under all operational conditions. This requirement excludes errors in transducers, but includes all system data in all forms.

C. CS/RTU Communication Timing: Maximum times allowed for the CS to perform data acquisition and command output functions with RTUs.

1. Station Scan: Maximum time for the CS to request information from a single RTU, receive a reply, and store the information in the data base 3 seconds. This requirement assumes:
   a. Station is a well RTU with maximum I/O count.
   b. No communication errors, i.e., that messages pass all security checks and no retries are required.
   c. No output commands are required.

2.02 CS/RTU COMMUNICATIONS

A. Radio Communication Links:

1. General:
   a. Radio communication links between CS and some of the RTUs at Owner's remote facilities as listed in Article Supplements.
   b. Functions are intended to identify minimum acceptable communication link performance requirements. Furnish functions and equipment necessary to effect completely operational communication links that function compatibly with the CS and the RTUs to form an overall operational SCADA system.
2. Configuration: Configure CS/RTU radio communication links as shown on Drawings and as follows:
   a. CS site has dual radio transceivers with only one active at any time. Active transceiver selected manually.
   b. Each site has a single antenna for both transmission and reception.
3. Remote sites.
4. Performance: CS/RTU radio communication links in accordance with the following minimum performances for communication channel and radio frequency signals:
   a. Radio communication channel suitable 40MB minimum, half duplex communication between CS and RTU facilities.
   b. Radio communication links in accordance with applicable FCC and FAA regulations. Radio communication link design provides for 99.9 percent reliability for CS to repeater link. 99.9 percent reliability is achieved if the fade margin is at least 30 dB. That is, the median received signal level is at least 30 dB above the minimum signal level required for satisfactory operation.
   c. Radio communication links between repeater and all facilities, other than CS facility, has a minimum of 20 dB fade margin. This is nominally 99.5 percent reliability.
   d. Use the following criteria for design of radio communication links:
      1) Maximum effective radiated power (ERP) 0.25 watts.
      2) Maximum antenna height above ground level 12 feet.
      3) Nominal antenna gain at all stations except central repeater 16 dBd.
      4) Nominal antenna gain at central repeater site 9 dBd.
      5) Operating frequencies of 5800 MHz.

2.03 EQUIPMENT

A. Radio Communication Equipment:

1. Transceivers and Repeaters: Contains FM transmitter and FM receiver suitable for operation in 5800 MHz band. Units in accordance with the following characteristics:
   a. Equipment FCC type accepted for intended application. Equipment capable of operation without significant degradation when subjected to applicable temperature, shock, humidity, and vibration tests in accordance with TIA/EIA 603. Unit, when contained in NEMA 1 housing in accordance with NEMA 250, meet or exceed all EIA performance criteria at an ambient temperature of plus 60 degrees C while subjected to 100 percent duty cycle.
   b. Transceivers operate from power provided by the RTU. Units employ solid state circuitry throughout.
   c. Antenna switches rated for 10 million operations, minimum.
   d. Unit Manufacturers and Products: Ubiquity Rocket M5, Ubiquity Nanostation.
2. Transmission Line:
   a. Transmission line performance characteristics in accordance with overall system functional requirements.
   b. Provide with a minimum bend radius 10 inches or less and dielectric jacket, and suitable for direct burial and outdoor design environments.
   c. Terminate only in connectors rated for the required service.
   d. Manufacturer and Product: Andrews; LDF4-50-A.
3. Antennas, Masts, and Poles:
   a. Masts and Poles:
      1) In accordance with TIA 222-G and TIA 222-G-1.
      2) Self-supporting (guyless).
      3) Support antenna at elevation and orientation necessary to achieve functional requirements.
      4) Suitable for outdoor environmental conditions.
      5) Adequate support and protection for transmission lines.
      6) Complete with necessary mounting accessories.
   b. Protective Equipment:
      1) Such as lightning arrestors to minimize damage due to lightning discharges.
      2) Lightning arrestors connected to ground rod by cable.
      3) Do not use mast, poles, or structures for ground path.

PART 3 EXECUTION

3.01 INSTALLATION

A. Transmission Line:

1. Secure transmission line to suitable supports 3 feet on centers with stainless steel ties.
2. Steel or galvanized steel cable clamps not permitted.
3. Replace transmission line jackets cut by ties.

B. Direct Embedment of Poles:

1. General:
   a. Poles set in sloping soil, increase setting depth to account for the reduced volume of bearing soil at ground line. Additional depth of setting equal to the drop in elevation in 5 feet measured horizontally. On sloping ground, measure setting depth from low side of pole ground line.
   b. Set poles in augured holes approximately 8 inches larger in diameter than pole butt.
2. Backfill: Earth backfill around all poles, except in areas designated otherwise on Drawings. Remove all organic materials and trash from excavation before placing backfill. At grade level, banked and tamped earth backfill around the base of each pole. Place earth backfill material in lifts of maximum 6-inch depth and compact each lift to 95 percent of maximum density at optimum moisture content in accordance with AASHTO T99, Method A. Maintain material at optimum moisture content for compaction.
3. Disposal of Excess Excavation: Dispose of all excess excavated materials, not required for backfill or fills, by carefully spreading.
4. Settlement in backfill occurring within the standard 1-year correction period shall be defective.
5. Pole Grounding: Ground immediately after setting with grounding method as shown on Drawings.

3.02 TRAINING

A. Provide a minimum of 1 instructor week of maintenance training specific to the Telemetry Subsystem hardware. Provide training at the Site of Work after RTU installation.

B. Provide formal classroom instruction and practical laboratory work. Training provides the instruction and experience to enable an instrument technician to properly install, startup, test, troubleshoot, and maintain the Telemetry Subsystem equipment. Cover the following areas, as a minimum:

1. Configuration, communication protocol, performance, interfaces, and hardware of the Telemetry Subsystem.
2. Theory, functions, configuration, performance, limitations, and interfaces of RTU and RTU Test Set hardware and software.
3. Present a short operator's course to ensure that the students understand the CS operator functions and man/machine interfaces. Explain displays and printouts so the student will understand how information is derived, and to recognize system problems.
4. Theory, operation, and analysis of data produced by Contractor's diagnostic programs on CS and RTU Test Set to identify and isolate system problems.
5. Techniques for installation, interfacing, and starting up RTUs.
6. Operations and troubleshooting procedures for RTU Test Set and general-purpose test equipment to diagnose RTU problems to the circuit board level.
7. Performance verification using RTU Test Set.

END OF SECTION

SECTION 40 95 80
FIBER OPTIC COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
2. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
3. Insulated Cable Engineers Association (ICEA):
   a. S-83-596, Optical Fiber Premises Distribution Cable.
   b. S-87-640, Optical Fiber Outside Plant Communications Cable.
   c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
4. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
5. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. QuEST Forum (QF): TL 9000, Quality Management Systems.
8. Rural Development Utilities Programs (RDUP):
   a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
   b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
9. Telecommunications Industry Association (TIA):
   a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
   b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
   c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
   d. 568-C.3, Optical Fiber Cabling Components Standard.
   e. 598, Optical Fiber Cable Color Coding.
   f. 606, Administration Standard for Commercial Telecommunications Infrastructure.

10. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
    a. 455-78, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.
    b. 455-133, FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
    c. 492AAAA, Detail Specification for 62.5-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
    d. 492AAAB, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter ClassIa Graded-Index Multimode Optical Fibers.
    e. 492AAAC, Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter ClassIa Graded-Index Multimode Optical Fibers.
    f. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
    g. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with LowWaterPeak.
    h. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
    i. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
    j. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
    k. 942, Telecommunications Infrastructure Standard for Data Centers.
    l. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.
    m. Underwriter Laboratories (UL): 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

B. DEFINITIONS

1. ATM: Asynchronous Transfer Mode.
2. AUI: Attachment Unit Interface.
3. dB: Decibel.
4. DNI: Desktop Network Interface.
5. EMB: Effective Modal Bandwidth.
6. ETL: Electrical Test Laboratories.
7. FDDI: Fiber Distributed Data Interface.
8. FIM: Facilities Information Management.

9. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.
10. FOCS: Fiber Optic Communication System.
11. FOIRL: Fiber Optic Inter Repeater Link.
12. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.
13. Hybrid Cable: Cable containing more than one type of fiber.
14. LAN: Local Area Network.
15. LIMS: Laboratory Information Management System.
16. m: Micrometer.
17. Mbps: Megabits per Second.
18. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.
19. Megahertz (MHz): One million cycles per second.
20. MHz: Megahertz.
21. micro: x 10^{-6}.
22. Micron: Micrometer or one millionth meter.
23. MIS: Management Information System.
24. n, nano: x 10^{-9}.
25. N: Newton.
26. nm: Nanometer—unit of measure equal to one billionth meter.
27. OFL: Over-filled Launch.
28. OFN: Nonconductive Optical Fiber Cable.
29. OFNP: Nonconductive Optical Fiber Plenum Cable.
30. OFNR: Nonconductive Optical Fiber Riser Cable.
31. OLTS: Optical Loss Test Sets.
32. OTDR: Optical Time Domain Reflectometer.
33. OVD: Outside Vapor Deposit.
34. PIC: Process Instrumentation and Control.
35. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.
36. RLM: Restricted Mode Launch.
37. ROL: Reverse Oscillation Lay.
38. SPC: Super Physical Contact.
39. UPC: Ultra Physical Contact.
40. UPS: Uninterruptible Power Supply.
41. V ac: Volts Alternating Current.
42. WAN: Wide Area Network.

1.02 SYSTEM DESCRIPTION

A. Function of FOCS is to transmit digital data between network nodes. Requirements listed identify minimum acceptable system performance.

B. Provide a FOCS based on referenced standards for use in the following local and wide area networks: Fast Ethernet.

1.03 SUBMITTALS

A. Action Submittals:

1. Site Layout Diagram Showing:
   a. Access holes, with identification.
   b. Above grade cable routings, with pole and cable identification.
   c. Below grade conduit routings between access holes and buildings, with conduit counts and identification.
   d. Below grade inner duct routings through conduits, with inner duct counts and identification.
   e. Cable routings through inner ducts and to patch panels, fiber centers, or network nodes, with cable and node identification.
2. Cable Schedule Showing:
   a. Cable identification.
   b. Fiber counts for each cable and identification of used fiber pairs.
   c. Cable length and attenuation, with splice(s), based on TIA 568-C.3, Annex H.
3. Component Data:
   a. Manufacturer and model number.
   b. General data and description.
   c. Engineering specifications and data sheet.
   d. Scaled drawings and mounting arrangements.

B. Informational Submittals:

1. Manufacturer’s statement that installer is certified to perform installation Work.

2. Subcontractor Qualifications:
   a. FOCS Subcontractor: Minimum of 5 years' experience providing, integrating, installing, and commissioning of similar systems.
      1) Statement of Experience: List of at least three fiber optic data communications systems comparable to system specified which have been furnished and placed into operation. For each system, provide following information:
         a) Owner's name, address, telephone number, and name of current operations supervisor or other contact.
         b) Description of system hardware configuration, including major equipment items, number of nodes, and communication standards implemented.
         c) System block diagram.
         d) Dates when contract was signed, equipment was delivered, and system was accepted by Owner. Also, include originally scheduled completion date and if different from actual date, explain why.
         e) Approximate value of listed FOCS provided in dollars.
         f) Detailed horizontal and riser routing.
         g) Distribution frame arrangements.
         h) Fiber and termination identification, including spares.
   b. FOCS Subcontractor's Site Representative: Minimum of 5 years' experience installing similar systems.
   c. Qualification of Personnel:
      1) Resumes identifying management and technical qualifications of supervisory, local service representative, and key personnel.
      2) Qualification data of firm and persons to demonstrate capabilities and experience in the following areas:
         a) Fiber optic cable handling and placement techniques.
         b) Fiber optic splicing and installation of connections.
         c) Attenuation testing procedures.
   d. Owner acceptance of FOCS Subcontractor does not exempt FOCS Subcontractor or Contractor from meeting Contract Document requirements nor does it give prior acceptance of subsystems, equipment, materials, or services.
   e. Sample of Network Test Report, 10 page-minimum, generated by Contractor in a previous project.
   f. Testing and acceptance plan, 30 days prior to beginning of testing.
   g. Fiber test results. Documentation covering fiber facility testing, not later than 2 days after testing, showing:
      1) Manufacturer's tag of attenuation per fiber as recorded from OTDR reading before shipment.
      2) Attenuation of each fiber upon delivery to Site.

3) Attenuation of each fiber plus connector after installation as recorded from OTDR with tracing.
4) Flux Budget calculations with comparison to measured attenuation for each run verifying adequate optical signal strength.

h. For each maintenance organization, identify location of base of service and how required coverage will be achieved.

3. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).
4. Manufacturer's suggested installation practice.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).

1.04 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

B. Equipment:

1. Outside, Aboveground: Minus 40 degrees C to 80 degrees C.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 18 degrees C to 24 degrees C.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 35 degrees C.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Cable:
   a. ISO 9001 or QF TL 9000 registered, whichever applies to material.
   b. Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
2. Housing: ISO 9001 and QF TL 9000 registered.
3. Connector:
   a. ISO 9001 or QF TL 9000 registered.
   b. Minimum 10-year history of manufacturing and supporting connector technology that does not require epoxy or polishing in field.
4. Jumper Cable: ISO 9001 and QF TL 9000 registered.

B. Installer Qualifications:

1. Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
2. Certified by fiber cable manufacturer.

C. Tester Qualifications: Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.

1. Technician: Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. Certificate may have been issued by the following organizations or an equivalent organization:
   a. Manufacturer of fiber optic cable and fiber optic connectors.
   b. Manufacturer of test equipment used for field certification.
   c. Other independent training organizations acceptable to Owner.

D. Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this specification section found defective during a period of 2 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

PART 2 PRODUCTS

2.01 SINGLE MODE FIBER OPTIC CABLE

A. Type OS2, Backbone for Underground Conduit Installation:

1. Individual Fibers: 8.3/125/250 microns.
2. Assembly:
   a. Nonmetallic, gel-free, dry water blocked, loose-tube fiber core with dielectric strength member enclosed by nonmetallic cross-ply sheath; requires buffer tubing.
   b. Cable: Comply with ICEA S-87-640 and RDUP 7 CFR 1755.902 for backbone, feeder and distribution cables.
3. NEC/UL Listing: None; not approved for general use within building, except when installed in metallic conduit.

4. Protective Covering: Black, antifungus, UV-resistant, polyethylene jacket with rip-cord.
5. Fiber Category G.652D, Code E.
6. Minimum Short Term Pull Strength: 600 lbf.
7. Manufacturers and Products:
   a. Corning Cabling Systems; ALTOS loose-tube dielectric cable.
   b. Mohawk; Outdoor loose-tube cable.

2.02 MULTIMODE FIBER OPTIC CABLES

A. 62.5/125-micron, graded-index for use in backbone and horizontal distribution subsystems, the fiber cables shall be color coded for quick and easy identification, and shall meet or exceed the requirements of TIA 568-C.3, including the following specifications:

1. Maximum Mean Fiber Loss:
   a. 3.5 dB per km at 850 nm.
   b. 1.5 dB per km at 1,300 nm.
2. Minimum OFL Bandwidth:
   a. OM1-200 MHz•km minimum at 850 nm; TIA 492AAAA.
   b. 500 MHz•km minimum at 1,300 nm.
3. Distance Capacity per IEEE 802.3:
   a. 100Mbit Ethernet: OM1 300 m at 850 nm and 2,000 m at 1,310 nm.
   b. 1 Gbit Ethernet:
      1) OM1: 300 m at 850 nm and 550 at 1310 nm.

B. Type 62.5/250 OM1, Backbone for Underground Conduit Installation:

1. Individual Fibers: 62.5/125 microns.
2. Assembly:
   a. Nonmetallic, gel-free, dry water blocked, loose-tube fiber core with dielectric strength member enclosed by nonmetallic cross-ply sheath; requires buffer tubing.
   b. Cable: Comply with ICEA S-87-640.
3. NEC/UL Listing: None; not approved for general use within building except when installed in metallic conduit.
4. Protective Covering: Black, antifungus, UV-resistant, polyethylene jacket with rip-cord.
5. Minimum Short Term Pull Strength: 600 lbf.
6. Manufacturers and Products:
   a. Corning Cabling Systems; ALTOS loose-tube dielectric cable.
   b. Mohawk; Outdoor loose-tube cable.

C. Ribbon Cable Spider Fan-Out Kit:

1. Individual Fibers: 62.5/125 microns.
2. Assembly: Spider fan out kit shall be used for field termination and pull out protection of fiber optic cables. The spider fan out shall consist to 24 buffer tubes for individual break out and connector installation.
3. Manufacturers and Products:
   a. Corning SFK, or equal.
   b. Cable: Comply with ICEA S-87-640.

2.03 FIBER OPTIC ETHERNET SWITCH

A. DIN Rail Mount Managed Modular Gigabit Ethernet Switch:

1. Features:
   a. Standard DIN rail mount Ethernet switch.
   b. All Gigabit modular design.
   c. High Environmental Specifications.
   d. Smart Plug and Play Operation.
   e. Supports up to three eight-port communications modules.
   f. Minus 40 degrees C to 85 degrees C operating temperature range.
   g. Fully managed Ethernet switch.
2. Manufacturer and Product: Ntron or equivalent.
   a. NT24k-DR24-AC Managed Industrial Ethernet Switch with three expansion slots and AC / DC power input.
   b. NT24k-FX8-SC Eight port 100BaseFX multimode fiber port slide in expansion module with SC Fiber connectors.
   c. NT24K-GXE8-SC-10 Eight port 1000BaseFX single mode fiber port slide in expansion module with SC Fiber connectors.

B. Rack Mount Managed Modular Gigabit Ethernet Switch:

1. Features:
   a. Standard rack mount Ethernet switch.
   b. All Gigabit modular design.
   c. High Environmental Specifications.
   d. Smart Plug and Play Operation.
   e. Supports up to three eight-port communications modules.
   f. Minus 40 degrees C to 80 degrees C operating temperature range.
   g. Fully managed Ethernet switch.
2. Manufacturer and Product: Ntron or equivalent.
   a. NT24k-AC1 Managed Industrial Ethernet Switch with three expansion slots and AC / DC power input.

b. NT24k-FX8-SC Eight port 100BaseFX multimode fiber port slide in expansion module with SC Fiber connectors.
c. NT24K-GXE8-SC-10 Eight port 1000BaseFX single mode fiber port slide in expansion module with SC Fiber connectors.
d. NT24k-TX8 Eight port 10/100/1000BaseTX module.

C. Rack Mount Managed Ethernet Switch:

1. Features:
   a. Standard rack mount Ethernet switch.
   b. Two 1000Base-SX/LX Fiber ports with LC style connectors.
   c. 24 10/100Base-TX RJ-45 ports.
   d. High Environmental Specifications.
   e. Smart Plug and Play Operation.
   f. Minus 40 degrees C to 80 degrees C operating temperature range.
   g. Fully managed Ethernet switch.
2. Manufacturer and Product:
   a. Ntron or equivalent.
   b. NT7026TX-AC or equivalent.
   c. NTSFP-LX-10 1000BaseLX single mode fiber SFP pluggable mini GBIC transceiver (LC style connector).

D. 9 Port Single Mode Ethernet Industrial Switch:

1. Features:
   a. Standard DIN rail mount Ethernet switch.
   b. High Environmental Specifications.
   c. Minus 40 degrees C to 85 degrees C operating temperature range.
   d. 9 port monitored Ethernet switch with eight 10/100BaseTX copper RJ45 ports and one 100BaseFX Fiber port with SC Fiber connectors.
2. Manufacturer and Product:
   a. Ntron or equivalent.
   b. 309FXE-N-SC-15 single mode with SC style Connectors.

E. 6 Port Multimode Ethernet Industrial Switch:

1. Features:
   a. Standard DIN rail mount Ethernet switch.
   b. High Environmental Specifications.
   c. Minus 40 degrees C to 85 degrees C operating temperature range.
   d. 6 port monitored Ethernet switch with four 10/100BaseTX copper RJ45 ports and two 100BaseFX Fiber port with SC Fiber connectors.

2. Manufacturer and Product:
   a. Ntron or equivalent.
   b. 306FX2-N-SC multimode with SC style Connectors.

F. 9 Port Multimode Ethernet Industrial Switch:

1. Features:
   a. Standard DIN rail mount Ethernet switch.
   b. High Environmental Specifications.
   c. Minus 40 degrees C to 85 degrees C operating temperature range.
   d. 9 port monitored Ethernet switch with eight 10/100BaseTX copper RJ45 ports and one 100BaseFX Fiber port with SC Fiber connectors.
2. Manufacturer and Product:
   a. Ntron or equivalent.
   b. 309FX-N-SC multimode with SC style Connectors.

