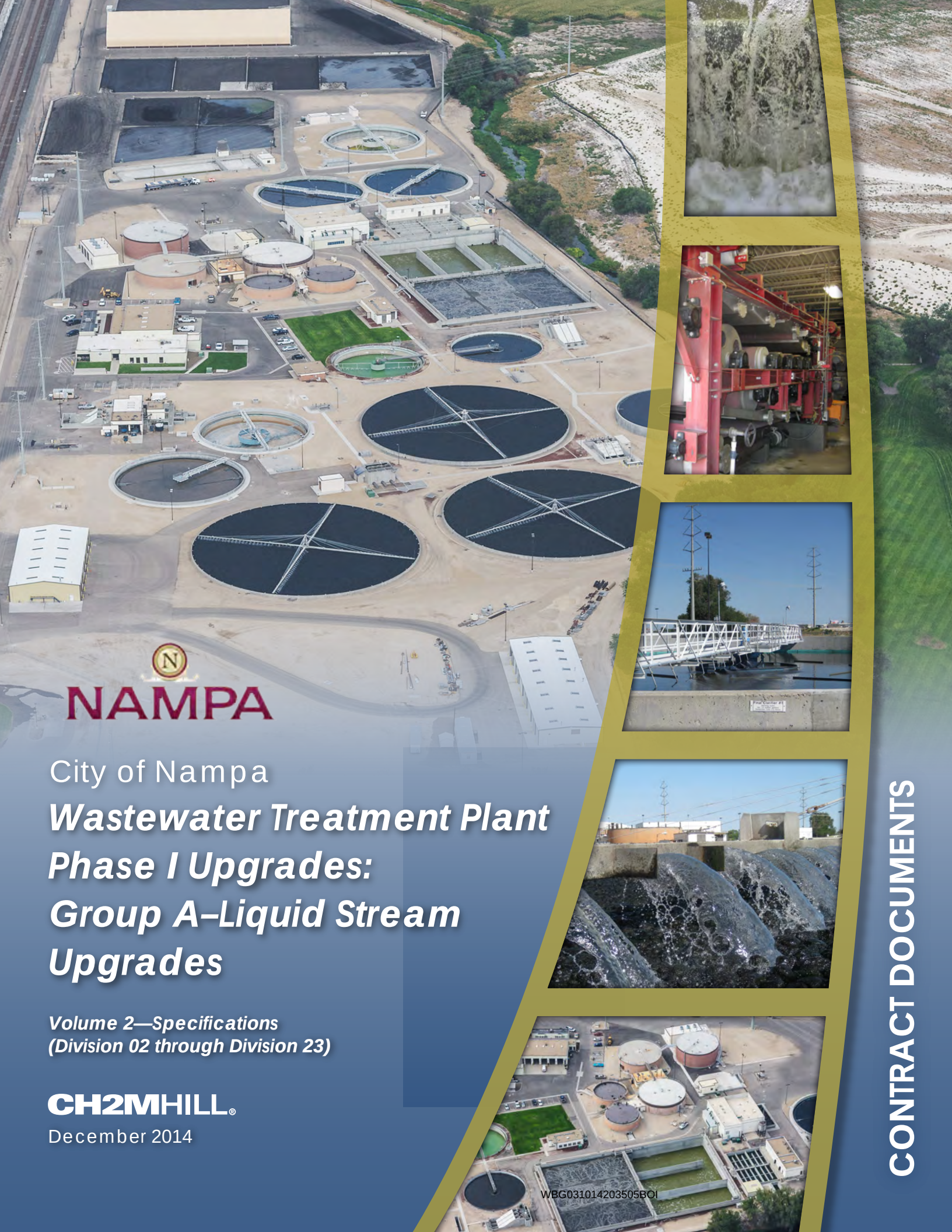

NAMPA

City of Nampa

Wastewater Treatment Plant Phase I Upgrades: Group A–Liquid Stream Upgrades

Volume 2—Specifications
(Division 02 through Division 23)

CH2MHILL®

December 2014

CONTRACT DOCUMENTS

WBG031014203505BOI

CITY OF NAMPA

NAMPA, IDAHO

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

VOLUME 2
DIVISION 02 THROUGH DIVISION 23

for the construction of the

Nampa WWTP Phase I Upgrades:
Group A—Liquid Stream Upgrades

Contract No. _____

****

17 Dec 2014

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December 2014

Project No. 480770 Copy No. _____

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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. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): Guideline K, Containers for Recovered Non-flammable Fluorocarbon Refrigerants.
2. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
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. Idaho Standards for Public Works Construction (ISPWC), 2010 Edition.
5. City of Nampa Standard Construction Specifications.
6. 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 82—Protection of Stratospheric Ozone.
    c. Part 273—Standards for Universal Waste Management.

1.02 DEFINITIONS

A. ACM: Asbestos-containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building, structure, or piping 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 the 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.
3. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped.
4. Submit a shipping receipt or bill of lading for all containers of ACM shipped.
5. Submit a shipping receipt or bill of lading for all universal waste shipped.

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 PLAN

A. Demolition 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 and daily wastewater treatment plant activities. Planned sequence of operations shall include specific identification of process or utility downtime. Contractor shall carefully consider and identify impacts of demolition or downtime activities on adjacent or interconnected utilities or processes. Contractor shall review required utility outages with utility owner prior to sending draft to Owner for review. Draft shall include all timing and sequencing requirements as specified by outside utility company for planned outages.
3. Procedures for removal and disposition of materials specified to be salvaged.
4. Procedures for removal and disposal of materials to be wasted.
5. Plan for temporary piping and facilities, transferring process flows to new, relocated pipes and abandoning existing.
6. Schedule and plan for excavation and shoring procedure.

1.06 SEQUENCING AND SCHEDULING

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

B. Include the Work of this specification in the progress schedule, as specified in Section 01 32 16, CPM Construction Schedule.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FACILITIES TO BE DEMOLISHED OR RENOVATED

A. Facilities: Generally including all or portions of buildings, process facilities, fences, buried concrete structures, buried or surface pipe, biological filter media, light bases or other structures and other areas scheduled for selective demolition and partial demolition. Work area are as shown on Drawings.

1. Portions of facilities scheduled for demolition or selective renovation are as shown.
2. See reference drawings contained within Volume 6 of the Contract Documents for more information on existing facilities to be demolished.

B. Structures: Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

C. Utilities and Related Equipment:

1. Notify Owner 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 the Drawings, notify Owner prior to further work in that area.
4. Remove meters and related equipment and deliver to a location as determined by the Owner.
5. Provide a permanent leak-proof closure for water and gas lines.
6. Completely remove all sections of pipe to be abandoned unless indicated otherwise or given approval from the Owner and Engineer prior to abandonment.

D. Paving and Sidewalks:

1. Remove concrete sidewalks and asphalt pavement, including aggregate base to a depth of 12 inches below existing adjacent grade, unless Engineer in field indicates existing aggregate base should be left to facilitate continued access during construction. Stockpile and save aggregate base approved for reuse by Engineer.
2. Provide neat sawcuts at limits of sidewalk and pavement removal as indicated.
3. Where new concrete adjoins existing, the new Work shall abut or tie into the existing construction as specified.

E. Cylinders and Canisters: Remove all fire suppression system cylinders and canisters and dispose as specified in Paragraph Ozone Depleting Substances (ODS).

F. Door Locksets: Remove all locksets from all doors indicated to be removed and disposed of. Turn locksets over to Owner immediately after their removal.

G. Gravel Surfacing: Remove gravel surfacing materials as indicated to a depth of 6 inches below existing adjacent grade. Stockpile and save materials for re-use as approved by Engineer and Owner.

H. 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 panelboards 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 panelboard circuit directory cards.

I. Universal Waste Lamps and Thermostats: Manage, contain, package, and label in strict accordance with 40 CFR 273.

3.02 PROTECTION

A. Dust and Debris Control:

1. Vacuum and dust the Work area daily.
2. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to vehicular traffic.

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 the 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. 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.

E. Protection of Personnel: Provide temporary barricades and other forms of protection to protect Owner’s personnel and the general public from injury due to demolition Work.

3.03 BURNING

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

3.04 RELOCATIONS

A. 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.

3.05 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 306, Trench Backfill of the ISPWC.

3.06 TITLE TO MATERIALS

A. All salvaged equipment and materials will remain the property of Owner.

B. With the exception of the following listed salvaged equipment and materials, all items designated to be removed shall become the property of Contractor:

1. Diffusers and headers in Aeration Basins No. 1 and 2.
2. Dissolved oxygen sensors in Aeration Basins No. 1 and 2.
3. Trickling Filter No. 2 mechanism, bearings, and seals.
4. Two 24-inch RAS valves.
5. Secondary effluent pumps.
6. Level element instruments in Parshall Flume No. 3.
7. Flow meter in Secondary Sludge Pump Station.
8. Weir gate to Trickling Filter No. 1 at head box in trickling filter recirculation pump station.

3.07 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor’s Demolition/Renovation Plan by Engineer.

B. Salvage equipment and material to the maximum extent possible.

C. Remove materials and equipment that are indicated and specified to be removed by Contractor and deliver to a storage site as directed by the Owner on the Site.

D. Remove salvaged items in a manner to prevent damage, and pack or crate to protect the items from damage while in storage or during shipment. Properly identify containers as to contents.

E. Repair or replace, at the discretion of Engineer, items damaged during removal or storage.

F. All items not specifically identified in the Contract for salvage shall become the property of the Contractor. The Contractor shall properly dispose of all such materials.

3.08 REUSE OF MATERIALS AND EQUIPMENT

A. Remove and store materials and equipment listed in Article Title to Materials to be salvaged for a location designated by Owner to prevent damage.

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.

3.09 SPECIALIZED SALVAGE

A. Ozone Depleting Substances (ODS):

1. Class I and Class II ODS are defined in Section 602(a) and (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting AHRI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling.
2. Dispose of all Class I and Class II ODS refrigerants in accordance with the Clean Air Act Amendment of 1990.
3. Products, equipment and appliances containing ODS in a sealed, self-contained system (e.g., residential refrigerators and window air conditioners) shall be disposed of in accordance with 40 CFR 82.

B. Fire Suppression Containers: Fire suppression system cylinders and canisters with electrical charges or initiators shall be deactivated prior to shipment. Also, safety caps shall be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.10 UNSALVAGEABLE MATERIAL

A. Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of offsite.

B. The fill in the disposal area after disposal is completed, the disposal area shall be uniformly graded to drain.

C. Combustible material shall be disposed of offsite.

D. Universal Waste Lamps and Thermostats: Dispose of in strict accordance with 40 CFR 273.

3.11 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. 318/318R, Building Code Requirements for Structural Concrete and Commentary.
   c. 347, Guide to Formwork for Concrete.

1.02 DESIGN REQUIREMENTS

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

B. When high range water reducer (superplasticizer) is used in concrete mix, forms shall be designed for full hydrostatic pressure per ACI 347.

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 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.
2. Samples: One each as follows:
   a. Form ties.

B. Informational Submittals:

1. Statement of qualification for formwork designer.
2. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 QUALIFICATIONS

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

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.

B. Column Forms:

1. Rectangular Columns: As specified for walls.
2. Circular Columns: Fabricated steel or fiber reinforced plastic with bolted together sections or spirally wound laminated fiber form internally treated with release agent for height of column.

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 not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatments of concrete surfaces when applied to forms. 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.
2. Manufacturers and Products:
   a. BASF, Shakopee, MN; MBT, Rheofinish 211.
   b. Cresset Chemical Company; Crete-Lease 20-VOC.

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

H. Form Ties:

1. Material: Steel.
2. Spreader Inserts:
   a. Conical or spherical type.
   b. Design to maintain positive contact with forming material.
   c. Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties not permitted.
4. 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.
5. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
   a. Integral steel water stop 0.103 inch thick and 0.625 inch in diameter tightly and continuously welded to tie.
   b. 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.
   c. Orient water stop perpendicular to tie and symmetrical about center of tie.
   d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
6. Through-Bolts: Tapered minimum 1-inch diameter at smallest end.

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 prior to coating surface.

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

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

3.02 ERECTION

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

B. Beveled Edges (Chamfer):

1. Form 3/4-inch bevels at concrete 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 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.

E. Form Tolerances: Provide forms in accordance with ACI 117/117R, ACI 347, and ACI 318/318R 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. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
   e. Form Offset: Between adjacent pieces of formwork, facing material shall not exceed 1/4 inch.
2. Beams and Columns 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.
d. Column Type C-A:
   1) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
   2) Plumb within 1/4 inch in 10 feet in all directions with maximum 1/2 inch out-of-plumb at top with respect to bottom.

3.03 FORM REMOVAL

A. 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.

B. 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.

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. 318, Building Code Requirements for Structural Concrete and Commentary.
   b. 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.
   f. A767/767M, Standard Specification for Zinc-Coated (Galvanized) Steel bars for Concrete Reinforcement
   g. A775/A775M, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
4. Concrete Reinforcing Steel Institute (CRSI):
   a. Placing Reinforcing Bars.
   b. 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:

a. Bending lists.
b. Placing drawings.

2. Welded, metallic sleeve splice, and mechanical threaded connection.

B. Informational Submittals:

1. Lab 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.

1.03 DELIVERY, STORAGE, AND HANDLING

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

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 metal coupling sleeve with internal threads engaging threaded ends of bars developing in tension or compression 125 percent of yield strength of bar.
   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.

2.02 ACCESSORIES

A. Tie Wire:

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

B. Bar Supports and Spacers:

1. Use precast concrete bar supports or all-plastic 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 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. Plastic Bar Supports: Manufactured by Aztec Concrete Accessories, Bloomington, CA.
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.

B. Bend bars cold.

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.

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.

B. Spacing and Positioning: Conform to ACI 318.

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

D. Splicing:

1. Follow ACI 318.
2. Use lap splices, unless otherwise shown or permitted in writing by Engineer.
3. Welded Splices: Not permitted.
4. Stagger splices in adjacent bars where indicated.

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. Extend steel reinforcing a standard lap length beyond opening at each end.

H. Welding Reinforcement: Not permitted.

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

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

3.03 TESTS AND INSPECTION

A. An independent testing agency will be retained by Owner to visually inspect and test reinforcing steel welds in accordance with AWS D1.4/D1.4M as specified in Section 05 05 23, Welding.