2.04 FIBER OPTIC ETHERNET SWITCH / MEDIA CONVERTER

A. Compact Industrial Media Converter:

1. Features:
   a. Standard DIN Rail Mount 5 port Ethernet switch / media converter.
   b. High Environmental Specifications.
   c. Converts 10/100BaseTX to 100Base FX.
   d. Minus 40 degrees C to 85 degrees C operating temperature range.
2. Manufacturer and Product:
   a. Ntron or equivalent.
   b. 305FX-N multimode with SC style Connectors.

B. Industrial Media Converter:

1. Features:
   a. Standard DIN Rail Mount 14 port Ethernet switch / media converter.
   b. High Environmental Specifications.
   c. Converts 10/100BaseTX to 100Base FX.
   d. Minus 40 degrees C to 85 degrees C operating temperature range.
2. Manufacturer and Product:
   a. Ntron or equivalent.
   b. 114FX6-SC or 714FX6-SC multimode with SC style Connectors.

2.05 MULTICELL CONDUIT SYSTEM

A. Nonmetallic, designed for fiber optic cabling and telecommunications.

1. Features:
   a. Outerduct, complete with innerducts preinstalled.
   b. Innerduct identification system.
   c. Gasketing that allows watertight assembly and disassembly of outer and innerducts for direct buried and encased installations.
   d. Couplings, access hole terminators, innerduct seals for both empty and cabled ducts, and fixed and flexible bends.
2. Outerduct (conduit located outside innerduct):
   a. Industry standard, 4-inch duct with integral bell end.
   b. Material: PVC Schedule 40.
   c. Marking: Indicate proper innerduct orientation and alignment.
3. Innerduct:
   a. Size and Count: 19 mm - 4.
   b. Material: Smoothwall PVC.
   c. Lubrication: Prelubricated with atomized silicone lubricant.
4. Manufacturer and Product: Carlon; Multi-Gard.

B. Innerduct:

1. Function: Installs into conduit system to provide smooth, low-friction path through conduit, with only one cable per path to facilitate changing individual cables.
2. Features:
   a. Size and Count, in 4-inch Conduit: 19 mm; 4.
   b. Type: Annular, corrugated innerduct.
   c. Material: HDPE.
   d. Color Code: Orange, blue, green, brown, white, or grey.
   e. Strength: Minimum 600-pound tensile strength, with no more than 5 percent ovalization at 600-pound tension.
   f. Lubrication: Prelubricated.
1. Manufacturers:
   a. Endocor.
   b. Dura-Line.

2.06 FIBER DISTRIBUTION FRAME

A. Function: Provides industry-standard rack mounting system for interface between fiber optic backbone and equipment cables.

B. Features:

1. Used in either cross-connect or interconnect configuration.
2. 23-inch (584-mm) rack for mounting 19-inch (483-mm) rack mount units.
   a. Accommodates up to 576 fiber terminations per frame.
   b. Accepts connector module housing and splice housing within same rack.
   c. Fiber Optic Connectors: Shall comply with IEC 61754-6-1 standard. Connectors shall be field installable. Same family of connector shall be used throughout the connectivity of the installation. Acceptable types are SC or LC as needed.
3. Fiber/Wire Management System:
   a. Vertical: 75-mm by 100-mm supports on 200-mm centers vertically on four sides (front LHS, back LHS, front RHS, back RHS).
   b. Horizontal: Supports on 100-mm centers horizontally above and below each termination frame front and back. Support may serve frames immediately above and below.
4. Mounting Hardware: Accepts standard 19-inch (483-mm) rack for integrated fiber optic system (for example, hubs, routers, patch panels).
5. Splice Trays with Coil Former: Former to wind slack cable around, provides controlled long radius bends.
   a. Doors: Pivot down lockable.
   b. Foot and End Caps: Included in final, assembled unit.
   c. Ancillaries: Jumper troughs and covers, cable tie brackets.

C. Manufacturers:

1. Ortronics.
2. Siecor.

2.07 FIBER CENTERS

A. Function: Provides secure place to terminate fiber optic cables.

B. Features:

1. Compartments: Two; one for fiber optic cable, one for jumpers to individual equipment.
2. Coil Former: Former to wind slack cable around, provides controlled long radius bends.
3. Connectors: Minimum 24 SC connectors for entry and exit.
4. Size: Maximum 450 mm by 300 mm by 100 mm.
5. Construction: 1.5-mm steel with corrosion proof finish.

6. Mountings: Suitable for permanent attachment as shown, or provide separate mountings that do not obscure covers and doors.

C. Manufacturers:

1. Ortronics.
2. AT&T.
3. Siecor.

2.08 HOUSINGS

A. Termination Housing:

1. Rack mountable connector housing.
2. Mountable in ECA 310-E compatible 465-mm or 592-mm rack.
3. Available in several sizes, including 1U, 2U, 3U, and 4U.One ECA rack space or panel height (denoted as U) is defined as being 44.45 mm in height.
4. In accordance with design requirements of TIA 568-C.3 and polymer compounds flammability requirements of UL 94.
5. Manufactured using 16-gauge aluminum or equivalent for structural integrity.
6. Finished with wrinkled black powder coat for durability.
7. Provide black installation fasteners.
8. Available sizes with their corresponding fiber capacities are noted below:

Termination Housing Sizes and Fiber Capacities				
Unit Size	**Panel Capacity**	**Fiber Capacity with 6f Panels**	**Fiber Capacity with 12f Panels**	**Fiber Capacity with 24f Panels**
1U	2	12	24	48
2U	4	24	48	96
3U	6	36	72	144
4U	12	72	144	288

B. Splice Housing:

1. Mountable in ECA 310-E compatible 465-mm or 592-mm rack.
2. Available in two rack mount sizes of 3U and 5U. One ECA rack space or panel height (denoted as U) is defined as being 44.45 mm in height.
3. Provide individual tray access with minimal disturbance to neighboring trays and fibers.

4. In accordance with design requirements of TIA 568-C.3 and polymer compounds flammability requirements of UL 94.
5. Manufactured using 16-gauge aluminum or equivalent for structural integrity.
6. Finished with wrinkled black powder coat for durability.
7. Front and rear doors shall be lockable.
8. Brackets shall allow wall mounting of rack-mounted hardware.
2. Provide black installation fasteners.
9. Available sizes with their corresponding fiber capacities are noted below:

Splice Housing Sizes and Splice Capacities			
Unit Size	**Tray Height (inches)**	**Tray Capacity**	**Splice Capacity**
3U	0.2	12	144
3U	0.4	7	84
5U	0.2	22	264
5U	0.4	14	168

C. Combination Termination/Splice Housings:

1. In accordance with design requirements listed in TIA 568-C.3, TIA/EIA-942, and polymer compounds flammability requirements of UL 94.
2. Mountable in ECA 310-E compatible 465-mm rack or 592-mm rack.
3. Available in 1U and 4U sizes.
   a. One ECA rack space or panel height (denoted as U) is defined as being 44.45 mm in height.
   b. 1U shall have removable top lid.
   c. 4U shall have integrated jumper routing guides.
4. Depth: 16 inches deep for extra cable routing.
5. Manufactured using 16-gauge aluminum or equivalent for structural integrity.
6. Finished with rustic gun-metal grey powder coat for durability.
7. Joints shall be welded and finished in a workman-like manner.
8. Provide installation fasteners that match housing color.
9. Provide clamshell-type cable clamping mechanism to provide cable strain relief.
10. Front and rear doors shall be lockable.
11. Connector housings shall have a labeling scheme that complies with TIA-606.

12. Available with factory-installed connectorized cable stubs in multiple cable and connector types.
13. Able to accommodate fusion splicing with additional hardware.

2.09 PANELS

A. Closet Connector Housing Panel:

1. Manufactured from 16-gauge cold rolled steel or injection-molded polycarbonate for structural integrity.
2. Designed to accommodate applications requiring specified labeling.
3. Offered in 6-fiber, 8-fiber, 12-fiber, 16-fiber, and 24-fiber versions.
   a. 6-fiber panels shall be offered in ST compatible, FC, SC simplex.
   b. 8-fiber and 12-fiber versions shall include ST Compatible Connector, FC, LC duplex, SC duplex and simplex, and MT-RJ multifiber connectors.
   c. For high-density applications, MT-RJ and LC duplex panels shall be available in 16-fiber and 24-fiber versions. When MT-RJ adapters are used, adapter shall be a style that has a polarity adjustment knock-out keyway tab that shall be oriented on inside of panel so that it is not accessible to user once system is installed.
4. Capable of being used with field-installable connectors or in applications where preconnectorized cables are routed directly from equipment to interconnect hardware.
5. Capable of accepting interchangeable connector panel.
6. Panel shall be attached with two push-pull latches to allow quick installation and removal.
7. Blank Connector Panel:
   a. Available to fill unused space within housing.
   b. Attached with at least two push-pull latches to allow quick installation and removal.
   c. Manufactured from injection-molded polycarbonate.

B. Pigtailed Adapter Panels:

1. Manufactured from 16-gauge cold rolled steel or injection-molded polycarbonate for structural integrity.
2. Attached with two push-pull latches to allow quick installation and removal.
3. Use for splicing preterminated pigtails to field cables.
   a. Pigtails shall be bundled in a MIC or Ribbon style subunit.
   b. Pigtail Length: 3 meters.
4. Offered in 6-fiber, 8-fiber, 12-fiber, 16-fiber, and 24-fiber versions.
   a. 6-fiber panels shall be offered in ST compatible, FC, SC simplex.

b. 8-fiber and 12-fiber versions shall include ST compatible connector, FC, LC duplex, SC duplex and simplex and MT-RJ multifiber connectors.
c. For high-density applications, MT-RJ and LC duplex panels shall be available in 16-fiber and 24-fiber versions.
    1) When MT-RJ adapters are used, adapter shall be a style that has a polarity adjustment knock-out keyway tab that shall be oriented on inside of panel so that it is not accessible to user once system is installed.
d. Each individual fiber shall be color coded in accordance with TIA 598.

2.10 SPLICE TRAY

A. General:

1. Compatible with hardware connector/splice housings.
2. Securely organize and provide physical protection without stress on fibers for both single-mode and multimode individual and ribbonized fiber splices.
3. Splice enclosures to include various lengths and depths for a variety of splicing methods.

B. Features:

1. Shall not induce attenuation of signal at operational wavelengths up to 1,550 nm.
2. Consist of rugged aluminum base and aluminum cover with crimpable metal tabs that provide buffer tube strain-relief on both ends of tray.
3. Hold up to 24 single-fiber splices and up to six mass fusion splices.
4. Splice Organizer:
    a. Accommodate fusion splice, fusion splice with heat-shrink sleeve or mechanical sleeve, and mechanical splice part.
    b. High-precision molded construction that holds and protects actual splice thus eliminating need for extra splice protection parts.
    c. Provide positive holding action for maximum splice protection during installation and operation.
5. Strain-relief Points: Tie-wrap buffer tubes or pigtails to metal tray.
6. Finish: Black powder coating for ease of fiber identification and protection.

2.11 SPLICE CLOSURES, AERIAL AND UNDERGROUND

A. Function: Enclose branch and inline splices in aerial and underground applications.

B. Available in canister (butt) and in-line styles to fit most applications.

C. Sizes:

1. Small: Accommodate up to 72 single-fiber splices or 144 ribbon-fiber splices using 12-fiber ribbons.
2. Medium: Accommodate up to 288 single-fiber splices or 432 ribbon-fiber splices.
3. Large: Accommodate up to 480 single-fiber splices or 864 ribbon-fiber splices.

D. Housing:

1. Nonmetallic, resistant to solvents, stress cracking, and creep.
2. Material shall be compatible with chemicals and other materials to which they might be exposed in normal applications.

E. End Caps:

1. Feature two express ports for uncut feeder cables.
2. Capable of accepting additional cables without removal of sheath retention or strength-member-clamping hardware on previously installed cables or disturbing existing splices.

F. Quick-seal mechanical seal drop ports.

G. Optical Fiber Closure:

1. Capable of accepting optical fiber cable commonly used in interoffice, outside plant, and building entrance facilities.
2. Provide clamping mechanism to prevent pistoning of central member or strength members, and to prevent cable sheath slip or pullout.
3. Ability to double cable capacity of installed canister splice closure by use of a kit. Such a conversion shall not disturb existing cables or splices.

H. Encapsulation shall not be required to resist water penetration.

I. Re-enterable.

J. Bonding:

1. Provide hardware to facilitate bonding and grounding of metal components in closure and armored cable sheath.

2. Cable bonding hardware shall be able to accommodate a copper conductor equal to or larger than 6 AWG.

K. Aerial Splice Closures:

1. Provide hardware to attach and secure closure to aerial strand.
2. Accommodate splice trays suitable for single fiber, single-fiber heat-shrink, and mechanical or ribbon heat-shrink splices.

L. Installation shall not require specialized tools or equipment other than those normally carried by installation crews.

2.12 CONNECTORS

A. General:

1. Comply with TIA/EIA 604-2, TIA/EIA 604-3, TIA/EIA 604-12, and TIA 568-C.3.
2. LC connectors.
3. Pull Strength: 0.2 N minimum.
4. Durability: Sustain minimum 500 mating cycles without violating other requirements.
   a. Ferrules: Free-floating low loss ceramic.
   b. Polarizing key on duplex connector systems.
5. Attenuation:
   a. In accordance with TIA 568-C.3.
   b. Maximum of 0.75 dB per connector pair.
6. Manufacturer: AMP.

2.13 PATCHCORDS

A. General:

1. In accordance with TIA 568-C.3.
2. Function: Connect fiber centers to network nodes, such as computer workstations.
3. Fiber Characteristics: In accordance with requirements for fiber optic cable.
4. Cable Configuration:
   a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.
   b. Protected with kevlar strength members and enclosed in thermoplastic jacket.
   c. All connections to Ethernet switches and media converters to be SC style connectors.

5. Length: Standard, to meet requirements shown, plus minimum 3 meters at workstations.
6. Connectors:
   a. As required by Article Connectors.
   b. On-axial Pull Strength: 33 N.
   c. Normal-to-Axial Pull Strength: 22 N.
7. Cable Rating: OFNR or OFNP.
8. Color: Per standards or as indicated.
9. Measured for insertion loss with the following values for each connector:
   a. Typical of 0.3 dB and maximum of 0.5 dB (LC typical of 0.1 dB and maximum of 0.3 dB).
   b. OM3 fiber shall be measured for insertion loss with the following values for each connector pair: Typical of 0.15 dB and maximum of 0.25 dB.

2.14 CONDUIT

A. In accordance with Section 26 05 33, Raceway and Boxes for Electrical Systems.

2.15 ACCESSORIES

A. Hardware: Provide cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 PREPARATION

A. Conduit:

1. Ensure installed conduit system conforms to fiber optic system requirements, including:
   a. Conduits and Inner ducts: Size and number.
   b. Access Holes, Hand holes, and Pull Boxes: Location and size, to ensure cables and inner ducts may be installed without exceeding manufacturer’s limitations.
   c. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.
2. Spare Conduit:
   a. No cables shall be pulled into spare conduit.
   b. 100 percent spare conduit capacity required for buried conduit only. For example, for every conduit with one or more cables in it, there shall be one spare equal-size conduit with no cables.
   c. Spare conduit need not have inner duct installed.

3. Expansion Plugs: Seal conduit to stop ingress of water and grit with fabricated expansion plugs.
4. Ensure duct bank, conduit, and other confined routing is free and clear of debris before cable placement.

B. Multicell Conduit System:

1. Cabled Inner Ducts: Seal cables into inner ducts to stop ingress of water and grit with fabricated expansion seals that have separate seals for each cable.
2. Empty Inner Ducts: Seal empty inner ducts immediately after installation to stop ingress of water and grit with fabricated expansion plugs. Remove plugs as required to install cables.

C. Inner Duct:

1. In accordance with manufacturer's recommendations.
2. Install no more than one inner duct of each color in single conduit.
3. Terminate inner ducts in conduit with fabricated termination kits.
4. Identify inner ducts at both ends by methods such as color-coding or waterproof tags wired through inner duct wall.
5. Sealing:
   a. Cabled Inner Ducts: Seal cables into inner ducts to stop ingress of water and grit with fabricated expansion seals that have separate seals for each cable.
   b. Inner Duct to Conduit: Seal gaps between inner ducts and conduit with sealing compound such as 3M Ductseal.
   c. Empty Inner Ducts: After installation, seal with fabricated expansion plugs to stop ingress of water and grit. Remove plugs as required to install cables.

3.02 INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on Drawings.
2. Installation by manufacturer's certified installer.
3. Install cables in accordance with manufacturer's requirements.
4. Install cable directly from shipping reels. Ensure that cable is:
   a. Not dented, nicked, or kinked.
   b. Not subjected to pull stress greater than manufacturer's specification.
   c. Not bent to a radius below manufacturer's minimum bend radius.
   d. Not subjected to treatment that may damage fiber strands during installation.

5. Cables per Conduit or Inner Duct: In accordance with NFPA 70 NEC conduit fill limitations.
6. If calculation indicates cable will attenuate signals more than 8 dB, reroute may be allowed if approved by Engineer.
7. Splices:
    a. Install fiber optic cables in unspliced lengths from fiber centers to switches or hubs.
    b. Fusion-splice fibers using apparatus applicable to type and size of fiber being spliced. Insert loss of splicing unit shall not exceed 0.2 dB on single-mode fibers and 0.25 dB on multimode fibers.
8. Connector: Insertion loss on multimode connections exceeding 0.5 dB and 0.4 dB on single-mode connections not permitted.
9. Identification:
    a. Identify cable on both ends, in access holes, and pull points.
    b. In accordance with TIA 606.
10. Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.
11. Access Holes:
    a. Provide supports for cables in access and hand holes.
    b. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

B. Fiber Center, Fiber Distribution Frame, Housing, Panel, Splice Tray: Install securely in field panels or enclosures as shown on Drawings.

C. Cable Terminations:

1. In accordance with TIA 568-C.3.
2. Fan out fiber cable to allow direct connectorization of connectors.
    a. Sleeve over individual fibers with transparent furcation tubes.
    b. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.
3. Break-out Kits:
    a. Terminate cables using manufacturer-supplied break-out kits.
    b. Terminate in accordance with manufacturer’s recommendations.
4. Slack:
    a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
    b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
5. Connectors:
    a. Terminate minimum 12 fibers in each cable to specified connector.
    b. Connect into fiber management system.

D. Ethernet Fiber Optic Repeaters:

1. Install repeaters in accordance with manufacturer's instructions.
2. Location: Install transceivers securely in enclosures as shown on Drawings.
3. Power: As indicated on Drawings.

E. Ethernet Fiber-to-Copper Transceivers:

1. Install transceivers in accordance with manufacturer's instructions.
2. Location: Install transceivers securely in field panels, close to network nodes and fiber centers.
3. Power: Energize each transceiver from its field panel's UPS, if applicable.
4. Connections:
   a. Connect transceiver to fiber optics and network node.
   b. Lace fiber optics neatly in place, routed through wireways.

F. Conduit: Install in accordance with Section 26 05 33, Raceway and Boxes for Electrical Systems.

3.03 LABELING CONVENTIONS

A. Conform to TIA 606 or to requirements specified by Owner or Owner's representative.

B. Backbone (Riser) Cables:

1. Multiconductor cables connecting main distribution field to an intermediate distribution field, usually a wiring closet or cabinet, and are labeled at each terminating end. Label name identifies each endpoint, cable medium, and number of conductors as follows:
   a. Copper: IDF-MDF-C-PPP-N.
   b. Fiber: IDF-MDF-F-MMM, SSS-N.

Where:

IDF Is the 3-5 position IDF/wiring closet/building code
MDF Is the 3-5 position MDF (or IDF) code
F Fiber
PPP Is pair count of a copper cable
MMM Is multimode strand count
SSS Is single-mode strand count
N Is a sequential number

C. Horizontal (Station) Cables:

1. Connect jack stations to wiring closets or cabinets and are labeled at each end to identify wiring closet they connect to and sequential jack station number as follows:
   a. Data: IDF-D-NNN-A/B.
   b. Voice: IDF-V-NNN-A/B.