B. An independent testing agency will be retained 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.

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 Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. 305.1, Specification for Hot Weather Concreting.
   d. 306.1, Standard Specification for Cold Weather Concreting.
   e. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures.
   f. CP-1, Technical Workbook for ACI Certification of Concrete Field Testing Technician – Grade 1.
2. ASTM International (ASTM):
   a. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   b. C33/C33M, Standard Specification for Concrete Aggregates.
   c. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   e. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   f. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   g. C150/C150M, Standard Specification for Portland Cement.
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
   j. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   k. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
   l. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
   m. C595/C595M, Standard Specification for Blended Hydraulic Cements.

n. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
o. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
p. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
q. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
r. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
s. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
t. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
u. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
v. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
w. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
x. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
y. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
z. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
aa. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
bb. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
cc. D4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding.
dd. E329, Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
ee. E1155, Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.

3. National Ready Mixed Concrete Association (NRMCA).

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 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 61 00, Common Product Requirements, for the following:
      1) Portland cement.
      2) Fly ash.

3) Slag cement.
4) Silica Fume.
5) Aggregates, including specified class designation for coarse aggregate.
6) Admixtures.
7) Concrete producer has verified compatibility of constituent materials in design mix.

d. Test Reports:
1) 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.

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) Percent of fine aggregate weight to total aggregate weight.
4) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
5) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
6) Test Reports:
a) 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.

f. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.

2. Product Data: Specified ancillary materials.
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, 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.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer's application instructions for bonding agent and bond breaker.
3. Manufacturer's Certificate of Compliance to specified standards:
   a. Bonding agent.
   b. Bond breaker.
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. Tightness test results.
8. 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.

1.04 QUALITY ASSURANCE

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

B. 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. 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.

C. 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.

D. 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 who authored Statement of Special Inspection Plan or Engineer's designee.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include:
    a. Admixture types, dosage, performance, and redosing at Site.
    b. Mix designs, test of mixes, and Submittals.
    c. Placement methods, techniques, equipment, consolidation, and form pressures.
    d. Slump and placement time to maintain slump.
    e. Finish, curing, and water retention.
    f. Thermal control plan.
    g. Protection procedures for weather conditions.
    h. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01 31 19, Communication and Project Meetings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cementitious Materials:

1. Cement:
   a. Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
   b. Blended Hydraulic Cement:
      1) Unless otherwise specified, conform to requirements of ASTM C595/C595M.
      2) Portland cement used in blended hydraulic cement, conform to requirements of ASTM C150/C150M.
   c. 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) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
   b. Slag Cement: In accordance with ASTM C989, Grade 100 or Grade 120.
   c. Silica Fume: ASTM C1240.

B. Aggregates: Furnish from one source for each aggregate type used in a mix design.

1. Normal-Weight Aggregates:
   a. In accordance with ASTM C33/C33M, except as modified herein.
      1) Class Designation: 4S unless otherwise specified.
   b. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
   c. Alkali Silica Reactivity: See Article Concrete Mix Design.
2. Fine Aggregates:
   a. 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 5 percent mass of total sample.
      2) Limit coal and lignite to 1.0 percent.
3. Coarse Aggregate:
   a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no

more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).

b. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

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

1. Characteristics:
   a. Compatible with other constituents in mix.
   b. Contain at most, only trace amount chlorides in solution.
   c. 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. 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.
5. Accelerating Admixture: ASTM C 494/C 494M, Type C.
6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
   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. Plasticizing Admixture: ASTM C1017/C1017M, Type I or Type II.
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 from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
   a. Chloride Content: 1,000 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.

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:

1. In accordance with requirements of Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
2. In accordance with requirements of Section 03 01 33, Repair of Horizontal Concrete Surfaces.

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

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, or plasticizing admixture in pumped concrete, in concrete with a water-cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.

5. Unless otherwise permitted, use water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in columns, piers, pilasters, and walls.
6. Use water-reducing admixture or high-range, water-reducing admixture, or plasticizing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.
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.

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 pozzolans into concrete mixture as necessary to satisfy testing for potential alkali reactivity.

C. Proportions:

1. Design mix to meet aesthetic, durability, and strength requirements.
2. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.

D. Slump Range at Site:

1. Prior to submitting mix design, consult with concrete producer and select a target slump value at point of delivery, for each application of each design mix. Unless otherwise permitted, target slump value will then be enforced for duration of Project.
2. Design mixes that include a high-range, water-reducing or a plasticizing admixture shall have a minimum slump of 2 inches prior to addition of admixture. Unless otherwise permitted, slump shall be 8 inches maximum at point of delivery, for concrete with a high-range, water-reducing admixture.
3. Slump tolerance shall meet requirements of ACI 117.

E. Combined Aggregate Gradation:

1. Combined Gradation Limits: Fine aggregate shall be in range of 36 percent to 40 percent of total aggregate weight.

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 Fahrenheit, and maximum temperature differential between center of section and external surfaces of concrete will not exceed 35 degrees Fahrenheit.

2.06 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 PLACING CONCRETE

A. Preparation: Meet requirements ACI 301, except as modified herein.

B. Inspection: Notify Engineer and Special Inspector at least 1 full working day in advance before starting to place concrete.

C. Placement into Formwork:

1. Reinforcement: Secure in position before placing concrete.
2. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs which shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
3. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
4. Use placement devices, for example chutes, pouring spouts, and pumps as required to prevent segregation.
5. Vertical Free Fall Drop to Final Placement:
   a. Forms 8 Inches or Less Wide: 5 feet.
   b. Forms Wider than 8 Inches: 8 feet, except as specified.
6. For placements where drops are greater than specified, use placement device such that free fall below placement device conforms to required value.
   a. Limit free fall to prevent segregation caused by aggregates hitting steel reinforcement.
7. Do not use aluminum conveying devices.
8. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
9. 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.

10. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.
11. Cure concrete as specified in Section 03 39 00, Concrete Curing.

D. 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.

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

F. 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.

G. 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 follows:
   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.

H. 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.
3. Construction Joints: Unless otherwise shown or permitted, locate construction joints as follows:
    a. Locate construction joints as shown on Drawings or where approved in joint location submittal required in Section 03 15 00, Concrete Joints and Accessories.
    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.

I. 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.

J. Consolidation and Visual Observation:

1. Consolidation Equipment and Methods: ACI 301.
2. Provide at least one standby vibrator in operable condition at Site prior to placing concrete.
3. Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.
4. Vibrate concrete in vicinity of joints to obtain impervious concrete.

K. 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 90 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.
2. Concrete Curing: As specified in Section 03 39 00, Concrete Curing.

L. 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. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Engineer.
   c. 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.
   d. 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.
   e. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
   f. 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.

3.02 CONCRETE BONDING

A. Construction Joints in New Concrete Members:

1. Prepare surface of construction joint as specified in Section 03 15 00, Concrete Joints and Accessories.
2. Horizontal Construction Joints Containing Waterstop in New Concrete Walls:
   a. Unless otherwise permitted, place slurry mixture 4-inch maximum thickness, 2-inch minimum thickness in horizontal construction joints containing waterstops.

b. Use positive measuring device such as bucket or other device that will contain only enough slurry mixture for depositing in visually measurable area of wall to ensure that portion of form receives appropriate amount of slurry mixture to satisfy placement thickness requirements.
c. Do not deposit slurry mixture from pump hoses or large concrete buckets, unless specified placement thickness can be maintained and verified through inspection windows close to joint, or by other means.
d. Limit concrete placed immediately on top of slurry mixture to 12 inches thick. Thoroughly vibrate to mix concrete and slurry mixture together.

B. Construction Joints at Existing Concrete:

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

3.03 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 defective areas of concrete.
3. Repair horizontal concrete surfaces in accordance with Section 03 01 33, Repair of Horizontal Concrete Surfaces.
4. Repair vertical and overhead concrete surfaces in accordance with Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
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: Unless otherwise specified, fill with specified repair material.

1. Prepare substrate and mix, place, and cure repair material per manufacturer's written recommendations.

C. 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.

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

3.04 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. Patch tie holes.
2. Grind off fins and other projections.
3. Repair defective areas to provide smooth uniform appearance.
4. Inject cracks in accordance with requirements of Section 03 64 23, Crack Repair Epoxy Injection Grouting.

C. Type W-3 (Controlled Permeability Form Liner): Not used

D. Type W-4 (Finish for Cementitious Coatings): In accordance with requirements for Type W-2 except as follows:

1. Leave surface ready for cementitious coating specified in Section 09 97 26, Cementitious Coatings.

E. Type W-5 (Finish for Painting): In accordance with requirements for Type W-2 except as follows:

1. Leave surface ready for painting as specified in Section 09 90 00, Painting and Coating.

3.05 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.

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:

E. Type S-4 (Exposed Aggregate Finish): Not used.

F. 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.

G. 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.

H. Type S-7 (for Clarifier or Float Thickener Slab): Not used.

I. 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.

3.06 CONCRETE SLAB TOLERANCES

A. Slab Flatness and Levelness:

1. Floor finish tolerances shall meet requirements specified herein, and as measured in accordance with ASTM E1155.
2. Levelness tolerance, FL, shall not apply to slabs placed on unshored form surfaces or shored form surfaces after removal of shores.
3. 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.

3.07 BEAM AND COLUMN FINISHES

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

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

C. Type B-3:

1. Repair rock pockets.
2. Fill air voids.
3. Match wall Type W-3.

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

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

F. Type C-3:

1. Fill air pockets.
2. Match wall Type W-3.

3.08 BACKFILL AGAINST STRUCTURES

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

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

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

3.09 FIELD QUALITY CONTROL

A. General:

1. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
2. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
3. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
4. Evaluation will be in accordance with ACI 301 and Specifications.
5. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
6. Frequency of testing may be changed at discretion of Engineer.
7. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M.

8. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing 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. High-Range, Water-Reducer (Superplasticizer) Admixture Segregation Test: Test each truck prior to use on Project.

1. Segregation Test Objective: Concrete with 4-inch to 8-inch slump shall stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
2. Test Procedure: Make slump test and check for excessive slump and observe to see if mortar or moisture flows from slumped concrete.
3. Reject concrete if mortar or moisture separates and flows out of mix.

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 or for prestressing.

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. Slab Flatness and Levelness: Make measurements within 72 hours of concrete placement.
      1) Flatness measurements are not applicable to unshored form surfaces or shored form surfaces after removal of shores.
      2) Levelness measurements are not applicable to cambered or sloped surfaces.
   b. Slab flatness and levelness shall be determined in accordance with ASTM E1155.

F. Liquid Tightness Tests:

1. Purpose: To determine integrity and liquid-tightness of finished exterior and interior concrete surfaces of liquid containment structures.
2. Test the following structures for liquid-tightness:
   a. Aeration Basin 3.
   b. Primary Effluent Pump Station (PEPS).
3. Water for initial tightness test shall be provided by Contractor.
4. Water source shall be determined by Contractor. Recommend using water from dewatering activities.
   a. Provide means to transport water to structure to be tested.
   b. If additional tightness tests are required because of failure to meet criteria, provide water for subsequent tests.
5. After testing has been completed, dispose of test water in a manner approved by Owner.
6. Liquid-Tightness Test Requirement:
   a. Perform tightness tests in accordance with ACI 350.1 and as specified herein.
   b. Do not place backfill or install brick facing, grout topping slab, coatings, or other work that will cover concrete surfaces until tightness testing has been completed and approved.
   c. Measure evaporation, precipitation, and temperature as specified.
7. Measure water surface at two points 180 degrees apart when possible where attachments, such as ladders exist, at 24-hour intervals.

8. Acceptance Criteria:
   a. Volume loss shall not exceed 0.050 percent of contained liquid volume per 24-hour period, adjusted for evaporation, precipitation, and temperature.
   b. Acceptance that structure has passed tightness test shall be based on total volume loss at end of specified test period.
9. Repairs When Test Fails:
   a. Dewater structure; fill leaking cracks with crack repair epoxy as specified in Section 03 64 23, Crack Repair Epoxy Injection Grouting.
   b. Patch areas of damp spots previously recorded, and repeat water leakage test in its entirety until structure successfully passes test.

3.10 MANUFACTURER'S SERVICES

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

1. Concrete Producer Representative:
   a. Observe how concrete mixes are performing.
   b. Be present during first placement of each type of concrete mix.
   c. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
   d. Establish control limits on concrete mix designs.
   e. 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.

3.11 PROTECTION OF INSTALLED WORK

A. 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.

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

3.12 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		
Abovegrade/exposed (above point 6" below finish grade)	W-2	W-B
Abovegrade/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
Walls to receive cementitious coatings	W-4	W-B
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
Water-holding tanks, channels, and basins/painted or coated	W-5	W-A
Exterior Slabs		
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

Area	Type of Finish	Required Form Tolerances
Sidewalks	S-6	S-B
Other exterior slabs	S-5	S-A
Interior Slabs		
Buildings, pipe galleries, and other dry areas	S-1	S-B
Hydraulic channels	S-1	S-A
Underside of elevated slabs	S-3	S-A
Beams and Columns		
Beams/coated	B-3	B-A
Beams/not coated	B-2	B-A
Columns/coated	C-3	C-A
Columns/not coated	C-2	C-A

3.13 SUPPLEMENTS

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

1. Concrete Mix Design, Class 4,000 psi (Typical).
2. Concrete Mix Design, Class 4,000 psi (Nonwater-Holding Structures).
3. Concrete Mix Design, Class 3,500 psi (Encasements).
4. Concrete Mix Design, Class 3,500 psi (Secondary Elements).

END OF SECTION

CONCRETE MIX DESIGN, CLASS 4,000 PSI (TYPICAL)

A. Mix Locations: Typical, unless otherwise specified.

B. Exposure Categories and Classifications: F3S1P2C2.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.40.
2. Minimum concrete compressive strength (f'c) shall be 4,000 psi at 28 days and 5,000 psi at 56 days.
3. Designed to conform to shrinkage limits.
4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

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

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

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

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

5. Limit supplementary cementitious materials measured as a percent of weight of total cementitious materials in mix design, as follows:
   a. Fly Ash and other Pozzolans: 25 percent.
   b. Slag Cement: 50 percent.

c. Silica Fume: 10 percent.
d. Combined Fly Ash and other Pozzolans Slag Cement, and Silica Fume: 50 percent, with fly ash and other pozzolans not exceeding 25 percent, and silica fume not exceeding 10 percent.
e. Total cementitious materials include ASTM C150/C150M and ASTM C595/C595M cement.
    1) Fly ash and other pozzolans in Type IP, blended cement, ASTM C595/C595M.
    2) Slag used in the manufacture of an IS blended cement, ASTM C595/C595M.
    3) Silica fume, ASTM C1240, present in blended cement.