   Where:

   IDF Is the 3-5 position IDF/wiring closet/building code
   D Data cable (green)
   V Voice cable (gray)
   NNN Is the sequence number
   A/B Indicates left or right port in faceplate

3.04 FIELD QUALITY CONTROL

A. General:

1. Advise Engineer at least 48 hours in advance of each test. Engineer shall have the option to witness and participate actively in tests.
2. In accordance with Section 01 91 14, Equipment Testing and Facility Startup (to be completed).
3. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
4. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
5. Testing performed on incomplete systems shall be redone on completion of the Work.
6. Document Test Results: Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
7. Confirm quantities and sizes of conduit and inner duct, in accordance with As-Built Conduit/Inner duct Installation form included as Supplement to this section.

B. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Optical Fiber Cable Testers:
   a. Field test instrument shall be within calibration period recommended by manufacturer.

b. Optical Loss Test Set (OLTS):
   1) Single-mode Optical Fiber Light Source:
      a) Provide dual laser light sources with central wavelengths of 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
      b) Output Power: Minus 10 dBm, minimum.
      c) Manufacturer: Fluke Networks.
   2) Multimode Optical Fiber Light Source:
      a) Provide dual LED light sources with central wavelengths of 850 nm (plus or minus 30 nm) and 1,300 nm (plus or minus 20 nm).
      b) Output Power: Minus 20 dBm minimum.
      c) Meet launch requirements of TIA/EIA 455-78. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap, as described in Clause 11 of TIA 568-C.3, with Category 1 light source.
      d) Manufacturer: Fluke Networks.
   3) Power Meter:
      a) Provide 850 nm, 1,300/1,310 nm, and 1,550 nm wavelength test capability.
      b) Power Measurement Uncertainty: Plus or minus 0.25 dB.
      c) Store reference power measurement.
      d) Save at least 100 results in internal memory.
      e) PC interface (serial or USB).
      f) Manufacturer: Fluke Networks.
   4) Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.

3. Optical Time Domain Reflectometer (OTDR):
   a. Bright, color transmissive LCD display with backlight.
   b. Rechargeable for 8 hours of normal operation.
   c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
   d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
   e. Serial and USB ports to transfer data to PC.
   f. Single-mode OTDR:
      1) Wavelengths: 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
      2) Event Dead Zone: 2 meters maximum at 1,310 nm and 2 meters maximum at 1,550 nm.
      3) Attenuation Dead Zone: 15 meters maximum at 1,310 nm and 15 meters maximum at 1,550 nm.

4) Distance Range: Minimum 10,000 meters.
5) Dynamic Range: Minimum 10 dB at 1,310 nm and 1,550 nm.

g. Multimode OTDR:
1) Wavelengths: 850 nm (plus or minus 20 nm) and 1,300 nm (plus or minus 20 nm).
2) Event Dead Zone: 1 meter maximum at 850 nm and 2 meters maximum at 1,300 nm.
3) Attenuation Dead Zone: 6 meters maximum at 850 nm and 15 meters maximum at 1,300 nm.
4) Distance Range: 2,000 meters minimum.
5) Dynamic Range: Minimum 10 dB at 850 nm and 1,300 nm.

h. Manufacturer: Fluke Networks.

4. Fiber Microscope:
a. Magnification: 250X or 400X for end-face inspection.
b. Manufacturer: Fluke Networks.

5. Integrated OLTS, OTDR, and Fiber Microscope:
a. Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.
b. Manufacturer: Fluke Networks.

C. Conduit Test:

1. Test and seal spare conduits.
2. Conduit and Inner Duct Testing:
a. Blow full-diameter mouse through each spare conduit and inner duct to verify they are unrestricted over full length.
b. If conduit is restricted over full length, advise Engineer.
3. Documentation: Confirm conduit test As-Built Conduit/Inner duct Installation form documentation includes details of inner ducts.

D. Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
a. LIA Z136.2.
b. TIA/EIA 455-78.
c. TIA/EAI 455-133.
d. TIA 526-7.
e. TIA 526-14.
f. TIA 568-C.1.
g. TIA 568-C.3.
h. TIA TSB 140.

2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
7. Document Tests:
   a. OLTS dual wavelength attenuation measurements for single-mode and multimode links and channels.
   b. OTDR traces and event tables for single-mode and multimode links and channels.

E. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (single-mode and multimode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.
         b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

Attenuation Coefficient				
Type of Optical Fiber	**Wave-length (nm)**	**Attenuation Coefficient (dB/km)**	**Wave-length (nm)**	**Attenuation Coefficient (dB/km)**
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5
Multimode 62.5/125 µm	850	3.5	1300	1.5
Multimode 50/125 µm	850	3.5	1300	1.5

b. OTDR Testing:
   1) Reflective Events: Maximum 0.75 dB.
   2) Nonreflective Events: Maximum 0.3 dB.
c. Magnified End face Inspection:
   1) Visually inspect fiber connections for end-face quality.
   2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

F. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

G. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

H. Test Execution:

1. Optical Fiber Cable Testing:
   a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
   b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated. Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.
   c. Perform Testing:
      1) On each cabling segment (connector to connector).
      2) On each cabling channel (equipment to equipment).
      3) Using high-quality test cords of same fiber type as cabling under test.
         a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
         b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.

2. Optical Loss Testing (OLTS):
   a. Backbone Link:
      1) Test single-mode at 1,310 nm and 1,550 nm in accordance with TIA 526-7, Method A.1, One Reference Jumper or equivalent method.
      2) Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
      3) Perform tests in both directions.
3. OTDR Testing:
   a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
      1) Single-mode: 1,310 nm and 1,550 nm.
      2) Multimode: 850 nm and 1,300 nm.
   b. Test each fiber link and channel in one direction.
   c. Install launch cable between OTDR and first link connection.
   d. Install receive cable after last link connection.
4. Magnified End face Inspection:
   a. Inspect fibers at 250X or 400X magnification.
      1) 250X magnification is suitable for inspecting multimode and single-mode fibers.
      2) 400X magnification may be used for detailed examination of single-mode fibers.
5. Length Measurement:
   a. Record length of each fiber.
   b. Measure optical length using OLTS or OTDR.
6. Polarity Testing:
   a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
   b. Verify polarity of paired duplex fibers using OLTS.
7. Test Results Documentation:
   a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
   b. Available for inspection by Owner or Owner’s representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.

c. Database for project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of building. CD-ROM shall include software tools required to view, inspect, and print test reports.
d. Circuit IDs reported by test instrument shall match specified label identification.
e. Provide in electronic database for each tested optical fiber with the following information:
    1) Identification of Site.
    2) Name of test limit selected to execute stored test results.
    3) Name of personnel performing test.
    4) Date and time test results were saved in memory of tester.
    5) Manufacturer, model, and serial number of field test instrument.
    6) Version of test software and version of test limit database held within test instrument.
    7) Fiber identification number.
    8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
    9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
    10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
    11) Length for each optical fiber as calculated by the OTDR.
    12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.

I. Drawings:

1. Record Copy: Provide at end of Project on CD-ROM.
    a. CAD format and include notations reflecting as-built conditions of additions and variations from Drawings provided, such as to cable path and termination point.
    b. CAD drawings shall incorporate test data imported from test instruments.
2. As-built Drawings:
    a. Include, but not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts, and frame installation details.
    b. Include field changes made up to construction completion:
        1) Field directed changes to pull schedule.
        2) Field directed changes to cross connect and patching schedule.

3) Horizontal cable routing changes.
4) Backbone cable routing or location changes.
5) Associated detail drawings.

3.05 TRAINING

A. Train Owner's staff in the following skills:

1. Connectorizing fibers.
2. Splicing optical fiber cables, including fiber splices.
3. Testing quality of connectors, splices and fibers.

B. Schedule: Provide two 8-hour training sessions on consecutive weekdays, to suit Owner's schedule.

C. Materials: Provide hardware for training, including fibers, connectors, and splice kits.

3.06 SUPPLEMENTS

A. Supplements listed below, following "End of Section," are part of this Specification.

1. As-Built Fiber Optic Cable Installation Form.
2. As-Built Conduit/Inner duct Installation Form.

END OF SECTION

Contractor: _____
Signed by: _____

AS-BUILT FIBER OPTIC CABLE INSTALLATION

Cable Identification: _____
Routing: From: _____ In: _____
(Identify field panel, control room, etc., in building)

Through: 1
(Identify access hole, building, gallery, etc.)
Through: 2 Through: 5
Through: 3 Through: 6
Through: 4 Through: 7
To: In:
See As-Built Conduit/Innerduct Installation forms for identification of conduits/innerducts cable is routed through.

Acceptable Attenuation:
Multimode Fibers

cable length*

850 nm: 3.5 dB/km x km + 1.5 dB = dB
1300 nm: 1.0 dB/km x km + 1.5 dB = dB

*Contractor to provide actual length installed, within ±0.1 km.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		850 nm	1,300 nm	850 nm	1,300 nm

Single-mode Fibers

	cable length*		
1310 nm:	_____ dB/km x	km + 1.5 dB =	dB
1550 nm:	_____ dB/km x	km + 1.5 dB =	dB

*Contractor to provide actual length installed, within ±0.1 km.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		1,310 nm	1,550 nm	1,310 nm	1,550 nm

Contractor: _____

Signed by: _____

AS-BUILT CONDUIT/INNERDUCT INSTALLATION

From: _____ To: _____
(Identify building, access hole, field panel, etc.) Sheet 1 of 1

Conduits:
Used: 4 inches; 2 inches
Spare: 4 inches; 2 inches Confirm all spares unrestricted: Yes/No
(Provide number of conduits in each category)

Innerducts:

Conduit ID*	Innerduct ID	Cable ID / Spare
(Continued overleaf delete if not applicable) *Provide conduit ID if required to identify innerduct uniquely in the access hole, if for example, color-coded innerduct is used in more than one conduit. If innerducts are tagged uniquely, leave this column blank.		

SECTION 41 22 13.13
OVERHEAD CRANES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B30.2, Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist).
   b. B30.10, Hooks.
   c. B30.11, Monorails and Underhung Cranes.
   d. B30.17, Overhead and Gantry Cranes (Top Running, Single Girder).
   e. HST 1M, Performance Standard for Electric Chain Hoists.
   f. HST 2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.
   g. HST 4M, Overhead Electric Wire Rope Hoists.
2. Crane Manufacturer's Association of America (CMAA):
   a. 70, Electric Overhead Traveling Cranes.
   b. 74, Top Running & Under Running Single Girder. Electric Overhead Traveling Cranes.
3. National Electrical Manufacturer's Association (NEMA):
   a. MG 1, Motors and Generators.
   b. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Occupational Safety and Health Act (OSHA).
6. Underwriters Laboratories (UL): 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 DESIGN REQUIREMENTS

A. Top-Running Multiple-Girder Overhead Traveling Crane: CMAA No. 70 and ASME B30.2 and B30.17.

B. Top-Running and Underhung Single-Girder Overhead Traveling Cranes: CMAA No. 74, and ASME B30.11.

C. Crane Service Class: CMAA No. 74.

D. Trolley Service Class: CMAA No. 70.

E. Wire Rope Hoist Service Class: ASME HST 4M and CMAA No. 70 or No. 74.

F. Chain Hoist Service Class: ASME HST 1M and CMAA No. 70 or No. 74.

G. Hook: ASME 30.10.

H. Building Clearances: CMAA No. 70 and No. 74. Where bridge span exceeds 40 feet, increase clearance to 6 inches.

I. Stress and Safety Factors: CMAA No. 70 and No. 74. Properly select materials of construction for stresses to which subjected.

J. Safety of Operation, Accessibility, Interchangeability, and Durability of Parts: ASME B30.2.0 and OSHA requirements. Design equipment for environment operated.

K. Provide system, equipment, and components, including supports and anchorages, designed in accordance with General Conditions (to be completed).

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, materials of construction, and specifications on bridge drive system, end trucks, runway stops, footwalks and platforms, wheels, shafting, drive motor, gears and bearing, steel framing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
   c. Structural design calculations for runway beams and support system and calculations of deflection and loads on building steel stamped by a registered professional engineer of the State of California.
   d. Detail Shop Drawings of crane runways, brackets, hangers, and their attachments to building structural steel.

e. Power and control wiring diagrams, including terminals and numbers.
f. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
g. Factory finish system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer's printed installation instructions.
3. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein
4. Suggested spare parts list to maintain the equipment in service for a period of 2 years Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
6. Operation and Maintenance Data: As specified in General Conditions Operation and Maintenance Data.
7. Manufacturer's Certificate of Proper Installation, in accordance with Section General Conditions

1.04 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Maximum 120 degrees F; minimum 30 degrees F.

B. Humidity: 30 percent.

C. Atmosphere: Mildly corrosive.

D. Ventilation: As shown on Drawings.

1.05 EXTRA MATERIALS

A. Furnish for each remote control crane:

1. One transmitter.
2. One battery.

PART 2 PRODUCTS

2.01 GENERAL

A. Crane manufacturer to coordinate equipment requirements with steel structures, panels, drive motor, control panel, trolley and hoist, hoisting cable or chain, hook, crane mounted conductors, rails, stops, and electrical equipment controls.

B. Where adjustable speed drives or remote control systems are required, crane manufacturer to furnish a coordinated operating system.

2.02 SUPPLEMENTS

A. See supplements to this section for additional requirements.

2.03 RUNWAY

A. Runway beams, brackets, and associated framework furnished under Section 05 12 00, Structural Steel Framing

B. Runway rails shall conform to cross-sections and weights per yard as specified in CMAA No. 70 or No. 74. Furnish rails, crane stops, and conductors by crane manufacturer.

C. Support underhung crane runway rails by a suspension system of hanger rods and joints which will permit runway rails to adjust to normal fluctuations of weight occurring as crane travels along rails. Design suspension system for minimal support rod bending stresses. Furnish slotted holes and shims for lateral and vertical rail adjustment. Brace one rail laterally to prevent excess motion of runway. Brace both rails longitudinally.

2.04 BRIDGE

A. Furnish girders from structural shapes proportioned to resist vertical, lateral, and torsional forces.

B. Construct bridge end trucks in accordance with CMAA No. 70 or No. 74. Furnish end trucks with rail sweeps and impact-absorbing bumpers.

C. Furnish runway stops attached to resist force applied when contacted and locate at limit of travel of bridge. Runway stops shall not engage the wheels.

D. Provide bridge travel limit switches, located approximately 5 feet from each end of bridge runway, or as required such that bridge travel speed is reduced

to low speed prior to bridge engaging runway end-stops. Bridge drive speed past the limit switch locations shall be limited to low speed.

E. For top running cranes, provide footwalk of antislip plate, with toe guard, trussed handrails, and live load in accordance with CMAA No. 70 or CMAA No. 74 and ASME B30.2. Footwalk shall be full crane width and provide access to trolley, hoist, bus bar, and electrical boxes. Furnish platform to electrical festoons, including crossover walkway to full walkway width.

F. Wheels: Rolled or forged steel with treads and flanges heat treated, or cast iron wheels with chilled tread. Minimum tread hardness 200 Brinell. Clearances, wheel loads, and tolerances in accordance with CMAA No. 70 or No. 74. Wheel axles of alloy steel, machined and ground to receive inner bearing races. Use rotating axles and wheels mounted by press fit and keys.

G. Bridge driving machinery consisting of a cross shaft driven by an electrical motor through a gear speed reducer unit. Cross shaft, high-grade steel, turned, ground, polished, and adequately supported with self-aligning bearings. Shaft diameter to resist torsional strains when bridge is traveling under full load, or when stopped suddenly. Furnish oiltight speed reducer gear case and support on common base with bridge brake.

H. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.

I. Bearings: Combination radial and thrust type, double row, spherical ball, either prelubricated and sealed or fitted for pressure lubrication. Pressure lubrication fittings for maintenance accessibility.

J. Brakes: Electrically operated, adjustable, suitable for the service class indicated, with rated torque capacities as specified in CMAA No. 70 or CMAA No. 74.

K. Lights:

1. For top running cranes, provide twin T8 bulb fluorescent lights, spaced 12-foot center-to-center along the bridge length.
2. Light fixtures shall be 4-foot enclosed and gasketed type, with fiberglass housing, high impact acrylic lens, and diffuser with a stippled interior surface to spread lamp image.
3. Locate lights adjacent to the access footwalk so lights may be accessed for maintenance from footwalk. Aim lights to illuminate floor area below the bridge.
4. Provide light control pushbutton on crane control pendant.

5. Manufacturers:
   a. Lithonia.
   b. DMW.

2.05 TROLLEY

A. Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Design to control deflection of trolley assembly while transmitting the carrying load to bridge rails.

B. Drive shall consist of trolley drive shaft, driven by an electric motor through a gear reduction unit.

C. Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Minimum tread hardness 210 Brinell.

D. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.

E. Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.

F. Brakes: Suitable for service class and rated torque capacities as specified in ASME B30.11. Furnish stops on trolley rails or beams.

G. For bridge spans greater than 40 feet provide trolley travel limit switches, located approximately 6 feet from each end of trolley rails/beams, or as required such that trolley travel speed is reduced to low speed prior to trolley engaging the trolley end-stops. Trolley drive speed past the limit switch locations shall be limited to low speed.

2.06 HOIST

A. Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position. Furnish reeving as specified on supplement located at end of section. Provide right and left-hand grooved drum when two-part double reeving is specified.

B. Rope drum and surrounding members constructed to minimize abrasion, crushing or jamming of hoist rope. Load blocks enclosed type. Hoisting rope extra flexible, improved plow steel wire rope, made especially for hoist service.

C. Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars or other devices.

D. Brakes: Mechanical and electric load brake and controls, designed in accordance with ASME 4M, and adjustable to compensate for wear.

E. Hoisting Machinery: Load chain wheel driven through gear reductions, an electric motor, a hand chain wheel, load blocks, sheaves, chain, hook, and hoist braking.

F. Chain: Nonjamming alloy type. Hand wheel shall have a guard that prevents chain slipping or jumping. Chain hoists shall have chain storage adequate for storing the full lift length of chain and shall be designed and located to avoid interference while hoisting.

G. Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load, and positively held in place with locknuts, collars or other devices.

H. Brakes: In accordance with ASME HST 1M and HST 2M, adjustable to compensate for wear, spring set, electric release load brake system, which releases load when drive motor is energized and holds load when the drive motor is de-energized.

2.07 ELECTRICAL

A. Furnish electrical equipment including motors, motor starters, pendant control, control systems, wire, and conduit. Bridge conductors may be removed for shipment. Crane wiring by crane supplier.

B. Electrical: In accordance with NFPA 70, NEC Article 610.

C. Furnish motors compatible with adjustable frequency, variable speed, drive system, 40 to 1 speed range, suitable for hoist, trolley, and bridge drive applications. Controls with 120V ac, microprocessor based, pulsed width modulation design, withstand 45 degree C temperatures, housed in NEMA 250, Type 3R enclosure, and supplied with 200 percent overcurrent protection.

1. Manufacturer:
   a. P & H Smartorque.
   b. Or approved equal.

D. Bridge and trolley conductor voltage drops from runway supply taps shall permit the crane motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.

E. Enclosed Bus Bar Conductors: steel strip enclosed in insulation. Collector sliding shoe type, with adjustable spring tension arms for contact between bus bar and controls.

F. Enclosed Bus Bar Conductors: Stainless steel clad hard copper enclosed in insulation. Collector sliding noncopper bearing, carbon shoe type, with adjustable spring tension arms for contact between bus bar and controls. Collector mechanism components aluminum, stainless steel, plastic, or other noncorrosive materials.

G. Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanently lubricated roller bearings, with monorail support system that will dispense and retrieve flexible cable without twisting or tangling, and 20 percent spare conductor in each cable assembly.

H. Cable Reel Conductors: Flexible cable, housed on a circular wheel, counter-torque spring to dispense and retrieve cable, with sag not more than 3 feet below connection point on crane at maximum travel.

I. Grounding: External in accordance with NFPA 70, NEC Article 250.

2.08 CONTROLS

A. Furnish electric cranes with pendant control having momentary contact pushbuttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.

B. Controls: Fully magnetic, plain reversing type, housed in NEMA 250, Type 3R enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified crane service class.

C. Bridge and Trolley Drives: Soft start controls, 460/230V ac series device, installed in between drive motor and motor starter with torque and acceleration rate adjustable, suitable for crane service, and work in conjunction with crane controls.

D. Pushbutton Control Stations: Heavy-duty, oiltight, suspended from trolley, with control transformers to supply 120V ac power to pushbutton control station. Pushbutton enclosure supported with chain or wire rope. Control wire cable attached to support chain or wire rope at not more than 6-foot intervals. Furnish control station buttons for control of bridge, trolley, and hoist, ON/OFF main line contactor power switch which removes all power from crane and controls.

E. Remote Control System: Infrared, line-of-sight system, handheld and capable of operating all crane functions.

F. Control motions indicate direction of resultant crane motion. Furnish spring-loaded switch motions, with return to OFF position when switch is released and designed to prevent runaway crane situations.

G. Crane motions shall stop automatically when crane can no longer receive remote signals and designed to stop when control signal for any motion becomes ineffective.

H. Remote Control Crane Motions: Hook raise and lower, trolley movement, bridge movement, and crane power up and power. Furnish an EMERGENCY OFF pushbutton station which will disconnect main line power via a remote switch, and manual reset function to activate all motions after an EMERGENCY OFF event.

2.09 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location. Mounted on separate components of each crane assembly, to facilitate assembly in the field.

B. Lifting Lugs: Equipment weighing over 100 pounds.

2.10 FACTORY FINISHING

A. Prepare and prime coat in accordance with manufacturer’s standard.

2.11 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels and equipment for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: No-load run test on all equipment furnished.

C. Factory test report shall include certified Test Data Sheets.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Provide lubrication and lubrication fittings.

3.02 FIELD FINISHING

A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Test: Conduct on each crane.

1. Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.

B. Performance Test:

1. Conduct on each crane.
2. Load tests in compliance with OSHA, ASME B30.11, and ASME B30.16.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance.
2. 1 person-day for prestartup classroom or Site training.
3. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner and Engineer.

3.05 SUPPLEMENTS

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

1. Crane Data Sheet.
2. Crane Dimension Sheet.
3. Induction Motor Data Sheet.

END OF SECTION

CRANE DATA SHEET

Project: Topock Groundwater Remediation Project
Owner: Pacific Gas and Electric
Service: Remedy Produced Water Conditioning Plant
Equip. Tag Number(s):

Manufacturer.:
Model No.:
Number of Units: 1
Rev/Date/By: _____/_____/_____

GENERAL REQUIREMENTS

Equipment Capacity: 2 tons
Method of Control: Pendant
Location of Control: Remedy Produced Water Conditioning Building
Equipment Location:
☒Indoors ☐Outdoors

Factory Testing:
☒Required ☐Not Required
Field Testing: ☐Not required
☒Required, functional and Performance

Power Supply: Electric
Voltage 460/230
Phase 3
Frequency 60 Hz

BRIDGE	TROLLEY	HOIST
Type: ☒Single Girder ☐Double Girder ☒Top Running ☐Underhung	Type: ☒Top Running ☐Underhung	Type: ☐Electric, Wire Rope ☒Hand Operated, Chain
Service Class (ANSI): ☐A (standby) ☐B (light) ☒C (moderate) ☐D (heavy) ☐E (severe) ☐F (continuous)	Service Class (ANSI): ☐A (standby) ☐B (light) ☒C (moderate) ☐D (heavy) ☐E (severe) ☐F (continuous)	Service Class (ANSI): ☐H1 (standby) ☐H2 (light) ☒H3 (standard ☐H4 (heavy) ☐H5 (severe)
Speed (fpm): 30 to 40 ☒Constant Speed ☐Variable Speed ☒Hand Operated	Speed (fpm): _____ to _____ ☒Constant Speed ☐Variable Speed ☒Hand Operated	Speed (fpm): _____ to _____ ☒Constant Speed ☐Two Speed ☐Variable Speed
Motor hp: 2	Motor hp: 0.3	Motor hp: 5
Main Runway Electric Conductors: ☐Bus Bar ☒Festoon	Electric Conductors: ☐Bus Bar ☒Festoon ☐_____ ☐Cable Reel	Hook: See Crane Dimension Sheet Hook Manufacturer:_____ Reeving: To be completed
Bridge Drive System (CMAA): ☒A1 ☐A2 ☐A3 ☐A4 ☐A5 ☐A6		

SPECIAL REQUIREMENTS

Accessories:
☐Service Platform
☐Central Lubrication System
☒OSHA Operating and Safety Devices

Remote Controls:
☐Infrared, line-of-sight
☐Frequency Modulated (FM)
Manufacturer:_____
☒Extended Grease Fittings

Special Electrical Requirements:

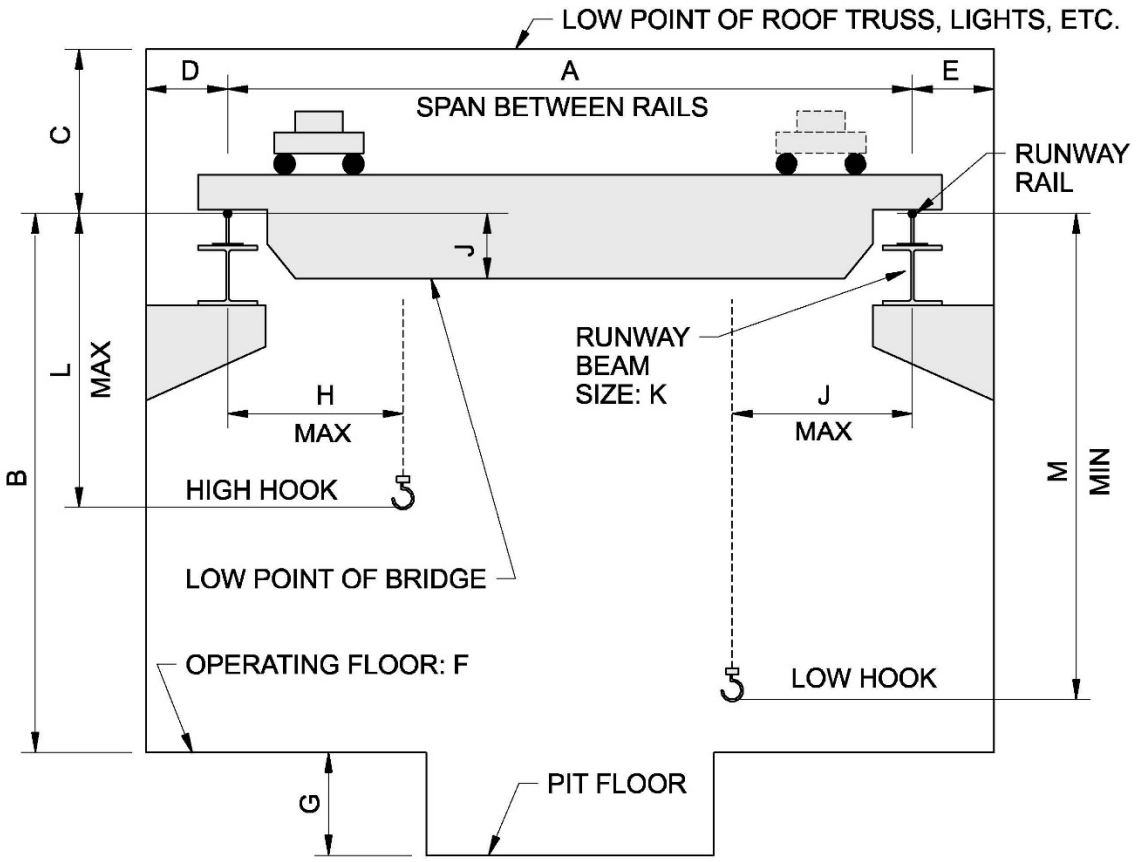
See Crane Dimension Sheet for clearances, lift distances, and details.

CRANE DIMENSION SHEET
Building Clearances for Top-Running Cranes

Project: Topock Groundwater Remediation Project

Owner: Pacific Gas and Electric

Equip. Tag No.:



A: 50’-5”	E: 1’-1”	I: NA
B: 15’-0.35”	F: 640.5	J: NA
C: 2’-6.65”	G: 0’-6”	K: See Drawings
D: 1’-1”	H: NA	L: 6’-0”

Notes:

1. Runway Length: 34’-6”
2. Bridge Wheelbase, Centered on Bridge, Maximum: NA

INDUCTION MOTOR DATA SHEET

Project: Topock Groundwater Remediation

Owner: Pacific Gas and Electric

Equipment Name: Remedy Produced Water Conditioning Plant

Equipment Tag Number(s):

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: 5

Voltage: 460/230

Phase: 3

Frequency: 60 Hz

Synchronous Speed: _____ rpm

☒ Thermal Protection: _____

☐ Space Heater: 120 volts, single-phase

Guaranteed Minimum Efficiency at Full Load: _____ percent

Guaranteed Minimum Power Factor at Full Load: _____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15

Enclosure Type: TEFC

☐ Multispeed, Two-Speed: _____ / _____ rpm

Winding:x ☐ One ☐ Two

Mounting Type: ☐ Horizontal ☒ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up _____ Down _____

☐ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

Operating Speed Range: _____ to _____% of Rated Speed

☐ Variable Torque

☒ Constant Torque

Additional Motor Requirements: ☐ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

SECTION 43 12 01
COMPRESSED AIR SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME): PTC 10, Compressors and Exhausters.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Standard Cubic Foot Per Minute (scfm): Volume flow rate of air at standard conditions of 60 degrees F, 14.7 psia, and 36 percent relative humidity.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Manufacturer’s catalog information, descriptive literature, and specifications.
   c. Detailed mechanical and electrical drawings showing equipment fabrications. Include dimensions, size, and locations of connections to other Work.
   d. External utility requirements such as air, water, power, and drain for each component.
   e. Functional description of internal and external instrumentation and controls including list of parameters monitored, controlled, or alarmed.
   f. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
   g. Power and control wiring diagrams, including terminals and numbers.
   h. Manufacturer’s diagrams for air compressor piping.

i. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing (to be completed).

B. Informational Submittals:

1. Manufacturer's recommended vibration limits of compressed air system.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing (to be completed).
3. Field performance test procedures.
4. Manufacturer's Instructions:
   a. Installation of equipment.
   b. Installation of vibration isolators.
5. Factory test reports of each test and inspection.
6. Field test reports for each functional and performance test of equipment.
7. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services (to be completed).
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. V-Belts: One set per compressor type.
2. Intake Filter Cartridges: Three per compressor type.
3. Prefilter Replaceable Elements: Five for each compressor type.
4. Oil Filter Replaceable Elements: Three for each compressor type.
5. Special Tools: One set.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. General: Furnish air compressors as a complete system that includes compressor, motor, controls, and accessories.

B. Rotary Screw Air Compressor:

1. Manufacturers: Quincy Northwest or Gardner Denver.

2. Air cooled, single-stage, rotary, oil-flooded, screw type with base mounted motor and V-belt drive with guard, including a convenient means for belt tensioning.
3. Rated for continuous operation at 115 degrees F at specified output without overheating.
4. Receiver mount and size to deliver 100 scfm at 100 psig under operating conditions of 14.7 psia and 115 degrees F at compressor inlet, with rotary screw speed on male drive rotor of not more than 4,000 rpm.
5. Oil Filter: Full flow type with replaceable elements capable of at least 1,000 hours of operation between changes.
6. Oil Separator Assembly:
    a. Rated at 150 psig and equipped with an ASME safety valve.
    b. Air leaving oil separator shall contain no more than 2 ppm of oil.
7. Oil Cooler: Air cooled, incorporate into oil system.
    a. Fouling Factor: 0.001.
8. Inlet Air Filter: Dry type with silencer and replaceable element.
9. Equip with pressure relief valve and vibration isolators.
10. Controls:
    a. Primary power disconnect switch.
    b. Combination motor starter with thermal overloads.
    c. ON/OFF/AUTO switch.
    d. Indicating lights.
    e. Elapsed time meter.
    f. Pressure switches.
    g. Fused control transformer sized to provide power for air dryer.
    h. Relays: Prewired and housed in NEMA 250, Type 12 panel mounted in convenient location on packaged compressor skid.
    i. Compressor shall start unloaded.
    j. Furnish automatic shutdown and illuminate alarm light mounted in control panel in event of:
        1) Loss of cooling water.
        2) High oil and air temperature.
    k. Manual Reset: Automatic shutdown.
    l. Pressure Switches:
        1) Mount in control panel with clearly labeled air-line connection installed to receiver.
        2) Bourdon tube actuated, double adjustment, SPDT mercury switch type rated for a minimum of 5 amps at 120V ac.
        3) Enclosures: NEMA 250, Type 12.

4) Initial Pressure Settings as follows:

Tag No.	Open At	Close At
Confirm with Engineer	75 psig rising	40 psig falling

m. Furnish ON/OFF/AUTO control and ON status indication for air compressor.
n. ON Mode: Compressor motor runs continuously.
o. AUTO Mode:
   1) Receiver pressure starts and stops compressor.
   2) Start compressor on falling pressure when contact closes.
   3) Activate low pressure alarm light if pressure falls further.
   4) As pressure increases, compressor stops on opening of contacts.
   5) Activate high pressure alarm light by closure of contacts.
   6) Furnish signal to activate the aftercooler control valve when compressor is operating.
p. Compressor Alarms:
   1) Indicate at control panel.
   2) Furnish normally open contacts for remote compressor FAIL indication when any alarm occurs.
q. Control Components:
   1) Prewired.
   2) Operate on a 120-volt ac power supply.
r. Power Supply: 460 volts, three-phase, 60 Hz.
s. Panel and Controls: Manufacturer's standard.
t. Enclosure: Provide sound insulation on 18 gauge (minimum) steel housing to achieve a sound output of 72 dBA maximum.

11. Motor: In accordance with NEMA MG 1.
   a. Type: Squirrel-cage, energy efficient.
   b. Enclosure: TEFC.
   c. Windings: Copper.
   d. Duty Cycle: Continuous.
   e. Temperature Rating: 40 degrees C ambient.
   f. Horsepower: Minimum: 15.
   g. Rpm: Maximum 1,800.
   h. Volts: 460.
   i. Phase: Three.
   j. Frequency: 60 Hz.
   k. Service Factor: 1.15.

l. Minimum Full-Load Efficiency: Not less than 93 percent.
m. Connected Load: Not to exceed motor nameplate horsepower rating at discharge pressures up to 125 psig.

C. Refrigerant Air Dryer:

1. Manufacturers and Products: Compressor manufacturer's standard.
2. Components:
   a. Hermetically sealed refrigeration unit with air-cooled refrigeration condenser.
   b. Air-to-refrigerant chiller and air-to-air precooler-reheater tube-in-tube, nonfouling heat exchanger(s).
   c. Combination Separator-Filter: Capable of removing 100 percent of solid particles 3 microns in size and larger.
      1) Separator: Stainless steel.
      2) Filter: Cold coalescing type.
   d. Equip dryer with an automatic drain trap for removing collected condensate.
   e. Provide power on light and high temperature air warning light.
   f. Utilize hot gas bypass system to maintain constant dew point from no-load to full-load conditions.
   g. Provide fan cutout switch to stop fans during low ambient temperature conditions.
3. House entire unit in 18-gauge steel case suitable for mounting on receiver.
4. Electrical System: Thermal and overload protection with automatic reset.
5. Dryer Capacity: 38 degrees F pressure dew point at 100 psig with a flow of 125 scfm at a dryer inlet temperature of 100 degrees F saturated.
   a. Dryer Pressure Drop: Maximum 5 psig.
6. Refrigerant Compressor Drive:
   a. 120 volts.
   b. Single-phase.
   c. 60 Hz.

D. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

E. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification numbers shown.

F. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

2.02 ACCESSORIES

A. Air Receiver DRM-103:

1. Horizontal welded steel ASME receiver.
2. Maximum Working Pressure: 150 psig.
3. Capacity: 200 gallons.
4. Maximum Length: 78 inches
5. Fabrication: Welded carbon steelplate with ASME code required inspection openings.
6. Plate Thickness: For a maximum allowable working pressure of 150 psig plus a 1/16-inch corrosion allowance.
7. Receiver shall have support saddles with pre-cut holes for anchor bolts.
8. In accordance with ASME Code for Unfired Pressure Vessels.

2.03 SHOP/FACTORY FINISHING

A. Prepare, and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Furnish manufacturer’s standard enamel finish, color as selected.

2.04 SOURCE QUALITY CONTROL

A. Inspect control panels for required construction, electrical connection, and intended function.

B. Test all equipment and control panels actually furnished.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install equipment on vibration isolators in accordance with manufacturer’s instructions.

1. Piping: Equip with full-size flexible discharge connection, check valve, and isolation valve.

B. Air Compressor Piping:

1. Install in accordance with manufacturer's piping diagrams.
2. Pipe relief valve, tank drain, and separator drain to floor drain.

3.02 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each piece of equipment in the system.

1. Vibration Test:
   a. System shall not develop amplitudes of vibration in excess of manufacturer's recommendations.
   b. Test with units installed and in normal operation.
   c. If units exhibit vibration in excess of the limits adjust or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.

B. Performance Test:

1. Conduct on each.
2. Perform under actual or approved simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Perform with Engineer present.
5. Adjust, realign, or modify units and retest.

END OF SECTION

SECTION 43 40 02
HIGH DENSITY POLYETHYLENE TANK

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME).
2. ASTM International (ASTM).

1.02 DEFINITIONS

A. HDPE: High Density Polyethylene.

1.03 DESIGN REQUIREMENTS

A. Design Loads: See data sheet.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fabricators catalog information, descriptive literature, specifications, and identification of materials of construction, including complete resin system information.
   b. Letter from resin manufacturer stating that selected resin is suitable for intended service.
   c. Detailed fabrication drawings.
   d. Tank data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, corrosion barrier thickness, and details of nozzle designs.
   e. Tank capacity chart indicating gallons (cubic feet of volume) for each inch of depth and cumulative total from bottom
   f. Fabricator’s detailed requirements for tank foundations.

B. Informational Submittals:

1. Complete design calculations for tanks, supports, anchorage, and appropriate accessories.
2. Fabricator’s Certificate of Compliance with fabrication requirements.
3. Quality Assurance Inspection.

4. Certification that supports and access nozzles have been coordinated with actual equipment being furnished.
5. Component and attachment testing seismic certificate of compliance as required.
6. Special shipping, storage and protection, and handling instructions.
7. Fabricator's printed installation and tank support instructions.
8. Manufacturer's Certificate of Proper Installation.

1.05 QUALITY ASSURANCE

A. Fabricator's Quality Assurance Supervisor: Minimum of 5 years' experience in producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least 5 years.

B. Designer: Registered professional engineer licensed in California.

C. Independent HDPE Quality Assurance Inspector:

1. Minimum 5 years' experience as HDPE tank inspector.
2. Representing a corporately and financially independent organization that can function as an unbiased inspection authority.
3. Professionally independent of manufacturers, suppliers, and installers of systems being inspected.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements (to be completed). In addition, prepare and protect tank for shipment as follows:

1. Mount tank on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
2. Protect flanged nozzles with wooden blinds bolted to flange and having a diameter of 2 inches greater than outside diameter of flange.
3. Provide either rigid plugs inside ends to prevent deflection or wooden boxes for unflanged components. Brace open end of tank with suitable stiffening member to prevent deflection.
4. Do not ship components or other pieces loose inside tank.
5. Load tank with at least 2 inches of clearance between tank (including fittings) and bulkheads, or bed of vehicle.
6. Regardless of mode of transportation, firmly fasten and pad components to prevent shifting of load or flexing of components while in transit.

1.07 SEQUENCING AND SCHEDULING

A. Do not ship tank from factory until Engineer's review of Certification of Factory Testing is completed.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

A. Some specific requirements relative to this section are attached as supplements at the end of section.

2.02 SERVICE CONDITIONS

A. Operating Pressure: Atmospheric.

2.03 MATERIALS

A. Resin: Suitable for intended service.

1. Premium grade and corrosion resistant.
2. Post-cure tank and appurtenances in accordance with resin manufacturer's recommendation for time and temperature. Post-curing should be completed with warm-to-hot dry air, free of combustion products. Hot spots shall be avoided.
3. Apply a white color coat after inspection of laminate has been completed.

B. Marking:

1. Identify each tank with fabricator's name, capacity in gallons, maximum temperature, design pressure/vacuum, specific gravity, pH, resin, minimum thickness, tank number, tank name, and date of manufacture.
2. Provide permanent marking. Seal decals, labels, etc., into laminate exterior with clear resin.
3. Calibration Strips:
   a. Translucent, 6 inches wide.
   b. Calibration: Multiples of 50 gallons or less.
   c. Stencil gallonage in 2-inch-high numerals.