6. Provide cementitious materials in accordance with one of the following:
    a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
    b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
        1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
        2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
    c. ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
        1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
7. Unless otherwise permitted, minimum cementitious materials content in mix design shall be as follows:
    a. 515 pounds per cubic yard for concrete with 1-1/2-inch nominal maximum size aggregate.
    b. 535 pounds per cubic yard for 1-inch nominal maximum size aggregate.
    c. 560 pounds per cubic yard for 3/4-inch nominal maximum size aggregate.
    d. 580 pounds per cubic yard for 1/2-inch nominal maximum size aggregate.
    e. 600 pounds per cubic yard for 3/8-inch nominal maximum size aggregate.
    f. Unless otherwise permitted, limit cementitious materials content to 100 pounds per cubic yard greater than specified minimum cementitious materials content in mix design.

8. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

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

CONCRETE MIX DESIGN, CLASS 4,000 PSI (NONWATER-HOLDING STRUCTURES)

A. Mix Locations: Nonwater-holding structures.

B. Exposure Categories and Classifications: F2S1P1C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) shall be 4,000 psi at 28 days and 4,500 psi at 56 days.
   a. Designed to conform to shrinkage limits.
   b. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
      1) Slabs to receive a hard-troweled finish.
      2) Slabs to receive a dry shake floor hardener.
   c. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

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

Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations. *Tolerance of air content is +1-1/2 percent. §Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on sieved fraction passing 1-1/2-inch sieve in accordance with ASTM C231/C231M.	

3. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
      3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

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

CONCRETE MIX DESIGN, CLASS 3,500 PSI (ENCASEMENTS)

A. Mix Locations:

1. Electrical duct banks.
2. Pipe encasements that are not cast monolithically with concrete base mats or slabs.
3. Where specified in Contract Documents.

B. Exposure Categories and Classifications: F1S1P0C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) shall be 3,500 psi at 28 days and 4,500 psi at 56 days.
3. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	6.0
1/2	5.5
3/4	5.0
1	4.5
1-1/2	4.5
2§	4.0
3§	3.5

Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations. *Tolerance of air content is +1-1/2 percent. §Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on the sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.	

4. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
      3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
         a) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
5. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

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

CONCRETE MIX DESIGN, CLASS 3,500 PSI (SECONDARY ELEMENTS)

A. Mix Locations: Concrete curbs and sidewalks, pipe encasements, duct banks, etc.

B. Exposure Categories and Classifications: F3S1P1C2.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.42.
2. Minimum concrete compressive strength (f'c) shall be 3,500 psi at 28 days and 4,500 psi at 56 days.
3. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

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

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

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

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

4. Limit supplementary cementitious materials measured as a percent of weight of total cementitious materials in a mix design, as follows:

a. Fly Ash and other Pozzolans: 25 percent.
b. Slag Cement: 50 percent.
c. Silica Fume: 10 percent.
d. Combined Fly Ash and other Pozzolans, Slag Cement, and Silica Fume: 50 percent, with fly ash and other pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
e. Total cementitious materials include ASTM C150/C150M and ASTM C595/C595M cement.
    1) Fly ash and other pozzolans in Type IP, blended cement, ASTM C595/C595M.
    2) Slag used in the manufacture of an IS blended cement, ASTM C595/C595M.
    3) Silica fume, ASTM C1240, present in blended cement.

5. Provide cementitious materials in accordance with one of the following:
    a. ASTM C150/C150M Type II.
    b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
        1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
        2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
    c. ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
        1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent, unless otherwise specified.
    a. Limits are stated in terms of chloride ions in percent by weight of cement.
    b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

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

SECTION 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.

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: Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:

1. Curing compound showing moisture retention requirements.

PART 2 PRODUCTS

2.01 MATERIALS

A. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315 Type I or Type II, Class A.

2. Manufacturers and Products:
   a. BASF Construction Chemicals, Shakopee, MN; Kure 1315.
   b. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
   c. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
   d. Vexcon Chemical, Inc.; Philadelphia, PA; Starseal 1315.
   e. Dayton Superior; Safe Cure and Seal 1315 EF.

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. 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 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: 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 MANUFACTURER'S SERVICES

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

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

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, in accordance with Section 01 61 00, Common Product Requirements:
   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, in accordance with Section 01 43 33, Manufacturers' Field Services.

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, attached at the end of this section. 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

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Column baseplates single-story	I or II		II
Machine bases 25 hp or less	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-yard 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 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 five 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. Mix and demonstrate patching through-bolt holes and blockouts for gate guides, and similar items.
7. Transport test cubes to independent test laboratory and obtain test reports.

3.04 SUPPLEMENTS

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

1. 24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

SUPPLEMENT 1

_____

(Test Lab Name)

_____

(Address)

_____

(Phone No.)

24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is to establish grout manufacturer's qualifications.

PRIOR TO TEST: Obtain five bags of each type of grout.

1. From intended grout supplier for Project.
2. Five bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

A.	Product data and warranty information contained in company literature and data?	Yes_____ No_____
B.	Literature and bag information meet specified requirements?	Yes_____ No_____
C.	Manufacturer guarantees grout as specified in Article Guarantee?	Yes_____ No_____
D.	Guarantee extends beyond grout replacement value and allows participation with Contractor in replacing and repairing defective areas?	Yes_____ No_____
E.	Water demands and limits printed on bag?	Yes_____ No_____
F.	Mixing information printed on the bag?	Yes_____ No_____
G.	Temperature restrictions printed on bag?	Yes_____ No_____

*Rejection of a grout will occur if one or more answers are noted NO.

GROUT TESTING PROCEDURES

A. Bagged Material:

1. List lot numbers. _____
2. List expiration date. _____
3. Weigh bags and record weight. _____

Owner's Representative will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of five bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties.)

B. Mixing and Consistency Determination:

1. Mix full bag of grout in 10 gallon pail.
2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).
3. Use maximum water allowed per water requirements listed in bag instructions.
4. Mix grout to maximum time listed on bag instructions.
5. In accordance with ASTM C939 (flow cone) determine time of mixed grout through the flow cone. _____ seconds
6. Add water to attain 20 to 30 second flow in accordance with ASTM C939.
7. Record time of grout through cone at new water demand. _____ seconds
8. Record total water needed to attain 20 to 30 second flow. _____ pounds
9. Record percent of water. _____ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer's listed maximum water, ASTM C1107/C1107M will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:

1. Fill two gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.
2. Place one can of grout in tub of ice water and leave one can at ambient temperature.
3. Cover top of both cans with glass or plastic plate preventing evaporation.
4. Maintain 38 degrees F to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.