C. Nozzles:

1. Gusset 4-inch or smaller nozzles with conical or plate type gussets. Larger nozzles shall be gusseted, if noted.

2. Finish flush with inside surface of tank, unless otherwise indicated.
3. Gaskets:
   a. Provide two per nozzle, 1/8-inch-thick, full-face elastomeric material having a hardness of Shore A60 plus or minus 5.
   b. Material shall be suitable for intended service.
4. Flanged Nozzles: Rated at 100 psi, with other dimensions and bolting corresponding to ASME B16.5 for 150-pound steel flanges.
5. Back face of flanges shall be spot-faced, flat and parallel to flange face of sufficient diameter to accept SAE metal washer under bolthead or nut.

D. Dip-Pipes: If provided, materials should conform to Section 40 50 00, Power Plant Piping Materials, and as per approved Shop Drawings.

2.04 APPURTENANCES

A. Supports:

1. Pipe Supports:
   a. Provide integral with tank wall for tank overflow pipes, loading pipes and recirculation pipes.
   b. Spacing of supports shall be as recommended by fabricator, but shall not be greater than 4 feet on center.

B. Lifting Lugs: Provide suitably attached for tank weighing over 100 pounds.

C. Anchor Bolts: Type 316 stainless steel bolts, sized by tank manufacturer.

D. Manway Bolts: Type 316 stainless steel bolts

E. Heat Tracing: See HDPE Tank Schedule.

2.05 SOURCE QUALITY CONTROL

A. Factory Test Reports: Certify results, by signature, of the following:

1. Inspections: Results of hydrostatic testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with fabricator’s written instructions.

B. Accurately place anchor bolts using templates furnished by fabricator.

3.02 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each tank.
2. Hydrostatic leak test with tank full of clean water. Allow water to stand for 24 hours to verify no leakage.

3.03 MANUFACTURER'S FIELD SERVICES

A. Provide fabricator's representative at Site for installation assistance, inspection and certification of proper installation for equipment.

3.04 SUPPLEMENT

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

1. HDPE Tank Schedule.

END OF SECTION

HDPE Tank Schedule						
Name of Tank	**25% Caustic Storage Tank**	**Coagulant Storage Tank**	**19% HCl Acid Tank**	**MW-20 Well Maint. Reagent Day Tank**	**TW Bench Well Maint. Reagent Day Tank**	**TW Bench Purge Water Return Tank**
Equipment Numbers	TNK-910	TNK-920	TNK-930	*T719	*T903	*T904
Rotationally or Contact-molded						
Maximum Capacity Measured to High Solution Level (gallons)	500	30 (Note 1)	500	1,000 gal	500 gal	1,000 gal
Installation (Vertical/Horizontal)	Vertical - Note 3	Vertical - Note 4	Vertical - Note 3	Vertical	Vertical	Vertical
Diameter (feet)	*	*	*	*	*	*
Straight Shell Height (feet)	*	*	*	*	*	*
Support (saddles, flat pad, legs)	*	*	*	*	*	*
Type of Bottom Head	Flat	Flat	Flat	Flat	Flat	Flat
Type of Top Head	Dished	Dished	Dished	Dished	Dished	Dished
Ladder Required (Yes/No)	No	No	No	No	No	No

HDPE Tank Schedule						
Name of Tank	**25% Caustic Storage Tank**	**Coagulant Storage Tank**	**19% HCl Acid Tank**	**MW-20 Well Maint. Reagent Day Tank**	**TW Bench Well Maint. Reagent Day Tank**	**TW Bench Purge Water Return Tank**
Tank Location (indoor/outdoor)	Indoor	Indoor	Indoor	Indoor	Indoor	Indoor
Ambient Temperature Range (degrees F)	250-130°F	25-130°F	25-130°F	25-130°F	25-130°F	25-130°F
Exterior Loading (psf):						
Personnel Roof Loads	*	*	*	*	*	*
Platforms	*			*	*	*
Mixers	N/A	N/A	N/A	N/A	N/A	N/A
Pipe Supports	*	*	*	*	*	*
Operating Contents:						
Temperature (degrees F, not to exceed 180)	75°F	75°F	75°F	75°F	75°F	75°F
Chemical Composition	25% Caustic	Nalco Ultrion 8187	19% HCl	Note 2	Note 2	Note 2
Specific Gravity	1.28	1.34	1.09	Note 2	Note 2	Note 2

HDPE Tank Schedule						
Name of Tank	**25% Caustic Storage Tank**	**Coagulant Storage Tank**	**19% HCl Acid Tank**	**MW-20 Well Maint. Reagent Day Tank**	**TW Bench Well Maint. Reagent Day Tank**	**TW Bench Purge Water Return Tank**
Concentration	25%	100%	19%	Note 2	Note 2	Note 2
pH Range	>14	3.5	<1	Note 2	Note 2	Note 2
Sight Glass Type (1 or 2)	*		*			
Sight Glass Tube Length	*		*			
Insulation/Heat Tracing (Yes/No)	Yes, Tracing	Yes, Tracing	No	No	No	No

NOTES:

*- Manufacturer to Specify
1. Capacity to be determined.
2. Tank contents to be determine.
3. Tank to be double wall
4. Provide tank stand and anchor to foundation.

SECTION 43 40 13
STEEL STORAGE TANK

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
2. ASTM International (ASTM).

1.02 DESIGN REQUIREMENTS

A. Design Loads: See data sheet.

B. Conform to AWWA D-100, Welded Carbon Steel Tanks for Water Service.

1.03 SUBMITTALS

A. Action Submittals - submit the following:

1. Shop Drawings:
   a. Layout and all critical dimensions.
   b. Materials.
   c. Fitting locations and details.
   d. Accessories.
   e. Anchors and holddowns, as required.
2. Product Data: Manufacturer's literature, illustrations, calibration charts, specifications, engineering data and installation instructions.

B. Informational Submittals - submit the following:

1. Certificates:
   a. Certification of Design, including Anchorage.
   b. Certificate of Compliance for Lightning Protection Systems.
2. Source Quality Control Submittals: Shop test reports.
3. Site Quality Control Submittals: Field inspection reports as specified in Part 3 of this specification.

1.04 QUALITY ASSURANCE

A. Fabricator's Quality Assurance Supervisor: Minimum of 5 years' experience in producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least 5 years.

B. Designer: Registered professional engineer licensed in California.

C. Independent Quality Assurance Inspector:

1. Minimum 5 years' experience as steel tank inspector.
2. Representing a corporately and financially independent organization that can function as an unbiased inspection authority.
3. Professionally independent of manufacturers, suppliers, and installers of systems being inspected.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements (to be completed). In addition, prepare and protect tank for shipment as follows:

1. Mount tank on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
2. Protect flanged nozzles with wooden blinds bolted to flange and having a diameter of 2 inches greater than outside diameter of flange.
3. Provide either rigid plugs inside ends to prevent deflection or wooden boxes for unflanged components. Brace open end of tank with suitable stiffening member to prevent deflection.
4. Do not ship components or other pieces loose inside tank.
5. Load tank with at least 2 inches of clearance between tank (including fittings) and bulkheads, or bed of vehicle.
6. Regardless of mode of transportation, firmly fasten and pad components to prevent shifting of load or flexing of components while in transit.

1.06 SEQUENCING AND SCHEDULING

A. Do not ship tank from factory until Engineer's review of Certification of Factory Testing is completed.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

A. Some specific requirements relative to this section are attached as supplements at the end of section.

2.02 SERVICE CONDITIONS

A. Operating Pressure: Atmospheric.

2.03 MATERIALS

A. Construction:

1. Tanks shall be fabricated in accordance with AWWA D-100, Welded Carbon Steel Tanks for Water Service (Shop Fabricated).
2. Steel shall conform to ASTM A36.
3. Minimum thickness for any part of the storage tank, wall, floor or roof shall be a minimum thickness, as determined in AWWA D-100 or as specified, whichever is greater.
4. All tanks shall be fabricated using a minimum number of joints.
5. All welds shall be non-porous and free from pinholes, cracking and under-cutting. Sharp edges and high spots shall be ground smooth. Corners shall be ground to a minimum radius of 1/8-inch. All weld flux, spatter and foreign matter shall be removed. All welds shall be continuous and smooth and by ASME Code qualified welders.
6. Interior and exterior surfaces and appurtenances shall be painted in accordance with Section 09 90 00, Painting and Coating.
7. The tanks shall be sealed air tight at all openings prior to shipment and installation.
8. Tanks shall be cathodically protected in accordance with Section 26 42 00, Cathodic Protection.

B. Nozzles:

1. Gusset 4-inch or smaller nozzles with conical or plate type gussets. Larger nozzles shall be gusseted, if noted.
2. Finish flush with inside surface of tank, unless otherwise indicated.
3. Gaskets:
   a. Provide two per nozzle, 1/8-inch-thick, full-face elastomeric material having a hardness of Shore A60 plus or minus 5.
   b. Material shall be suitable for intended service.

4. Flanged Nozzles: Rated at 100 psi, with other dimensions and bolting corresponding to ASME B16.5 for 150-pound steel flanges.
5. Back face of flanges shall be spot-faced, flat and parallel to flange face of sufficient diameter to accept SAE metal washer under bolthead or nut.

2.04 APPURTENANCES

A. Supports:

1. Pipe Supports:
   a. Provide for tank overflow pipes and loading pipes.
   b. Spacing of supports shall be as recommended by fabricator, but shall not be greater than 4 feet on center.

B. Lifting Lugs: Provide suitably attached for tank weighing over 100 pounds.

C. Anchor Bolts: Type 316 stainless steel bolts, as sized by manufacturer.

D. Manway Bolts: Type 316 stainless steel bolts.

2.05 SOURCE QUALITY CONTROL

A. Factory Test Reports: Certify results, by signature, of the following:

1. Inspections.
2. Results of hydrostatic testing.
3. Test reports of physical properties of standard laminates.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with fabricator’s written instructions.

B. Accurately place anchor bolts using templates furnished by fabricator.

3.02 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each tank.
2. Hydrostatic leak test with tank full of clean water. Allow water to stand for 24 hours to verify no leakage.

3.03 MANUFACTURER'S FIELD SERVICES

A. Provide fabricator's representative at Site for installation assistance, inspection and certification of proper installation for equipment.

3.04 SUPPLEMENT

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

1. Steel Tank Schedule.

END OF SECTION

Steel Tank Schedule		
Name of Tank*	**MW-20 Carbon Substrate Tank**	**TWB Carbon Substrate Tank**
Equipment Numbers	*T701	*T901
Filament-wound or Contact-molded		
Maximum Capacity Measured to High Solution Level (gallons)	15,000 gal	3,000 gal
Installation (Vertical/Horizontal)	Horizontal	Horizontal
Diameter (feet)	*	*
Straight Shell Height (feet)	*	*
Support (saddles, flat pad, legs)	*	*
Type of Ends	Flat	Flat
Ladder Required (Yes/No)	No	No
Tank Location (indoor/outdoor)	Outdoor	Outdoor
Ambient Temperature Range (degrees F)	30-120°F	30-120°F
Exterior Loading (psf):		
Personnel Roof Loads	20 psf	20 psf
Platforms	*100 psf	100 psf
Mixers	N/A	N/A
Pipe Supports	*	*
Operating Contents:		
Temperature (degrees F, not to exceed 180)	75°F	75°F
Chemical Composition	Note 2	Note 2
Specific Gravity	Note 2	Note 2
Concentration	Note 2	Note 2
pH Range	Note 2	Note 2
Sight Glass Type (1 or 2)		
Sight Glass Tube Length		
Insulation/Heat Tracing (Yes/No)	No	No

NOTES:

*- Manufacturer to Specify
1. Capacity to be determined.
2. Tank contents to be determined.
3. Tank to be double wall and heat traced.

Steel Tank Schedule	
Name of Tank*	**Conditioned Water Storage Tank**
Equipment Numbers	*T510
Filament-wound or Contact-molded	
Maximum Capacity Measured to High Solution Level (gallons)	42,000 gal
Installation (Vertical/Horizontal)	Vertical
Diameter (feet)	25
Straight Shell Height (feet)	12
Support (saddles, flat pad, legs)	*
Type of Ends	Flat
Ladder Required (Yes/No)	Yes
Tank Location (indoor/outdoor)	Outdoor
Ambient Temperature Range (degrees F)	30-120°F
Exterior Loading (psf):	
Personnel Roof Loads	20 psf
Platforms	100 psf
Mixers	N/A
Pipe Supports	*
Operating Contents:	
Temperature (degrees F, not to exceed 180)	75°F
Chemical Composition	Treated water
Specific Gravity	Note 2
Concentration	Note 2

Steel Tank Schedule	
pH Range	Note 2
Sight Glass Type (1 or 2)	None
Sight Glass Tube Length	NA
Insulation/Heat Tracing (Yes/No)	No

Steel Tank Schedule	
Name of Tank*	**Remedy FreshWater Storage Tank**
Equipment Numbers	*T103
Filament-wound or Contact-molded	
Maximum Capacity Measured to High Solution Level (gallons)	10,000 gal
Installation (Vertical/Horizontal)	Vertical
Diameter (feet)	10
Straight Shell Height (feet)	10
Support (saddles, flat pad, legs)	*
Type of Ends	Flat
Ladder Required (Yes/No)	Yes
Tank Location (indoor/outdoor)	Outdoor
Ambient Temperature Range (degrees F)	30-120°F
Exterior Loading (psf):	
Personnel Roof Loads	20
Platforms	*100 psf
Mixers	N/A
Pipe Supports	*
Operating Contents:	
Temperature (degrees F, not to exceed 180)	75°F
Chemical Composition	Note 2

Steel Tank Schedule	
Specific Gravity	Note 2
Concentration	Note 2
pH Range	Note 2
Sight Glass Type (1 or 2)	None
Sight Glass Tube Length	NA
Insulation/Heat Tracing (Yes/No)	No

SECTION 44 42 56.04
SUBMERSIBLE WELL PUMPS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME).
2. ASTM International (ASTM).
3. Hydraulic Institute Standards (HIS).
4. National Electrical Manufacturers Association (NEMA).
5. National Fire Protection Association (NFPA): 70, National Electrical Code.
6. Underwriters Laboratories Inc. (UL).

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction, including cable seal details.
3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.
4. Power and control wiring diagrams, including terminals, and numbers.
5. Motor data, in accordance with the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
6. Factory-finish system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer’s printed installation instructions.

3. Suggested spare parts list to maintain equipment in service for period of 1 year. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
4. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
5. Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

A. Submersible pump for pumping groundwater.

B. Designed for continuous operation under submerged conditions.

2.02 COMPONENTS

A. Equipment consists of pump complete with motor, control system, and power cable.

B. Motor nameplate horsepower not to be exceeded at head-capacity point on pump curve.

C. Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NEC specifications for pump motors. Cables shall be of sufficient length to reach junction boxes without strain or splicing.

D. Pumps to be designed, manufactured, and tested in accordance with all applicable ANSI/HI 2000 Standards.

2.03 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.

2.04 SOURCE QUALITY CONTROL

A. Submersible Motor Functional Test: In accordance with HIS 11.6.

PART 3 EXECUTION

3.01 SUPPLEMENTS

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

1. Submersible Well Pump PMP-001 Data Sheet.
2. Submersible Well Pump PMP-002 Data Sheet.
3. Submersible Well Pump PMP-440 Data Sheet.
4. Submersible Well Pump PMP-442, 443 Data Sheet.
5. Submersible Well Pump PMP-*541, *542 Data Sheet.
6. Submersible Well Pump PMP-*544, *545, *543 Data Sheet.
7. Submersible Well Pump PMP-*546, *547, *548, *549 Data Sheet.
8. Submersible Well Pump PMP-*641A, *641B Data Sheet.
9. Submersible Well Pump PMP-441 Data Sheet.
10. Submersible Well Pump PMP-*540 Data Sheet.
11. Submersible Well Pump PMP-*640 Data Sheet.

END OF SECTION

SUBMERSIBLE WELL PUMP DATA SHEET

Equipment Tag Numbers: PMP-001

Service: Freshwater Injection well, FW-001, Backwash Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **385S400-5**
No .Pumps Required: 1	Drive Type: Constant Speed (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Groundwater/Backwash	**Capacity: (US gpm): Rated: 400**
Pumping Temperature (°F):	TDH at Submersible Pump Outlet (ft): 276
Normal 86 Max 100 Min 65	Minimum Submergence: 5 ft
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water up to 2,200 mg/L	Elevation: Ground Surface: 561 Depth to Water: 106 Depth to Pump Screen: 160
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) -	
Max Pump Speed @ Rated Capacity (rpm):	3450
Notes: *- Manufacturer to Specify 1. Backwash Pump operates intermittently on a weekly backwash cycle	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Carbon Steel (ASTM A53 Gr. B or API 5CT J55)
Impeller Material: Type 304 stainless steel	Size: Well has 14”-inch diameter casing. Pump Submergence is 62’. Well is 356’ deep
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Manufacturer to Specify
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Manufacturer to Specify
Notes:	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed:
Motor Horsepower: Manufacturer to Specify	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

SUBMERSIBLE WELL PUMP DATA SHEET

Equipment Tag Numbers: PMP-002

Service: Freshwater Injection well, FW-002, Backwash Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **230S150-5B**
No .Pumps Required: 1	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Freshwater/Backwash	**Capacity: (US gpm): Rated: 200**
Pumping Temperature (°F):	TDH at Submersible Pump Outlet (ft): 204
Normal 86 Max 130 Min 20	Minimum Submergence: 5 ft
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: 546 Depth to Water: 91 Depth to Pump Screen: 106
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): 3450	
Notes: *- Manufacturer to Specify 1. Backwash Pump operates intermittently on a weekly backwash cycle	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Carbon Steel (ASTM A53 Gr. B or API 5CT J55)
Impeller Material: Type 304 stainless steel	Size: Well has 14”-inch diameter casing. Pump Submergence is 45’. Well is 151’ deep
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Manufacturer to Specify
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Manufacturer to Specify
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed:
Motor Horsepower: Manufacturer to Specify	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

Equipment Tag Numbers: PMP-440

Service: Extraction Well Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **5S05-13**
No .Pumps Required: 5	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Groundwater	**Capacity: (US gpm): Rated: 1.5**
Pumping Temperature (°F):	TDH at Submersible Pump Inlet (ft): 300
Normal 86 Max 130 Min 20	Minimum Submergence: TBD ft
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: 546 Depth to Water: See Contract Drawings Depth to Pump Screen: See Contract Drawings
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): *	
Notes: *- Manufacturer to Specify 1. Extraction Well pump operates continuously	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Stainless Steel
Impeller Material: Type 304 stainless steel	Size: Refer to Contract Drawings
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Viton
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Viton
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed: TBD
Motor Horsepower: 1/2	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

Equipment Tag Numbers: PMP-442,443

Service: Backwash Well Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **40S50-15**
No .Pumps Required: 4	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Freshwater/Backwash	**Capacity: (US gpm): Rated: 40**
Pumping Temperature (°F):	TDH at Submersible Pump Inlet (ft): 240
Normal 86 Max 130 Min 20	Minimum Submergence: TBD ft
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: See Contract Drawings Depth to Water: See Contract Drawings Depth to Pump Screen: See Contract Drawings
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): *	
Notes: *- Manufacturer to Specify 1. Backwash Pump operates intermittently on a weekly backwash cycle	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Stainless Steel
Impeller Material: Type 304 stainless steel	Size: Refer to Contract Drawings
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Viton
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Viton
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed: TBD
Motor Horsepower: 5	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

Equipment Tag Numbers: PMP-*541, *542,

Service: Backwash Well Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **60S75-13**
No .Pumps Required: 6	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Freshwater/Backwash	**Capacity: (US gpm): Rated: 50**
Pumping Temperature (°F):	TDH at Submersible Pump Inlet (ft): 268 (*541, *542
Normal 86 Max 130 Min 20	Minimum Submergence: TBD
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: See Contract Drawings Depth to Water: See Contract Drawings Depth to Pump Screen: See Contract Drawings
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): *	
Notes: *- Manufacturer to Specify 1. Backwash Pump operates intermittently on a weekly backwash cycle	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Stainless Steel
Impeller Material: Type 304 stainless steel	Size: Refer to Contract Drawings
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Viton
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Viton
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed: TBD
Motor Horsepower: 7 1/2	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

Equipment Tag Numbers: PMP-*544, *545, *543

Service: Backwash Well Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **40S50-15**
No .Pumps Required: 13	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Freshwater/Backwash	**Capacity: (US gpm): Rated: 35**
Pumping Temperature (°F):	TDH at Submersible Pump Inlet (ft): 200
Normal 86 Max 130 Min 20	Minimum Submergence: TBD
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: See Contract Drawings Depth to Water: See Contract Drawings Depth to Pump Screen: See Contract Drawings
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): *	
Notes: *- Manufacturer to Specify 1. Backwash Pump operates intermittently on a weekly backwash cycle	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Stainless Steel
Impeller Material: Type 304 stainless steel	Size: Refer to Contract Drawings
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Viton
	Model: Manufacturer to Specify
	Material: Manufacturer to Specify
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Viton
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed: TBD
Motor Horsepower: 5	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

Equipment Tag Numbers: PMP-*546, *547, *548, *549

Service: Backwash Well Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **40S50-12**
No .Pumps Required: 64	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Freshwater/Backwash	**Capacity: (US gpm): Rated: 40**
Pumping Temperature (°F):	TDH at Submersible Pump Inlet (ft): 180
Normal 86 Max 130 Min 20	Minimum Submergence: TBD
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: See Contract Drawings Depth to Water: See Contract Drawings Depth to Pump Screen: See Contract Drawings
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): *	
Notes: *- Manufacturer to Specify 1. Backwash Pump operates intermittently on a weekly backwash cycle	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Stainless Steel
Impeller Material: Type 304 stainless steel	Size: Refer to Contract Drawings
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Viton
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Viton
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed: TBD
Motor Horsepower: 5	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

Equipment Tag Numbers: PMP-*641A, *641B

Service: Backwash Well Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **385S300-4**
No .Pumps Required: 4	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Freshwater/Backwash	**Capacity: (US gpm): Rated: 400**
Pumping Temperature (°F):	TDH at Submersible Pump Inlet (ft): 280
Normal 86 Max 130 Min 20	Minimum Submergence: TBD
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: See Contract Drawings Depth to Water: See Contract Drawings Depth to Pump Screen: See Contract Drawings
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): *	
Notes: *- Manufacturer to Specify 1. Backwash Pump operates intermittently on a weekly backwash cycle	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Stainless Steel
Impeller Material: Type 304 stainless steel	Size: Refer to Contract Drawings
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Viton
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Viton
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed: TBD
Motor Horsepower: 30	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

Equipment Tag Numbers: PMP-441

Service: Extraction Well Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **5S05-13**
No .Pumps Required: 2	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Groundwater	**Capacity: (US gpm): Rated: 1.5**
Pumping Temperature (°F):	TDH at Submersible Pump Inlet (ft): 311-313
Normal 86 Max 130 Min 20	Minimum Submergence: TBD ft
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: 546 Depth to Water: See Contract Drawings Depth to Pump Screen: See Contract Drawings
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): *	
Notes: *- Manufacturer to Specify 1. Extraction Well pump operates continuously	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Stainless Steel
Impeller Material: Type 304 stainless steel	Size: Refer to Contract Drawings
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Viton
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Viton
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed: TBD
Motor Horsepower: 1/2	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

Equipment Tag Numbers: PMP-*540

Service: Extraction Well Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **5S05-13**
No .Pumps Required: 1	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Groundwater	**Capacity: (US gpm): Rated: 50**
Pumping Temperature (°F):	TDH at Submersible Pump Inlet (ft): 270
Normal 86 Max 130 Min 20	Minimum Submergence: TBD ft
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: 546 Depth to Water: See Contract Drawings Depth to Pump Screen: See Contract Drawings
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): *	
Notes: *- Manufacturer to Specify 1. Extraction Well pump operates continuously	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Stainless Steel
Impeller Material: Type 304 stainless steel	Size: Refer to Contract Drawings
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Viton
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Viton
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed: TBD
Motor Horsepower: 7 1/2	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

Equipment Tag Numbers: PMP-*640

Service: Extraction Well Pump	
Pump Manufacturer **1. Grundfos** **2.** **3.**	**Model Number** **230S200-7C**
No .Pumps Required: 5	Drive Type: Constant (Note 1)
LIQUID	**OPERATING/SERVICE CONDITIONS**
Liquid Pumped: Groundwater	**Capacity: (US gpm): Rated: 50**
Pumping Temperature (°F):	TDH at Submersible Pump Inlet (ft): 270
Normal 86 Max 130 Min 20	Minimum Submergence: TBD ft
Specific Gravity at 60°F: 1	
Vapor Pressure at 60°F: 0.256 psia	Min. Pump Bowl Efficiency @ rated Capacity: *
Viscosity (cP): 1	**Location: Topock Compressor Station, Needles, CA**
pH: 6.5-8.5	
Corrosion/Erosion caused by: Corrosives /chlorides in water	Elevation: Ground Surface: 546 Depth to Water: See Contract Drawings Depth to Pump Screen: See Contract Drawings
PERFORMANCE REQUIREMENTS:	
Pump Speed Range (rpm) - *	
Max Pump Speed @ Rated Capacity (rpm): *	
Notes: *- Manufacturer to Specify 1. Extraction Well pump operates continuously	

COMPONENTS	
IMPELLER	**PUMP COLUMN**
Impeller Type: *	Column Material: Stainless Steel
Impeller Material: Type 304 stainless steel	Size: Refer to Contract Drawings
Impeller Wear Ring: Manufacturer to Specify	Connections: NPT couplings
BOWL AND BELL	**MOTOR**
Bowl and Suction Case Material: Type 304 stainless steel	Type: Franklin or approved equal
Bowl and Suction Case Bearings: Manufacturer to Specify	Material: Type 304 stainless steel
Suction Bell: Type 304 stainless steel	
Strainer: Pump Screen Type 304 stainless steel	**FACTORY TESTING**
	MECHANICAL SEAL
	Manufacturer: Manufacturer to Specify
	Model: Manufacturer to Specify
	Material: Viton
	API Class Code: N/A
	Rotating Face: Manufacturer to Specify
	Stationary Face: Manufacturer to Specify
	O-Rings: Viton
Notes: Provide motor shroud	

ELECTRIC MOTOR DATA	
Type: Submersible Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer. Service Factor (rated @ maximum ambient temperature): 1.15 at 50°C ambient	
General:	Driven Speed: TBD
Motor Horsepower: 20	
Voltage: 460	
Phase: 3	
Frequency: 60-Hz	
Torque: Variable	
Additional Requirements:	

SECTION 44 42 56.09
SUBMERSIBLE CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers' Association (ABMA).
2. American Society of Mechanical Engineers (ASME): B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
3. ASTM International (ASTM): A48/A48M, Standard Specification for Gray Iron Castings.
4. Hydraulic Institute Standards (HIS).
5. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
6. Occupational Safety and Health Administration (OSHA).

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each pump assembly.
   b. Complete pump and motor catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data curves at nominal pump speed showing head, capacity, horsepower demand, NPSH required, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately head, capacity, horsepower demand, NPSHR, and overall efficiency required at Rated Conditions and at Secondary Conditions (if applicable).
   d. Certified detail mechanical, and electrical drawings showing equipment dimensions, arrangement, assembly, including

locations and type of connections and weights of major equipment and components.

e. Power and control wiring diagrams, including terminals and numbers.

f. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.

g. Factory finish system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer's printed installation instructions.
3. Suggested spare parts list to maintain equipment in service for period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
4. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
5. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data (to be completed).

1.04 EXTRA MATERIALS

A. Furnish for each set of pumps:

1. One complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide a complete, coordinated, and fully functional operating system.

B. Pumps supplied under this section to be a standard product of manufacturer and to have proven reliability.

2.02 SUPPLEMENTS

A. No "or-equal" or substitute products will be considered.

2.03 EQUIPMENT

A. Description:

1. Type: Simplex, heavy-duty, nonclog, close-coupled submersible centrifugal sewage ejector pump.
   a. Volute: Cast iron, foot mounted.
   b. Impeller: Cast iron.
   c. Wear Plates: Stainless steel.
   d. Motor Enclosure: Cast iron, Buna-N O-ring seals with corrosion-resistant exterior finish.
   e. Motor: Continuous-duty, built-in thermal overload protection.
   f. Shaft Seals: Tandem, mechanical type.
   g. Shaft: Stainless steel.
2. Bearings: Permanently lubricated, ball bearing with B10 bearing life of 17,500 hours.
3. Electrical: Inner seal chamber with two moisture sensing probes and attached power and control cables, with length, voltage, and power requirements as indicated on data sheet at end of section.
4. Controls:
   a. Circuit Breakers: Motor rated.
   b. Motor Starters: Magnetic with thermal overload protection device.
   c. Level Control: Polypropylene-encapsulated mechanical float switch.
   d. Leak Detection: Pump seal alarm circuit.

B. Pump:

1. Heavy-duty, solids handling, nonclog, close coupled, submersible centrifugal design.
2. Continuously rising head-capacity curve from runout to shutoff.
3. Designed to operate continuously at any point on specified operating range of performance curve without cavitation, overheating, or excessive vibration.
4. Motor nameplate horsepower rating not to be exceeded by pump brake horsepower required at any point on nominal pump performance curve.

C. Casing:

1. Flanges if required:
   a. Conform to ASME B16.1, Class 125-pound, flat face standard.
   b. Provide 1/2-inch gauge connection drilled and tapped in discharge flange.

2. Diffusion vanes or stationary guides are not allowed.

D. Suction Cover (Fronthead):

1. Single-piece construction designed to provide even flow to impeller eye.
2. Flanged connection conforming to ASME B16.1, Class 125-pound, flat face standard.
3. Machine register fitted to casing.

E. Stuffing Box Cover (Backhead):

1. Single-piece construction designed with integral stuffing box suitable for use of either conventional packing or mechanical seal. Drilled and tapped 3/4-inch drain connection and large openings to allow easy access to stuffing box.
2. Designed for installation of a minimum of five rings of packing and a split type lantern ring and a split type gland follower. Provide stuffing box with 1/4-inch minimum drilled and tapped connection for injection or venting of the stuffing box.
3. Machine register fitted to casing.

F. Bearing Frame and Bearings:

1. Removable, single-piece construction.
2. Machined for accurate bearing alignment and completely enclosing shaft between bearings.
3. Provide with retainer covers on inboard and outboard ends of frame equipped with lip-type grease seals to prevent entrance of contaminants.
4. Single or double row bearings at inboard and outboard ends designed to take radial, weight, and thrust loads of pump and associated shafting loads. Bearings to be designed for an L10 life per ABMA at best efficiency point.
5. Grease packed at factory and provided with grease fittings for bearing lubrication (if standard).

G. Impeller:

1. Single suction, enclosed, non-clogging type design with extremely smooth passageways to prevent clogging.
2. Single-piece construction.
3. Secure to shaft with stainless steel bolt, washer, and key to prevent loosening from either forward or reverse rotation.

4. Dynamically balanced to assure vibration limits for pump are not exceeded.
5. Wear ring securely fastened to impeller with recessed stainless steel screws. Impeller wear ring to be a minimum of 50 Brinell softer than suction head wear ring.

H. Shaft: Stainless steel.

I. Pump Base: Rugged, heavy duty, with ample strength for support of entire pump and imposed static and operational loads.

2.04 ACCESSORIES

A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8 inch high die-stamped block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

2.05 FACTORY FINISHING

A. Manufacturer’s standard enamel finish.

2.06 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments:

1. Factory testing to be in accordance with the standards of the Hydraulic Institute, latest edition.
2. Test all pumps actually furnished. Use actual motor to be provided for factory tests.
   a. Make necessary adjustments, realignments, and retest to bring pumps into compliance.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s printed instructions.

B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.

C. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

D. Connect suction and discharge piping without imposing strain to pump flanges.

3.02 FIELD FINISHING

A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests:

1. Conduct on each pump, system, and subsystem as specified in Section 01 91 14, Equipment Testing and Facility Startup (to be completed).
2. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
3. Flow Output: Measure using plant instrumentation and storage volumes.

B. Performance Test: Conduct on each pump as specified in Section 01 91 14, Equipment Testing and Facility Startup (to be completed).

1. Perform under simulated operating conditions at full rated speed.
2. Use of plant instrumentation is allowed for tests.

3.04 SUPPLEMENTS

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

1. Influent Tank Farm, Decon Pad, Remedy Produced Water Conditioning Plant Sump Pumps Submersible Centrifugal Pump Data Sheet.
2. Conditioning Water Tank Farm Sump Pump Submersible Centrifugal Pump Data Sheet.

END OF SECTION

INFLUENT TANK FARM, DECON PAD, REMEDY PRODUCED WATER CONDITIONING PLANT SUMP PUMPS SUBMERSIBLE CENTRIFUGAL PUMP DATA SHEET

Tag Numbers: PMP-205, PMP-507, PMP-907, PMP-607

Pump Name: Influent Tank Farm, Decon Pad, Remedy Produced Water Conditioning Plant Sump Pumps

Manufacturer and Model Number: (1) Goulds WS0511B

(2) _____

(3) _____

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Containment area water

Pumping Temperature (Fahrenheit): Normal: 86 Max: 100 Min: 70

Specific Gravity at 60 Degrees F: 1 Viscosity Range: 1 cps

Vapor Pressure at 60 Degrees F: 13 mg Hg pH: 6.5-8.5

Abrasive (Y/N) N caused by _____

Possible Scale Buildup (Y/N): Y caused by calcium carbonate

Corrosive caused by chlorides (1,500 to 3,000 ppm)

Total Suspended Solids (mg/L) <1 mg/L

Min. NPSH Available (Ft. Absolute): Flooded

Area Classification: None

Ambient Temperature (F): 30 to 115

Location Indoor/Outdoor: Outdoor

Altitude: 626’ MSL

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 35

Total Dynamic Head (Ft): Rated: 15 Secondary: 19

BHP at Rated Point: *

NPSH Required, Max. (Ft Absolute) at Rated Point: _____

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): *

Max. Pump Speed at Rated Capacity (rpm): *

Constant Speed: Y

Adjustable Speed: N Minimum Speed: *

Maximum Head, Rated Impeller (ft): *

Maximum Power, Rated Impeller (BHP): *

Sphere Size Required (to pass through impeller), Min. (in): *

PUMP CONSTRUCTION DETAILS

Configuration: Vertical, Close-Coupled: Y

Size: Suction (in.): * Discharge (in.): *

Casing: Single Volute: *

Tangential Discharge: * Centerline Discharge: *

Impeller: Enclosed: * Two Vane: * Three Vane: *
Bladeless: *

Wear Rings: Suction Cover: * Impeller: *

Axial Type: * Radial Type: * L Type: *

Bearings L10 Life: 100,000 Hr: * 50,000 Hr: * 25,000 Hr: *

Shaft Sleeve: Yes * No *

Pump Base: Heavy Duty Fabricated Steel: *

Cast Iron Combination Base Elbow: Y

Cast Mounting Pads Integral With Casing: N

Suction Elbow: Yes Y No _____ Type: _____

Material: Cast Iron, ASTM A48 Class 30: Y
With 3% Nickel: N

Coupling: Standard Flexible Type: _____ Spacer Type: _____

Manufacturer: _____ Manufacturers Standard: _____

Seal: Packing: _____

Mechanical Seal: Y Single: * Double: *

Mechanical Seal Manufacturer/Model: *

Lubrication: *

Extension Shafting: Solid Type: * Tubular Type: *
No of Segments: *
Max Drive Shaft Segment Length (in): *

Materials: Pump Castings (includes casing, suction cover, stuffing box cover, bearing frame):

Cast Iron, ASTM A48/A48M Class 30 * With 3% Nickel *

Cast Iron, ASTM A48/A48M Class 35 * With 3% Nickel *

Impeller: Cast Iron, ASTM A48/A48M Class 30 * With 3% Nickel *

Pump Shaft: High Strength Steel * AISI 1045 Steel, HR *

Type 4140 Alloy Steel * Type 304 Stainless Steel *

Shaft Sleeve: Hardened Stainless Steel * Corrosion-Resistant Bronze *

Wear Rings: Hardened Stainless Steel Y

Packing: Graphite Impregnated Braided Synthetic *

Lantern Ring: Bronze * Teflon *

Follower Gland: Bronze * Cast Iron *Steel *

Mechanical Seal: Buna N * Viton * EPT *

Carbon * Tungsten Carbide * Silicone Carbide *

18-8 Stainless Steel * Type 316 Stainless Steel *

Extension Shafting: Steel * Fiber Reinforced Composite *

DRIVE MOTOR (See Section : 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 0.5 Voltage: 120 Phase: 1 Hertz: 60

Synchronous Speed (rpm): *

Service Factor (at max. ambient temp.): 1.0 _____ 1.15 _____

Insulation Class: B Temperature Rise: *

Inverter Duty Rated (Y/N): * Thermal Protection: *

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC _____ CISD-TEFC _____

TENV _____ WPI _____ WPII _____ SUBM __Y_____

Mounting Type: Horizontal _____ Vertical Solid Shaft: __Y_____

REMARKS

* - Manufacturer to specify

CONDITIONING WATER TANK FARM SUMP PUMP SUBMERSIBLE CENTRIFUGAL PUMP DATA SHEET

Tag Numbers: PMP-407

Pump Name: Conditioning Water Tank Farm Sump Pump

Manufacturer and Model Number: (1) Goulds WS03034D3
(2)
(3)

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): ____Containment area water__
Pumping Temperature (Fahrenheit): Normal: 86 Max: 100 Min: 70___
Specific Gravity at 60 Degrees F: 1__ Viscosity Range: 1_____cps__
Vapor Pressure at 60 Degrees F: 13 mg Hg pH: 6.5-8.5
Abrasive (Y/N) __N____ caused by _____
Possible Scale Buildup (Y/N): __Y__ caused by __ calcium carbonate____
Corrosive caused by chlorides (1,500 to 3,000 ppm)
Total Suspended Solids (mg/L) <1 mg/L
Min. NPSH Available (Ft. Absolute): ___Flooded___
Area Classification: None
Ambient Temperature (F): 30 to 115
Location Indoor/Outdoor: Outdoor
Altitude: 609' MSL

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 35
Total Dynamic Head (Ft): Rated: 53
BHP at Rated Point: ___*___
NPSH Required, Max. (Ft Absolute) at Rated Point: _____

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): *

Max. Pump Speed at Rated Capacity (rpm): *

Constant Speed: Y

Adjustable Speed: N Minimum Speed: *

Maximum Head, Rated Impeller (ft): *

Maximum Power, Rated Impeller (BHP): *

Sphere Size Required (to pass through impeller), Min. (in): *

PUMP CONSTRUCTION DETAILS

Configuration: Vertical, Close-Coupled: Y

Size: Suction (in.): * Discharge (in.): *

Casing: Single Volute: *

Tangential Discharge: * Centerline Discharge: *

Impeller: Enclosed: * Two Vane: * Three Vane: *
Bladeless: *

Wear Rings: Suction Cover: * Impeller: *

Axial Type: * Radial Type: * L Type: *

Bearings L10 Life: 100,000 Hr: * 50,000 Hr: * 25,000 Hr: *

Shaft Sleeve: Yes * No *

Pump Base: Heavy Duty Fabricated Steel: *

Cast Iron Combination Base Elbow: Y

Cast Mounting Pads Integral With Casing: N

Suction Elbow: Yes Y No _____ Type: _____

Material: Cast Iron, ASTM A48 Class 30: Y
With 3% Nickel: N

Coupling: Standard Flexible Type: _____ Spacer Type: _____

Manufacturer: _____ Manufacturers Standard: X

Seal: Packing: _____

Mechanical Seal: Y Single: * Double: *

Mechanical Seal Manufacturer/Model: *

	Lubrication: *
Extension Shafting:	Solid Type: * Tubular Type: * No of Segments: * Max Drive Shaft Segment Length (in): *
Materials:	Pump Castings (includes casing, suction cover, stuffing box cover, bearing frame):
	Cast Iron, ASTM A48/A48M Class 30 * With 3% Nickel *
	Cast Iron, ASTM A48/A48M Class 35 * With 3% Nickel *
Impeller:	Cast Iron, ASTM A48/A48M Class 30 * With 3% Nickel *
Pump Shaft:	High Strength Steel * AISI 1045 Steel, HR *
	Type 4140 Alloy Steel * Type 304 Stainless Steel *
Shaft Sleeve:	Hardened Stainless Steel * Corrosion-Resistant Bronze *
Wear Rings:	Hardened Stainless Steel Y
Packing:	Graphite Impregnated Braided Synthetic *
Lantern Ring:	Bronze * Teflon *
Follower Gland:	Bronze * Cast Iron * Steel *
Mechanical Seal:	Buna N * Viton * EPT *
	Carbon * Tungsten Carbide * Silicone Carbide *
	18-8 Stainless Steel * Type 316 Stainless Steel *
Extension Shafting:	Steel * Fiber Reinforced Composite *

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 3 Voltage: 240 Phase: 1 Hertz: 60

Synchronous Speed (rpm): *

Service Factor (at max. ambient temp.): 1.0 _____ 1.15 _____

Insulation Class: B Temperature Rise: *

Inverter Duty Rated (Y/N): * Thermal Protection: *

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC _____ CISD-TEFC _____

TENV _____ WPI _____ WPII _____ SUBM __Y_____

Mounting Type: Horizontal _____ Vertical Solid Shaft: __Y_____

REMARKS

* - Manufacturer to specify

SECTION 44 42 56.10
HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers' Association (ABMA).
2. Hydraulic Institute Standards.
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
4. Occupational Safety and Health Administration (OSHA).