5. Visually check for bleeding of water at 15-minute intervals for 2 hours.
6. Perform final observation at 24 hours.

If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II and Category III):

1. Divide the remaining grout into two 3 gallon cans. Place the cans into the 40-degree F and 100-degree F containers and leave for 20, 40, and 60 minutes. Every 20 minutes remove and check for segregation or settlement of aggregate. Use a gloved hand to reach to the bottom of the can, if more than 1/4-inch of aggregate has settled to the bottom or aggregate has segregated into clumps reject the grout.
2. Right after the settlement test mix the grout with the drill mixer for 10 seconds. Take a ASTM C939 flow cone test of grout and record flow time. Maintain this process for 1 hour at ambient temperatures of 40 degrees F and 100 degrees F.
   a. 20 min _____, sec. @ 40 degrees F.
   b. 40 min _____, sec. @ 40 degrees F.
   c. 60 min _____, sec. @ 40 degrees F.
   d. 20 min _____, sec. @ 100 degrees F.
   e. 40 min _____, sec. @ 100 degrees F.
   f. 60 min _____, sec. @ 100 degrees F.

All Category II and Category III grout that will not go through the flow cone with continuous flow after 60 minutes will be disqualified.

_____ _____

Qualified Disqualified

F. 24-hour Strength Test:

1. Using grout left in mixing cans in accordance with ASTM C1107/C1107M for mixing and consistency determination test and for extended time flow test, make minimum of nine cube samples.
2. Store cubes at 70 degrees F for 24 hours.
3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are less than 2,500 psi for grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the Project for the application indicated in Nonshrink Grout Schedule.

_____ _____

Signature of Independent Testing Laboratory Date Test Conducted

SECTION 03 63 00
CONCRETE DOWELING

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. International Code Council (ICC):
   a. 2012 International Building Code (IBC).
   b. Evaluation Services Reports.

1.02 DEFINITIONS

A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.

B. Special Inspection: As defined in the ICC IBC.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer’s catalog information.

B. Informational Submittals:

1. Manufacturer’s qualifications; include client name, address, contact person, phone number, project location, and description of work.
2. Manufacturer’s instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
3. Manufacturer’s written letter of certification identifying installer’s qualifications to install products.
4. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: At least three similar projects with same products within last 3 years.
2. Installer: Trained and certified by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Container Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

B. Store adhesive components in accordance with manufacturer's written instructions.

C. Dispose of when:

1. Shelf life has expired.
2. Stored other than per manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

1. Approved by an ICC Evaluation Services Report for conformance to 2012 IBC requirements for doweling of steel reinforcing bars in cracked concrete.
2. Suitable for long-term loads as well as for wind and seismic loads.
3. Meet requirements of ASTM C881/C881M.
4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
5. Disposable, Self-Contained Cartridge System:
   a. Capable of dispensing both components in proper mixing ratio.
   b. Fit into manually or pneumatically operated caulking gun.
6. Mixed Adhesive: Nonsag, light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout.
7. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
8. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT-RE 500-SD or HIT-HY 200 MAX-SD Adhesive Anchors.

b. Powers Fasteners, Brewster, NY; Power PE1000+ Epoxy Adhesive Anchor System (1/2-inch to 7/8-inch diameter anchors).
c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors.

B. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.

C. Reinforcing Dowels:

1. As specified in Section 03 21 00, Reinforcing Steel.
2. Smooth Epoxy-Coated Expansion Joint Dowels: As specified in Section 03 15 00, Concrete Accessories.

PART 3 EXECUTION

3.01 INSTALLATION

A. Drilling Equipment:

1. Drilling Hammers for Dowel Holes:
   a. Electric or pneumatic rotary type with medium or light impact.
   b. Hollow drills with flushing air systems are preferred.
2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.

C. Obstructions in Drill Path: When existing reinforcing steel is encountered during drilling, obtain Engineer approval for proposed fix.

D. Doweling:

1. Install per details shown on Drawings and in accordance with adhesive manufacturer’s instructions.
2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
3. Bent Bar Dowels: Where edge distances are critical, and intersection with reinforcing steel is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.
4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.

E. Adhesive:

1. Install in accordance with manufacturer's instructions.
2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.02 FIELD QUALITY CONTROL

A. Special Inspection:

1. Special inspection will be performed by the Special Inspector in accordance with ICC ESR requirements and as specified in Section 01 45 33, Special Inspection and Testing.
2. Continuous inspection required where noted herein and where concrete dowels are installed in overhead applications.
3. Periodic inspection required where continuous inspection is not specified.

END OF SECTION

SECTION 04 22 00
CONCRETE UNIT MASONRY

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): 530.1/ASCE 6/TMS 602, Building Code Requirements for Masonry Structures and Specifications for Masonry Structures and Related Commentaries.
2. ASTM International (ASTM):
   a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   c. C33, Standard Specification for Concrete Aggregates.
   d. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   e. C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   f. C144, Standard Specification for Aggregate for Masonry Mortar.
   g. C150, Standard Specification for Portland Cement.
   h. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   i. C270, Standard Specification for Mortar for Unit Masonry.
   j. C404, Standard Specification for Aggregates for Masonry Grout.
   k. C476, Standard Specification for Grout for Masonry.
   l. C1314, Standard Test Method for Compressive Strength of Masonry Prisms.
   m. E514, Standard Test Method for Water Penetration and Leakage through Masonry.
3. International Code Council (ICC):
   a. International Building Code (IBC), Chapter 21.
   b. ICC Evaluation Service (ICC-ES) Reports.
4. National Concrete Masonry Association (NCMA).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Information illustrating horizontal joint reinforcement and preformed control joint materials proposed.

b. Grout proportions.
c. Mortar proportions.
d. Letter of certification stating grout aggregates and mortar sand meet requirements of ASTM C33, including nonreactivity.

2. Samples:
a. One of each type of masonry unit to be used on Project.
b. Two each; textured, glazed, sound absorbing, and brick units for selection of color and texture.
c. Mortar colors for color selection.

B. Informational Submittals:

1. Method of placing grout.
2. Certified field test results within 5 days of performing specified tests.
3. Letter of certification from masonry unit manufacturer stating that units comply with IBC Table 2105.2.2.1.2.
4. Letter from water repellent admixture manufacturer verifying masonry unit manufacturer's proper use of product.
5. Certified test reports showing compliance with specified performance tests.
6. Statement of acknowledgement of Quality Assurance Plan in accordance with IBC Section 1705.3
7. Method and materials for removal of efflorescence.

1.03 QUALITY ASSURANCE

A. Mockups:

1. Lay up Sample panel for each type of masonry at Site.
2. Dimensions: Minimum 4 feet high by 4 feet long.
3. May be part of permanent construction.
4. Approved panels shall serve as basis of color, texture, bond, quality of finished joints, and for acceptance of permanent construction.
5. Demonstrate ability to keep insulation and grout isolated and in certain cells during any sequence of placement, and to demonstrate materials will be restricted to cells and bond beams intended to receive each material.
6. Construction shall show areas required to receive mortar, including webs on each side of each cell to prevent insulation from entering cells to receive grout or to prevent grout from entering cells to receive insulation.

7. Where bond beams are to be used, demonstrate proper placement of both insulation and grout to bond beam level, and proper placement of bond beam prior to placement of insulation and grout above bond beam level.
8. Demonstrate proper use of running bond.

B. Comply with the requirements and criteria of the NCMA, BIA, ASTM C90, ASTM C216, and ACI 530.1 for masonry finish and appearance, dimension tolerances, tolerances of construction, joint tolerances, and wall plumb tolerances.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Keep lime and other ingredients dry.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not lay masonry when ambient temperature is below 32 degrees F on a rising temperature, or below 40 degrees F on a falling temperature, or when there is a probability of such conditions occurring within 48 hours, unless written approval of procedures for protection from freezing is obtained from Engineer.

B. Moisture Protection: Protect masonry construction from loss of moisture during curing period of 7 days when ambient air temperature is 90 degrees F or greater and when relative humidity is less than 50 percent.

PART 2 PRODUCTS

2.01 COMPRESSIVE STRENGTH OF MASONRY

A. Minimum 28-Day Compressive Field Strength (f'm) of Completed Assemblage: 1,500 psi.

2.02 MASONRY UNITS

A. General:

1. Furnish or cut special shapes for corners, jambs, lintels, and other areas shown or required.
2. Special units shall match color and texture of standard units.
3. Where units are placed so end of unit is exposed, such as at a corner or intersection, exposed end of that block shall have surface to match color and texture of sides of other units.
4. Furnish sound, dry, clean units free of cracks, prior to placing in structure.

5. Vertical Cells to be Grouted: Capable of alignment sufficient to maintain clear, unobstructed continuous vertical cell dimensions in accordance with ACI 530.1, Table 7.
6. Masonry unit size and shape shall allow for all placement patterns to prevent materials, such as grout or poured insulation, from escaping from cell being filled to adjacent cells where material is not intended to be placed.

B. Concrete Masonry Units (CMU):

1. ASTM C90: Medium weight.
2. Water Repellent Admixture:
   a. Structural concrete masonry units in weather exposed exterior wall shall be manufactured with integral liquid polymeric admixture to provide resistance to water penetration.
   b. Manufacturer and Product: W.R. Grace & Co.; Dry-Block Block Admixture.
3. Nominal Size: 16 inches long by 4 inches or 8 inches high by thickness shown on Drawings.
4. Compressive Strength: 1,900 psi minimum, in accordance with ASTM C90, Table 2.
5. Color of Units: Colors to be selected by Architect/Owner from manufacturer's full range of colors.
6. Surface Texture on Exposed Surfaces: As shown on Drawings.
7. Surface Texture: Smooth on interior and concealed exterior.

2.03 MORTAR AND GROUT MATERIALS

A. Cement: ASTM C150, Type II, portland cement.

B. Lime: ASTM C207, Type S hydrated.

C. Aggregates:

1. Mortar: ASTM C144, sand.
2. Grout: ASTM C404.

D. Water: Fresh, clean, and potable.

E. Mortar Plasticizer Admixture:

1. May be used instead of lime.
2. Manufacturer and Product: American Colloid Co.; Easy/Spred Plasticizer.

F. Water Repellent Admixture: Mortar for structural and textured concrete masonry units in weather exposed exterior walls shall include an integral liquid polymeric admixture to provide resistance to water penetration.

G. Grout Admixture:

1. Controlled expansion additive.
2. Manufacturer and Product: Sika Corporation, Lyndhurst, NJ; Grout Aid.

2.04 REINFORCEMENT

A. Deformed Bars: As specified in Section 03 21 00, Reinforcing Steel.

2.05 PREFORMED CONTROL JOINTS

A. Solid rubber cross-shape extrusions as manufactured by:

1. Dur-O-Wal, Inc., Aurora, IL; Regular Rapid Control Joint.
2. Sonneborn-Contech Co., Oakland, CA; Sonneborn Control Joint.
3. Hohmann and Barnard, Inc.; #RS-Standard.

2.06 MORTAR MIXES

A. Minimum average mortar 28-day compressive strength 1,800 psi.

B. Proportions:

1. In accordance with ASTM C270, Type S.
2. Mortar plasticizer admixture may be substituted for lime. Batch in accordance with ICC, ICBO, BOCA, or Standard Building Code Current Reports for specified mortar type and strength.

C. Mixing:

1. Machine mix in approved mixers.
2. Keep mixer drums clean and free of debris and dried mortar.
3. Mix by placing 1/2 water and 1/2 aggregate in operating mixer.
4. Add cement.
5. Add remaining aggregate and water and mix for at least 2 minutes.
6. Add lime and continue mixing as long as needed to secure a uniform mass, but no less than 3 minutes after addition of lime.
7. Time addition of admixture in accordance with manufacturer’s instructions. Procedure used for adding it to mix shall provide good dispersion.
8. Follow manufacturer’s instructions for mortar plasticizer admixture.

9. Follow manufacturer's instructions for water repellent admixture.
10. Review compatibility with other mortar admixture.

D. Where colored masonry units are used:

1. Color mortar to match. Inert coloring pigments may be added, but shall not exceed 6 percent by weight of cement.
2. Colors shall be selected by Architect/Owner from manufacturer's full range of colors.

2.07 GROUT MIXES

A. Proportions: Conform to ASTM C476 for coarse grout and as follows:

1. Compressive Strength: Minimum 2,000 psi at 28 days.
2. For Pouring:
   a. Fluid consistency (suitable for pouring without segregation) meeting requirements of ASTM C476.
   b. Conform to IBC Table 2103.11, except as noted.
3. For Pumping: Fluid consistency with minimum seven sacks of cement in each cubic yard.

B. Mixing:

1. Onsite: Follow procedure specified in Article Mortar Production.
2. Transit-Mixed Grout: Meet requirements of ASTM C476.
3. Add approved grout expansion admixture in accordance with manufacturer's recommendations. Premix admixture with water and add resulting solution to grout mix and thoroughly mix. Do not exceed quantity of admixture recommended by manufacturer.

2.08 WATER REPELLENT MASONRY SEALER

A. Characteristics:

1. Water-based blend of silanes and siloxanes.
2. VOC compliant.
3. 12 percent solids/active content by weight, with density of 8.2 pounds per gallon.

B. Manufacturer and Product: W. R. Grace & Co.; Infiniseal DB Sealer.

PART 3 EXECUTION

3.01 GENERAL

A. Protect masonry construction to prevent efflorescence. Provide measures to prevent moisture from entering incomplete walls.

3.02 PREPARATION

A. Prepare surface contact area of foundation concrete for initial mortar placement by one of following methods:

1. Sandblasting foundation and reinforcing dowels after concrete has fully cured to remove laitance and spillage and to expose sound aggregate.
2. Water blasting foundation and reinforcing dowels after concrete has partially cured to remove laitance and spillage and to expose sound aggregate.
3. Green cutting fresh concrete with high pressure water and hand tools to remove laitance and spillage from foundation and reinforcing dowels and to expose sound aggregate.