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.
   d. Detailed mechanical and electrical drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.
   e. Power and control wiring diagrams, including terminals and numbers.
   f. Complete motor nameplate data, as defined by NEMA, motor manufacturer.
   g. Factory finish system data sheets.

B. Informational Submittals:

1. Factory Functional Test Reports.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's printed installation instructions.
4. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
6. Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

2.03 FACTORY FINISHING

A. Manufacturer's standard.

2.04 SOURCE QUALITY CONTROL

A. Factory Inspections for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment.

C. Factory Test Report: Include test data sheets, curve test results.

D. Functional Test: Perform manufacturer's standard.

E. Performance Test:

1. In accordance with Hydraulic Institute Standards.
2. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards, if necessary.

F. Motor Test: Perform Manufacturer's Standard.

G. Hydrostatic Tests: Perform Manufacturer's Standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

3.02 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Vibration Test: Test with unit installed and in normal operation, and discharging to the connected piping systems at rates between low discharge head and high discharge head conditions specified and with actual building structures and foundations provided shall not develop vibration at any frequency or in any plane exceeding the limits specified in excess of 3 mils.
3. Flow Output: Measured by plant instrumentation and storage volumes.

B. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

C. Performance Test:

1. Conduct on each pump.
2. Perform under simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction. For PMP-501, test duration shall be 30 minutes.
4. Test Log: Record the following:
   a. Total head.
   b. Capacity.
   c. Horsepower requirements.
   d. Flow measured by factory instrumentation and storage volumes.

e. Average distance from suction well water surface to pump discharge centerline for duration of test.
f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
g. Driving motor voltage and amperage measured for each phase.

3.03 SUPPLEMENTS

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

1. Influent Storage Tank Recirculation Pump #1, 2, 3, 4 Pump Data Sheet.
2. Filter Feed Pump 1 – A Side, Filter Feed Pump 2 – A Side Data Sheet.
3. Filter Feed Pump 1 – B Side, Filter Feed Pump 2 – B Side (respectively) Data Sheet.
4. Conditioned Water Transfer Pump 1 & 2 Data Sheet.
5. Truck Loading Pump Data Sheet.
6. Motor Data Sheet.

END OF SECTION

INFLUENT STORAGE TANK RECIRCULATION PUMP #1, 2, 3, 4 DATA SHEET

Tag Numbers: PMP-201, PMP-202, PMP-203, PMP-204

Pump Name: Influent Storage Tank Recirculation Pump #1, 2, 3, 4

Manufacturer and Model Number: (1) Fybroc

(2) _____

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Groundwater

Pumping Temperature (Fahrenheit): Normal: 86 Max 130 Min 60

Specific Gravity at 60 Degrees F: 1 Viscosity Range, cps: 1

Vapor Pressure at 60 Degrees F: 13mmHg pH: 6.5 - 8.5

Abrasive (Y/N) N (Corrosive) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 24-540

Min. NPSH Available (Ft. Absolute): 17

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

Capacity (US gpm): Rated: 492

Total Dynamic Head (Ft): Rated: 101

Min. Hydraulic Efficiency (%): *

Maximum Shutoff Pressure (Ft): *

Max. Pump Speed at Design Point (rpm): Note 1

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS

ANSI (Y/N) Y Standard (Y/N) N Design: Frame-mounted (Y/N) _____
Close-Coupled Casing (Y/N) Y Back Pullout (Y/N) *

Discharge Orientation: * Rotation (view from end coupling): *

Casing Materials: FRP, PVC, or other approved material – Note 2

Case Wear Ring (Y/N) * Material: *

Impeller: Type: * Material: *

Impeller Wear Ring (Y/N): * Material: *

Shaft Material: * Shaft Sleeve Material: *

Shaft Seal: * Packing (Y/N) N Material: *

Mechanical (Y/N) Y Type: *

Lubrication: *

ABMA L-10 Bearing Life (Hrs): 50,000 Lubrication: *

Coupling: * Falk (Y/N) * Fast (Y/N) *

Baseplate: Design: * Material: *

Drive Type: Direct-Coupled: Y

Other: _____

DRIVE MOTOR (See Attached Motor Datasheet)

Horsepower: * Voltage: 460 Phase: 3 Frequency: 60 Hz

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: TEFC

Mounting Type: Non-reverse Ratchet (Y/N) N

REMARKS

* - Manufacturer to specify.

1. Maximum pump rpm to be 1,800, unless approved by Engineer.

2. Corrosive process fluid (chlorides 1,500 to 3,000 mg/L).

3. Vendor to provide motor and required horsepower.

4. Assume liquid level is at pump centerline as worst case scenario.

5. Intermittent operation.

6. Area Classification is nonclassified.

7. If pump seal requires external seal flush, vendor to provide flush assembly package including 1) shut off valves, pressure gauges, solenoid valve and flow meter/metering valve mounted on epoxy-coated steel mounting bracket(s) and necessary tubing and fittings to pipe system to seal gland.

FILTER FEED PUMP 1 – A SIDE, FILTER FEED PUMP 2 – A SIDE DATA SHEET

Tag Numbers: PMP-310, PMP-320

Pump Name: Filter Feed Pump 1 – A Side, Filter Feed Pump 2 – A Side

Manufacturer and Model Number: (1) Fybroc

(2) _____

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Groundwater

Pumping Temperature (Fahrenheit): Normal: 86 Max 130 Min 20

Specific Gravity at 60 Degrees F: 1 Viscosity Range, cps: 1

Vapor Pressure at 60 Degrees F: 13 mmHg pH: 6.5 - 8.5

Abrasive (Y/N) N (Corrosive) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 24-540

Min. NPSH Available (Ft. Absolute): 28

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

Capacity (US gpm): Rated: 35

Total Dynamic Head (Ft): Rated: 47

Min. Hydraulic Efficiency (%): *

Maximum Shutoff Pressure (Ft): *

Max. Pump Speed at Design Point (rpm): *

Constant (Y/N): N Adjustable (Y/N): Y

DESIGN AND MATERIALS

ANSI (Y/N) Y Standard (Y/N) N Design: Frame-mounted (Y/N) N
Close-Coupled Casing (Y/N) Y Back Pullout (Y/N) *

Discharge Orientation: * Rotation (view from end coupling): *

Casing Materials: FRP, PVC, or other approved material – Note 1

Case Wear Ring (Y/N) * Material: *

Impeller: Type: * Material: *

Impeller Wear Ring (Y/N): * Material: *

Shaft Material: * Shaft Sleeve Material: *

Shaft Seal: * Packing (Y/N) N Material: *

Mechanical (Y/N) Y Type: *

Lubrication: *

ABMA L-10 Bearing Life (Hrs): 50,000 Lubrication: *

Coupling: * Falk (Y/N) * Fast (Y/N) *

Baseplate: Design: * Material: *

Drive Type: Direct-Coupled: Y

Other:

DRIVE MOTOR (See Attached Motor Datasheet)

Horsepower: * Voltage: 460 Phase: 3 Frequency: 60 Hz

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: TEFC

Mounting Type: Nonreverse Ratchet (Y/N) N

REMARKS

* - Manufacturer to specify.

1.Corrosive process fluid. (chlorides 1,500 to 3,000 mg/L).

2. Vendor to provide motor and required horsepower.

3. Assume liquid level is at pump centerline as worst case scenario.

4. Continuous operation. One pump in standby.

5. Area Classification is nonclassified.

6. If pump seal requires external seal flush, vendor to provide flush assembly package including 1) shut off valves, pressure gauges, solenoid valve and flow meter/metering valve mounted on epoxy-coated steel mounting bracket(s) and necessary tubing and fittings to pipe system to seal gland.

FILTER FEED PUMP 1 – B SIDE, FILTER FEED PUMP 2 – B SIDE DATA SHEET

Tag Numbers: PMP-330, PMP-340

Pump Name: Filter Feed Pump 1 – B Side, Filter Feed Pump 2 – B Side (respectively)

Manufacturer and Model Number: (1) Fybroc

(2) _____

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Groundwater

Pumping Temperature (Fahrenheit): Normal: 86 Max 130 Min 20

Specific Gravity at 60 Degrees F: 1 Viscosity Range, cps: 1

Vapor Pressure at 60 Degrees F: 13 mmHg pH: 6.5 - 8.5

Abrasive (Y/N) N (Corrosive) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 24-540

Min. NPSH Available (Ft. Absolute): 3

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

Capacity (US gpm): Rated: 35

Total Dynamic Head (Ft): Rated: 72

Min. Hydraulic Efficiency (%): *

Maximum Shutoff Pressure (Ft): *

Max. Pump Speed at Design Point (rpm): *

Constant (Y/N): N Adjustable (Y/N): Y

DESIGN AND MATERIALS

ANSI (Y/N) Y Standard (Y/N) N Design: Frame-mounted (Y/N) N
Close-Coupled Casing (Y/N) N Back Pullout (Y/N) *

Discharge Orientation: * Rotation (view from end coupling): *

Casing Materials: FRP, PVC, or other approved material – Note 1

Case Wear Ring (Y/N) * Material: *

Impeller: Type: * Material: *

Impeller Wear Ring (Y/N): * Material: *

Shaft Material: * Shaft Sleeve Material: *

Shaft Seal: * Packing (Y/N) N Material: *

Mechanical (Y/N) Y Type: *

Lubrication: *

ABMA L-10 Bearing Life (Hrs): 50,000 Lubrication: *

Coupling: * Falk (Y/N) * Fast (Y/N) *

Baseplate: Design: * Material: *

Drive Type: Direct-Coupled: Y

Other:

DRIVE MOTOR (See Attached Motor Datasheet)

Horsepower: * Voltage: 460 Phase: 3 Frequency: 60 Hz

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: TEFC

Mounting Type: Nonreverse Ratchet (Y/N) N

REMARKS

* - Manufacturer to specify.

1. Corrosive process fluid. (chlorides 1,500 to 3,000 mg/L).

2. Vendor to provide motor and required horsepower.

3. Assume liquid level is at pump centerline as worst case scenario.

4. Continuous operation. One pump in standby.

5. Area Classification is nonclassified.

6. If pump seal requires external seal flush, vendor to provide flush assembly package including 1) shut off valves, pressure gauges, solenoid valve and flow meter/metering valve mounted on epoxy-coated steel mounting bracket(s) and necessary tubing and fittings to pipe system to seal gland.

CONDITIONED WATER TRANSFER PUMP 1 & 2 DATA SHEET

Tag Numbers: PMP-0405/0406

Pump Name: Conditioned Water Transfer Pump 1 & 2 (Note 5)

Manufacturer and Model Number: (1) Fybroc

(2) _____

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Groundwater

Pumping Temperature (Fahrenheit): Normal: 86 Max 130 Min 60

Specific Gravity at 60 Degrees F: 1 Viscosity Range, cps: 1

Vapor Pressure at 60 Degrees F: 13 mmHg pH: 6.5 - 8.5

Abrasive (Y/N) N (Corrosive) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) <1

Min. NPSH Available (Ft. Absolute): 25

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

Capacity (US gpm): Rated: 35

Total Dynamic Head (Ft): Rated: 52

Min. Hydraulic Efficiency (%): *

Maximum Shutoff Pressure (Ft): *

Max. Pump Speed at Design Point (rpm): Note 1

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS

ANSI (Y/N) Y Standard (Y/N) N Design: Frame-mounted (Y/N) N
Close-Coupled Casing (Y/N) Y Back Pullout (Y/N) *

Discharge Orientation: * Rotation (view from end coupling): *

Casing Materials: FRP, PVC, or other approved material – Note 2

Case Wear Ring (Y/N) * Material: *

Impeller: Type: * Material: *

Impeller Wear Ring (Y/N): * Material: *

Shaft Material: * Shaft Sleeve Material: *

Shaft Seal: * Packing (Y/N) N Material: *

Mechanical (Y/N) Y Type: *

Lubrication: *

ABMA L-10 Bearing Life (Hrs): 50,000 Lubrication: *

Coupling: * Falk (Y/N) * Fast (Y/N) *

Baseplate: Design: * Material: *

Drive Type: Direct-Coupled: Y

Other:

DRIVE MOTOR ()

Horsepower: * Voltage: 460 Phase: 3 Frequency: 60 Hz

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: TEFC

Mounting Type: Nonreverse Ratchet (Y/N) N

REMARKS:

* - Manufacturer to specify.

1. Corrosive process fluid. (chlorides 1,500 to 3,000 mg/L).

2. Vendor to provide motor and required horsepower.

3. Assume liquid level is at pump centerline as worst case scenario.

4. Area Classification is nonclassified.

TRUCK LOADING PUMP DATA SHEET

Tag Numbers: PMP-501

Pump Name: Truck Loading Pump

Manufacturer and Model Number: (1) AMT -2876-95

(2) Teel 3P707

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Brackish Groundwater

Pumping Temperature (Fahrenheit): Normal: 86 Max 130 Min 60

Specific Gravity at 60 Degrees F: 1 Viscosity Range, cps: 1

Vapor Pressure at 60 Degrees F: 13 mmHg pH: 6.5 - 8.5

Abrasive (Y/N) N (Corrosive) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) <1

Min. NPSH Available (Ft. Absolute): 15

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

Capacity (US gpm): Rated: 35

Total Dynamic Head (Ft): Rated: 52

Min. Hydraulic Efficiency (%): *

Maximum Shutoff Pressure (Ft): *

Max. Pump Speed at Design Point (rpm): Note 1

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS

ANSI (Y/N) Y Standard (Y/N) N Design: Frame-mounted (Y/N) N
Close-Coupled Casing (Y/N) * Back Pullout (Y/N) *

Discharge Orientation: * Rotation (view from end coupling): *

Casing Materials: Cast Iron

Case Wear Ring (Y/N) * Material: *

Impeller: Type: * Material: *

Impeller Wear Ring (Y/N): * Material: *

Shaft Material: * Shaft Sleeve Material: *

Shaft Seal: * Packing (Y/N) N Material: *

Mechanical (Y/N) Y Type: *

Lubrication: *

ABMA L-10 Bearing Life (Hrs): 50,000 Lubrication: *

Coupling: * Falk (Y/N) * Fast (Y/N) *

Baseplate: Design: * Material: *

Drive Type: Direct-Coupled: Y

Other:

DRIVE MOTOR (See Attached Motor Datasheet)

Horsepower: * Voltage: 460 Phase: 3 Frequency: 60 Hz

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: TEFC

Mounting Type: Nonreverse Ratchet (Y/N) N

REMARKS:

* - Manufacturer to specify

1. Corrosive process fluid. (chlorides 1,500 to 3,000 mg/L).

2. Vendor to specify motor enclosure type and provide motor and required horsepower.

3. Area Classification is: non-classified.

4. Provide optional metal mounting base.

ELECTRIC MOTOR DATA SHEET

Equipment Tag Number(s): PMP,201, PMP-202, PMP-203, PMP-204, PMP-310, PMP-320, PMP-330, PMP-340, PMP-501, PMP-405/406

ELECTRIC MOTOR DATA

Type: Squirrel-cage induction meeting requirements of NEMA MG1
Manufacturer: For multiple units of this same type of equipment, furnish motors and accessories of a single manufacturer.

Service Factor (rated @ maximum ambient temperature): 1.15 at 50 C ambient

General:

Motor Horsepower: Manufacturer to Specify

Voltage: 460

Phase: 3

Frequency: 60-Hz

Torque: Variable

Enclosure Type: TEFC

Optional Features:

Thermal Protection: Temperature switch (NC)

Oversize main terminal (conduit) box for motors

Terminal for connection of equipment grounding wire in each terminal box.

Driven Speed:

Constant Speed: Manufacturer to Specify rpm, synchronous

Variable Speed: Manufacturer to Specify (MTS) rpm, synchronous

Mounting Type:

Vertical: Non-reverse Ratchet No

Shaft Type: MTS

Guaranteed Minimum Efficiency @ Full Load MTS

Guaranteed Minimum Power Factor @ Full Load MTS

Additional Requirements

Motor shall have Class F insulation with Class B Rise at nameplate horsepower and shall be provided with oversize main terminal box.

Area Classification is : non-classified

.

ELECTRIC MOTOR DATA SHEET

Bearings and Lubrication:
Thrust Bearings:
a. Manufacturer's standard bearing for application
b. Manufacturer's standard lubrication for application
c. Minimum 50,000 hours L-10 bearing life
Guide Bearings:
a. Manufacturer's standard bearing for application
b. Manufacturer's standard lubrication for application
c. Minimum 100,000 hours L-10 bearing life
Regreasable Antifriction Bearings:
a. Readily accessible, grease injection fittings
b. Readily accessible, removable grease release plugs
Oil Lubrication Systems:
a. Oil Reservoirs with sight level gauge
b. Oil fill and drain openings with opening plugs
c. Provisions for necessary oil circulation and cooling

SECTION 44 42 56.15
AIR-OPERATED DIAPHRAGM PUMPS

PART 1 GENERAL

1.01 REFERENCES

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

1. Hydraulic Institute Standards (HIS).

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, and weight of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data curves showing head, capacity, air consumption and pressure, displacement per stroke, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity.
   d. Detailed mechanical drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.
   e. Control wiring diagrams, including terminations and wire numbers.
   f. Factory finish system.

B. Informational Submittals:

1. Factory Functional Test Reports.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer’s printed installation instructions.
4. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include list of special tools required for checking,

testing, parts replacement, and maintenance with current price information.

5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data (to be completed).

1.04 EXTRA MATERIALS

A. Furnish for each pump:

1. One diaphragm.
2. One check valve ball.
3. One complete set of ball check valve seats.
4. One solenoid valve.
5. Two spring assemblies.
6. One complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.02 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.

B. Lifting Lugs: For equipment weighing over 100 pounds.

2.03 FACTORY FINISHING

A. Manufacturer’s standard.

2.04 SOURCE QUALITY CONTROL

A. Functional Test: Perform manufacturer’s standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

3.02 FIELD QUALITY CONTROL

A. Conduct tests on each pump.

B. Functional Tests: Proper Alignment, connection, and quiet operation.

C. Performance Test: To be performed under actual or approved simulated operating conditions.

3.03 SUPPLEMENT

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

1. Solids Pump Air-Operated Diaphragm Pump Data Sheet.

END OF SECTION

SOLIDS PUMP AIR-OPERATED DIAPHRAGM PUMP DATA SHEET

Tag Numbers: PMP-601

Pump Name: Solids Pump

Manufacturer and Products: (1) ARO (2) Wilden

SERVICE CONDITIONS

Liquid Pumped (Material and Percent solids): Remedy Water: Up to 100 ppm of silt/sand/soft biological solids

Pumped Liquid Temperature (deg. F): Normal: 86 Max 100 Min 60

Liquid Specific Gravity at 60 Degrees F: 1 Viscosity Range: 0.8 to 1.0 cp

pH: 6.5-8.5

Abrasive (Y/N): Y Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L): 60

Min. NPSH Available (Ft. Absolute): 25

Will the pump be submerged? (Y/N) N

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 20

Total Dynamic Head (Ft): Rated: 20

Suction Lift (Ft): Rated: *

Air Consumption (SCFM): *

Inlet Air Pressure (psig): 80 - 100

Largest diameter solid pump can pass (inches): *

PUMP CONSTRUCTION DESIGN AND MATERIALS

Suction Size (inches): 1” NPT Discharge Size (inches): 1" NPT

Casing Type: Polypropylene or approved equal

Max Allowable Pressure (psig) at 60 deg F: *

Max Allowable Pressure (psig) at normal pumping temperature: *

Hydro Test Pressure (psig): *

Diaphragm Diameter (inches): *

Diaphragm Actuation:

Air Only (Y/N): * Spring Assisted (Y/N): *

Cylinder Assisted (Y/N): * Position Indication (Y/N): *

Check Valves:

Single (Y/N): N Dual (Y/N): Y

Inlet Diameter (inches): * Outlet Diameter (inches): *

Ball Check with Cleanout (Y/N): * Inline Ball Check (Y/N): *

Flap Check (Y/N): * Ball Valve Seats (Y/N): *

Body Material: Polypropylene Body Lining: *

Ball Material: FKM or Viton Ball Lining: *

Ball Seats: Polypropylene

Air Cushion Chamber (Y/N): *

Diameter (inches): * Length (feet): *

Air Header Assembly (Y/N): *

Three-way Solenoid Valve (Y/N): * Size (inches): *

Muffler (inches): * Air Regulator, Size (inches): *

Air Strainer, Size (inches): *

Pressure Gauge (psig): * to *

Casing Material: * Casing Lining: *

Cover Material: * Diaphragm: FKM or Viton

Base Tee: * Base Tee Lining: *

Air Cushion Chamber: *

Solenoid Valves: * Pump Baseplate: Yes

Type: * Material: *

ADDITIONAL REQUIREMENTS

Drilled and tapped pump body covers for pressure air connections? (Y/N) *

Tapped and plugged air cushion chambers for gauge connections? (Y/N) *

Maximum Allowable Noise Limit (dBA): 85 at 3ft.

To Provide the following accessories: Pulsation Dampeners, Filter-Regulator-Lubricator, Leak Detector, Suction inlet screen, inlet air pressure regulator and Relief Valve.

REMARKS

* - Manufacturer to Specify.

1. Location is Outdoor at grade.

2. Pump operation is Intermittent.

3. Vendor to show air consumption for the specific pump being offered.

SECTION 44 43 13.16
CARTRIDGE FILTERS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code; Section VIII, Division 1.
2. American National Standards Institute (ANSI): B16.5.

1.02 SUBMITTALS

A. Shop Drawings:

1. Make, model, weight of each assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Head loss versus flow curves throughout operating ranges and maximum allowable differential pressure.
4. Detailed drawings showing dimensions, size, and locations of components.

B. Quality Control Submittals:

1. Manufacturer's Certificate of Compliance.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's written/printed installation instructions.
4. Routine maintenance requirements prior to plant startup.
5. Manufacturer's Certificate of Proper Installation.
6. Operation and Maintenance Manuals.
7. Pressure test and control/valve test results prior to shipment.

1.03 SPARES

A. Filter O-Rings.

B. Filter Cartridges: Replacement sets of cartridges for each filter vessel as specified herein.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The cartridge filters to be provided under this section shall be as supplied by:

1. Harmsco-Geiger HUR 1x170 Filter Housings.

2.02 SERVICE CONDITIONS

A. Influent Water Characteristics:

	Process Feed
Temperature (degrees F)	60 to 100 Normal = 86
Chlorides (mg/L)	600 to 3,000
TDS (mg/L)	1500 to 12,000
pH (units)	6.5 to 8.5

B. Flow Rates per Cartridge Filters:

	Process Feed
Normal (gpm)	20
Maximum (gpm)	35

C. Pressures:

1. Inlet Operating Pressure Range: 40 to 80 psig.

2.03 PERFORMANCE REQUIREMENTS

A. Maximum Cartridge (Filter Element) Loading Rate: Each cartridge filter vessel shall contain a sufficient number of cartridges of the specified type such that the maximum loading rate for each cartridge shall be 150 gpm per 30-inch nominal equivalent length

B. The cartridges shall be NSF approved and shall have ratings as specified below:

1. A Side Cartridge Filters: Tag numbers FIL-0311 and FIL-0321 are the coarse filters and Tag numbers FIL-0312 and FIL-0322 are the fine filters. Fine Cartridge filters shall have cartridges rated for 90 percent (minimum) removal of 5 micron-size particles or less.
2. B Side Cartridge Filters: Tag numbers FIL-0331 and FIL-0341 are the coarse filters and Tag numbers FIL-0332 and FIL-0342 are the fine filters. Fine Cartridge filters shall have cartridges rated for 90 percent (minimum) removal of 5 micron-size particles or less.
3. Vendor to supply two cartridges each for the coarse filters in 20, 50 and 100-micron size. Vendor to supply 16 5-micron size cartridges.

2.04 EQUIPMENT/MATERIALS DESCRIPTION

A. Cartridge filter vessels shall be as generally shown on Drawings and as follows: Provide two quad systems (mount four cartridge filters to each skid).

B. Filter Vessel: Each filter housing shall be of Type 304 stainless steel and pressure-retaining welds shall be crevice-free. The vessel shall be rated for 150 psi working pressure maximum. Carbon steel base epoxy coated with fork lift pockets and anchor-bolt tie downs.

C. Skid Flanges: Flat face, 150-pound, ANSI B16.5 flanges.

D. Cartridges: All cartridges shall be FDA approved for potable use.

E. All piping shall be Schedule 80 CPVC at a size suitable for flow conditions. Two pneumatically actuated butterfly valves on inlet and outlet sides shall be supplied for each filter housing. Valves shall be lug style with EPDM seats. Valve actuators shall be single acting (with spring-return to fail-closed).

F. Piping shall be configured to allow flow to go through any pair of fine and coarse filters on each skid.

G. Each filter shall be monitored by a differential pressure transmitter with three-way bypass valve. Transmitters shall be Endress & Hauser.

H. Supply skid with NEMA 4 control panel with 24V dc control solenoid valves, limit switches, and manual override. Panel shall include scalable process controller for local display of differential pressure with digital alarm output for high differential pressure, 24V dc power supply, terminal points and relays for control of air actuated valves by digital input to the panel, (logic for valve

actuation by Owner's SCADA), and terminal strip wiring. Panel shall be fabricated of painted carbon steel.

I. Automatic drain valves shall be installed on each filter and plumbed to a common drain manifold. Drain valves are 120V actuated and allow operator adjustment of automatic purge timing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions and in accordance with Piping Materials Specification Section.

3.02 TESTING

A. All testing described below should be performed by Contractor following manufacturer's recommendations.

B. Contractor shall be responsible for providing all necessary equipment to complete testing described herein.

C. After installation, conduct pressure and leakage tests for each unit as part of the piping tests for the pipe sections.

D. Conduct a pressure head loss test on each fully loaded cartridge filter at a flow rate adequate to show that, at maximum flow rate, the maximum allowable pressure differential identified by manufacturer is not exceeded.

END OF SECTION

SECTION 44 44 13.01
CHEMICAL METERING PUMPS

PART 1 GENERAL

1.01 REFERENCES

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

1. Hydraulic Institute Standards.
2. Institute of Electrical and Electronics Engineers (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data on pumps, including curves showing flow rate verses pump stroke setting (in percent) at specified maximum speed in strokes per minute and at minimum pump speed.
   d. Pump data sheet confirming pump capacity in gallons per hour and pressure in psig, required backpressure valve setting, pumped chemical characteristics, pipe connection sizes, stroke rate, materials, testing requirements, intermediate fluid type, and appurtenances to be provided with pumps.
   e. Detailed dimensional drawings for pump and driver, including mounting requirements and piping connection sizes and locations.
   f. Power and control wiring diagrams, including terminals and numbers.

g. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
h. Manufacturer's materials compatibility information, confirming compatibility of wetted parts with specified pumped chemicals.
i. Factory finish system.

B. Informational Submittals:

1. Factory Functional Test Reports.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's printed installation instructions.
4. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
6. Operation and Maintenance Data.

1.04 EXTRA MATERIALS

A. Furnish for each pump:

1. One complete pump, drive motor, and gear box.
2. One variable speed drive controller.
3. One diaphragm back pressure control valve.
4. One printed circuit board of each type.
5. One complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 DIAPHRAGM PUMP

A. Positive displacement self-compensating hydraulically activated diaphragm type consisting of simplex pumping heads, with internal automatic pressure relief valve, external manually adjustable stroke positioner from 0 percent to

100 percent, and with maximum stroke rate as specified in attached Pump Data Sheet.

B. Alternatively, pump shall be simplex, motor-driven, reciprocating, mechanically-actuated diaphragm type. Pump shall include an integral motor, oil-lubricated gear reducer and a cam-spring drive mounted in aluminum housing. Maximum stroke rate shall be as specified in attached Pump Data Sheet.

C. Lubricant, nontoxic-food grade quality.

D. Pump leakage shall be prevented through diaphragm design.

E. Pump shall include adjustable, spring-loaded internal pressure relief valve to protect pump against excessive hydraulic pressure.

2.03 PULSATION DAMPENERS

A. Single diaphragm type mounted on discharge piping as shown for pneumatic-hydraulic pulsation dampening. Size for pump-stroke volume.

B. Air charging valve and pressure gauge.

2.04 VALVES

A. Adjustable diaphragm backpressure sustaining type installed on pump discharge and set at as recommended by pump manufacturer.

B. Adjustable pressure relief type installed on pump discharge as shown on Drawings and set at as recommended by pump manufacturer.

2.05 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. Anchor Bolts: Galvanized, 1/2-inch minimum diameter.

D. Gauge Connections: Tapped and plugged suction and discharge gauge connections on piping headers adjacent to pumps.

E. Screens or Guards: Mesh size of less than 0.5 inch, exposed rotating shafts, rotors, couplings, pulley, wheel, bolts, chains, or similar components. Where guards/screens are over grease fittings, couplings, or other items requiring maintenance, provide a means for ready access.

F. Calibrated Cylinder: Graduated in 50-mL increments, constructed of clear polypropylene and PVC with ball type shutoff valve. Provide calibration column.

2.06 HOSE PUMPS

A. Pump Heads:

1. Pump head shall consist of fixed track with hinged or removable guard door or front cover.
2. Capable of delivering continuous discharge pressure specified in the attached Pump Data Sheets.
3. Bing.
4. Capable of self-priming with suction lift capability of 30 feet of water.
5. Able to run dry without damaging pump or hose.
6. Pump shall be oil lubricated.

B. Hose:

1. During normal operation, hose’s inner wall shall be the only surface in contact with pumped fluid.
2. Hose shall be extruded from material compatible with pumped fluid.

C. Drive: Drives shall be variable speed.

2.07 FACTORY FINISHING

A. Manufacturer’s standard finish.

2.08 SOURCE QUALITY CONTROL

A. Factory Test Report:

B. Functional Test: Perform manufacturer’s standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

3.02 FIELD QUALITY CONTROL

A. Conduct tests on each pump.

B. Functional Test:

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

C. Performance Test:

1. Perform under actual or approved simulated operating conditions.
2. Test for a continuous 3-hour period without malfunction.

3.03 SUPPLEMENTS

A. Supplements listed below, following "End of Section," are part of this Specification.

1. Caustic Feed Pump 1 and 2 Data Sheet.
2. Coagulant Feed Pump 1 and 2 Data Sheet.
3. Acid Feed Pump 1 and 2 Data Sheet.
4. Carbon Substrate Pumps, Well Maintenance Reagent Pumps Data Sheet

END OF SECTION

CAUSTIC FEED PUMP 1 AND 2 DATA SHEET

Tag Numbers: PMP-0911/0912

Pump Name: Caustic Feed Pump 1 and 2

Manufacturer and Model Number: (1) LMI Milton Roy – C77

(2) Pulsafeeder

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): 25% NaOH

Ambient Temperature (Fahrenheit): Normal: 75 Max 140 Min 20

Liquid pH: >14

Abrasive (Y/N) N (Highly Corrosive) Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum 0

Altitude (ft msl): 625 Area Classification: Not classified Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 35 Minimum: 20

Maximum Discharge Pressure (psig): 3 psi

Internal Bypass Valve Setting (psig): *

Relief Valve Setting (psig/as recommended): *

Back Pressure Valve Setting (psig/as recommended): *

Max. Stroke Rate (spm): Mfr. (1) 100 Mfr. (2) ____

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y

Tubular (double) Diaphragm (Y/N) N Other ____

Wet End Material: Teflon Tubular Diaphragm Housing Material: N/A

Check Valve Material: X Configuration(Single/Double): ____

Diaphragm Material: * Primary: ____ Tubular: N/A

Calibration Cylinder: Quantity: 2 Material: * Units: ____ Capacity: ____

Diaphragm Actuation Type: Mechanical ____ Hydraulic ____

Stroke Position Adjustment: Manual ____ Automatic X

Pump Speed Control: Constant ____ Variable X

DRIVE MOTOR

Horsepower: N/A Voltage: 120 Phase: 1 Synchronous Speed (rpm) N/A

Service Factor: N/A

TESTING

Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) Y

Field Functional (Y/N) Y Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) ____ Other _____

_____

REMARKS

* Vendor Supplied Information

1. Vendor to provide motor and horsepower requirements.
2. Unless, otherwise stated, vendor to provide, backpressure protection, integral bypass, pressure relief valve, and pulsation damper.
3. Vendor to provide panel- or skid-mounted unit (all equipment plumbed, wired and installed) with the pumps and other equipment listed above. A single feed line with two separate discharge lines and separate calibration columns shall be included on the panel. Piping shall be 1/2 inch Sch. 80 PVC. Isolation valves shall be provided and shall true union ball type. Piping shall be supported/fixed to the panel. A NEMA 4X control box with power light switches, circuit breaker, and terminal strip for wiring shall be mounted to the panel. A GFCI outlet with weatherproof cover shall be included. Pumps shall be activated and controlled with 4 to 20 mA signal. Panel materials shall be suppliers standard. If metallic materials are supplied, an Engineer-approved coating or galvanizing will be provided.

COAGULANT FEED PUMP 1 AND 2 DATA SHEET

Tag Numbers: PMP-0921/0922

Pump Name: Coagulant Feed Pump 1 and 2

Manufacturer and Model Number: (1) LMI Milton Roy – C77

(2) Pulsafeeder

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Nalco Ultrion 8187

Ambient Temperature (Fahrenheit): Normal: 75 Max 140 Min 20

Liquid pH: 3.5

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum 0

Altitude (ft msl): 625 Area Classification: Not classified Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 10 Minimum: _____

Maximum Discharge Pressure (psig): 35 psi

Internal Bypass Valve Setting (psig): *

Relief Valve Setting (psig/as recommended): *

Back Pressure Valve Setting (psig/as recommended): *

Max. Stroke Rate (spm): Mfr. (1) 100 Mfr. (2) _____

_____

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y

Tubular (double) Diaphragm (Y/N) N Other _____

Wet End Material: Teflon Tubular Diaphragm Housing Material: N/A

Check Valve Material: * Configuration (Single/Double): _____

Diaphragm Material: _____ Primary: _____ Tubular: N/A

Calibration Cylinder: Quantity: 2 Material: * Units: _____ Capacity: _____

Diaphragm Actuation Type: Mechanical X Hydraulic X

Stroke Position Adjustment: Manual _____ Automatic X

Pump Speed Control: Constant _____ Variable X

DRIVE MOTOR

Horsepower: N/A Voltage: 120 Phase: 1 Synchronous Speed (rpm) N/A

TESTING

Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) Y

Field Functional (Y/N) Y Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) ____ Other _____

REMARKS

* Vendor Supplied Information

1. Vendor to provide motor and horsepower requirements.

2. Unless, otherwise stated, vendor to provide, backpressure protection, integral bypass, pressure relief valve, and pulsation damper.

3. Vendor to provide panel- or skid mounted unit (all equipment plumbed, wired and installed) with the pumps and other equipment listed above. A single feed line with two separate discharge lines and separate calibration columns shall be included on the panel. Piping shall be 1/2 inch Sch. 80 PVC. Isolation valves shall be provided and shall true union ball type. Piping shall be supported/fixed to the panel. A NEMA 4X control box with power light switches, circuit breaker, and terminal strip for wiring shall be mounted to the panel. A GFCI outlet with weatherproof cover shall be included. Pumps shall be activated and controlled with 4 to 20 mA signal. Panel materials shall be suppliers standard. If metallic materials are supplied, an Engineer-approved coating or galvanizing will be provided.

ACID FEED PUMP 1 AND 2 DATA SHEET

Tag Numbers: PMP-0931/0932B

Pump Name: Acid Feed Pump 1 and 2

Manufacturer and Model Number: (1) LMI Milton Roy – C77

(2) Pulsafeeder

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): 19% Hydrochloric Acid

Pumping Temperature (Fahrenheit): Normal: 75 Max 140 Min 60

Liquid pH: <2

Abrasive (Y/N) N (Highly Corrosive) Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum 0

Altitude (ft msl): 625 Area Classification: Not classified Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 10 Minimum:

Maximum Discharge Pressure (psig): 35 psi

Internal Bypass Valve Setting (psig): *

Relief Valve Setting (psig/as recommended): *

Back Pressure Valve Setting (psig/as recommended): *

Max. Stroke Rate (spm): Mfr. (1) 100 Mfr. (2)

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y

Tubular (double) Diaphragm (Y/N) N Other

Wet End Material: Teflon Tubular Diaphragm Housing Material: N/A

Check Valve Material: * Configuration (Single/Double):

Diaphragm Material: * Primary: Tubular: N/A

Calibration Cylinder: Quantity: 2 Material: Units: Capacity:

Diaphragm Actuation Type: Mechanical X Hydraulic

Stroke Position Adjustment: Manual Automatic X

Pump Speed Control: Constant Variable X

DRIVE MOTOR

Horsepower: N/A Voltage: 120 Phase: 3 Synchronous Speed (rpm)____

Service Factor: N/A

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

TESTING

Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) Y

Field Functional (Y/N) Y Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) ____ Other _____

_____

REMARKS

* Vendor Supplied Information

1. Vendor to provide motor and horsepower requirements.

2. Unless, otherwise stated, vendor to provide, backpressure protection, integral bypass, pressure relief valve, and pulsation damper.

3. Vendor to provide panel-mounted unit (all equipment plumbed, wired and installed) with the pumps and other equipment listed above. A single feed line with two separate discharge lines and separate calibration columns shall be included on the panel. Piping shall be 1/2 inch Sch. 80 PVC. Isolation valves shall be provided and shall true union ball type. Piping shall be supported/fixed to the panel. A NEMA 4X control box with power light switches, circuit breaker, and terminal strip for wiring shall be mounted to the panel. A GFCI outlet with weatherproof cover shall be included. Pumps shall be activated and controlled with 4 to 20 mA signal. Panel materials shall be suppliers standard. If metallic materials are supplied, an Engineer-approved coating or galvanizing will be provided.

CARBON SUBSTRATE PUMPS,
WELL MAINTENANCE REAGENT PUMPS DATA SHEET

Tag Numbers: P-*740, *741,* 742,*743, * 940,* 941,*942

Pump Name: Carbon Substrate Pumps, Well Maintenance Reagent Pumps,

Manufacturer and Model Number: (1) APEX 20

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Ethanol

Ambient Temperature (Fahrenheit): Normal: 75 Max 140 Min 20

Liquid pH: n/a.

Abrasive (Y/N) Y Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum 0

Altitude (ft msl): 625 Area Classification: Not classified Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 230 Minimum: 2.3

Maximum Discharge Pressure (psig): 116 psi

Internal Bypass Valve Setting (psig): *

Relief Valve Setting (psig/as recommended): *

Back Pressure Valve Setting (psig/as recommended): *

Max. Stroke Rate (spm): Mfr. (1) * Mfr. (2)

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) N/A

Tubular (double) Diaphragm (Y/N) N Other

Wet End Material: CSM Tubular Diaphragm Housing Material: N/A

Check Valve Material: X Configuration(Single/Double):

Diaphragm Material: N/A Primary: N/A Tubular: N/A

Calibration Cylinder: Quantity: N/A Material: * Units: Capacity:

Diaphragm Actuation Type: Mechanical N/A Hydraulic

Stroke Position Adjustment: N/A Automatic X

Pump Speed Control: Constant Variable X

DRIVE MOTOR

Horsepower: TBD Voltage: 120 Phase: 1 Synchronous Speed (rpm) TBD

TESTING

Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) Y

Field Functional (Y/N) Y Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) ____ Other _____

REMARKS

* Vendor Supplied Information

1. Vendor to provide motor and horsepower requirements

2. Unless, otherwise stated, vendor to provide, backpressure protection, integral bypass, pressure relief valve, and pulsation damper.

3. Vendor to provide panel- or skid mounted unit (all equipment plumbed, wired and installed) with the pumps and other equipment listed above. A single feed line with two separate discharge lines and separate calibration columns shall be included on the panel. Piping shall be 1/2 inch Sch. 80 PVC. Isolation valves shall be provided and shall true union ball type. Piping shall be supported/fixed to the panel. A NEMA 4X control box with power light switches, circuit breaker, and terminal strip for wiring shall be mounted to the panel. A GFCI outlet with weatherproof cover shall be included. Pumps shall be activated and controlled with 4 to 20 mA signal. Panel materials shall be suppliers standard. If metallic materials are supplied, an Engineer-approved coating or galvanizing will be provided.