B. Clean surfaces of loose material prior to initial mortar placement.

C. Prevent surface damage to foundation concrete that will be exposed to view outside of contact area.

3.03 LAYING MASONRY UNITS

A. General:

1. Conform to building code applicable to this Project and as supplemented by these Specifications.
2. Do not start laying masonry units unless foundation wall is plumb within 1/4 inch in 10 feet or not straight within 5/16 inch in 10 feet.
3. Finish Tolerances (Measured on Interior Surfaces):
   a. Maximum permissible variation from plumb of masonry wall or of line of joints in masonry wall: 1/16 inch per foot of height and 1/4 inch in total height of wall.
   b. Maximum permissible variation from horizontal line along base of wall or for lines of horizontal joints: 1/16 inch per block and 1/4 inch per 50 feet of wall with proportionately greater tolerance for longer walls up to 1/2 inch in total length of wall.
4. Place units with chipped edges or corners such that chipped area is not exposed to view.

B. Wall Units:

1. General:
   a. If necessary to move a unit after once set in-place, remove from wall, clean, and set in fresh mortar.
   b. Toothing of masonry units is not permitted.
2. Running Bond:
   a. Unless otherwise shown, lay up walls in straight, level, and uniform courses using a running bond pattern.
   b. Place units for continuous vertical cells and mortar joints to prevent materials, such as grout or poured insulation, from escaping from cell being filled to adjacent cells where material is not intended to be placed.
3. Corners: Lay standard masonry bond for overlapping units and grout solid.
4. Intersecting Walls: Bond with reinforcement, not with masonry bond.

C. Special Shapes:

1. Provide and place such special units as corner block, doorjamb block, lintel block fillers, and similar blocks as may be required.
2. Use required shapes and sizes to work to corners and openings, maintaining proper bond throughout wall.

3.04 BUILT-IN ITEMS

A. Position door frames, windows, vents, louvers, and other items to be built in wall, and construct wall around them.

B. Install masonry anchors to secure items to wall.

C. Fill spaces around items with mortar or grout.

D. Do not place electrical, instrumentation, or water conduits in a cell containing reinforcement, unless approved in writing by Engineer. Pipes, sleeves, and conduits shall not be placed closer than three diameters, center-to-center, nor shall they impair strength of construction.

3.05 MORTAR JOINTS

A. General:

1. Straight, clean, with uniform thickness of 3/8 inch.
2. Horizontal and vertical mortar joints shall have full mortar coverage on face shells.

3. Vertical Head Joints:
   a. Butter well on each unit for a width equal to face shell of unit, shove tightly so mortar bonds well to both units.
   b. Solidly fill joints from face of block to at least depth of face shell.
4. As units are laid, remove excess mortar from grout space of cells to be filled.
5. Place mortar before initial setting of cement takes place. Do not retemper mortar that has started to set or is not used within one hour. Retempering of colored mortar is not allowed.
6. Remove mortar containing water repellent admixture from face of masonry, before it sets.

B. Exposed Joints:

1. Tool joints exposed to view after final construction, unless otherwise noted or shown.
2. Cut joints flush and as mortar takes its initial set tool to provide a concave joint.
3. Perform tooling when mortar is partially set but still sufficiently plastic to bond.
4. Perform tooling with tool that compacts mortar, pressing excess mortar out rather than dragging it out.
5. Rake out joints that are not tight at time of tooling, point, and then tool.
6. Rake and tool joints at split-face surfaces, interior and exterior.

C. Concealed Joints: Strike flush with no further treatment required.

3.06 CONTROL JOINTS

A. Preformed Control Joints:

1. Omit mortar from vertical joints.
2. Place rubber control joint material as wall is built.
3. After wall is grouted, cured, and cleaned, install backing rod and sealant as specified in Section 07 92 00, Joint Sealants.
4. Place and tool sealant to match depth of typical joint.

3.07 REINFORCING

A. Foundation Dowels:

1. Size, number, and location of foundation dowels shall match vertical wall reinforcing, unless otherwise noted.
2. When foundation dowel does not line up as intended, with vertical core, do not slope more than 1 horizontal to 6 vertical to bring it into alignment.

B. Vertical Reinforcing:

1. Use deformed bars.
2. Hold in position near the ends of bars by wire ties to dowels or by reinforcing positioners.
3. Lap reinforcing bars as shown, where spliced and wire tie together.
4. Minimum Bar Clearance: One bar diameter from masonry and from additional parallel bars in same grout space.
5. Hold in position at maximum intervals of 160 bar diameters by reinforcing positioners.

C. Horizontal Reinforcing:

1. Use deformed bars.
2. Lay on webs of bond beam units and place as wall is built.
3. Lap reinforcing bars as shown, where spliced and wire tie together.
4. Minimum Bar Clearance: One bar diameter from masonry and from additional parallel bars in same grout space.
5. Terminate reinforcing bars 2 inches clear from control joints as shown.

3.08 MORTAR PRODUCTION

A. General:

1. Mix ingredients 3 minutes to 5 minutes after all ingredients are introduced.
2. Provide volumetric control by using batching box or similar measuring device. Do not use shovel to introduce materials directly into batch.
3. Keep sand damp and loose.
4. Use cool mix water.

3.09 GROUTING

A. General:

1. Do not mix, convey, or place with equipment constructed of aluminum.
2. Secure vertical and horizontal reinforcement, ties, bolts, anchors, and other required embedments in place; inspect and verify before placing grout.
3. Grout beams over openings in one continuous operation.
4. Maintain vertical alignment in ACI 530.1, Table 7.
5. Place grout as soon as possible after mortar has set to reduce shrinkage cracking of vertical joints.

6. Vertical Reinforcement:
    a. First wire tie to foundation dowels, then build wall around it.
    b. Provide reinforcing positioners or approved cross bracing to secure top of steel in place.
    c. Do not drop in vertical steel after block is laid, unless reinforcing positioners are provided in the course above previously grouted course.

B. Grouting Requirements:

1. Slump: 8 inches to 11 inches.
2. Do not start grouting until wall has cured for 24 hours, minimum.
3. Solid Grouting Requirements: Only where indicated on Drawings.
4. Partial Grouting Requirements:
    a. Walls Not Requiring Solid Grouting: Fill cells containing reinforcing steel, anchor bolts, and other embedded items as shown with grout.
    b. Construct cells to be filled to confine grout within cell.
    c. Cover tops of unfilled vertical cells under a bond beam with metal lath to confine grout fill to bond beam section.
5. Form horizontal construction joints between pours by stopping grout pour 1-1/2 inches below a mortar joint, except at a bond beam; stop pour 1/2 inch below top of masonry unit.
6. Partial Grouting with Insulation Fill:
    a. Where cells of masonry units are to receive masonry fill insulation in some cells and to receive grout in some cells, provide continuous mortar on block webs on each side of cells to be filled with grout to ensure insulation will not enter grout cells.
    b. Where bond beams are required with masonry fill insulation and grout, limit pours to less than 6 feet in height.
7. Fully embed horizontal steel with grout in an uninterrupted pour.
8. Do not construct wall more than one course above top of grout pour prior to placing grout.
9. Vibration:
    a. Use internal “pencil” type, low energy vibrator to thoroughly consolidate grout and reduce amount of air voids. Do not use concrete vibrators.
    b. After waiting sufficient time to permit grout to become plastic, but before it has taken any set, reconsolidate grout.
    c. Waiting period will vary depending upon weather conditions and block absorption rates, but under “normal” weather conditions with average masonry units the waiting period should be between 30 minutes to 60 minutes.

10. Cleanouts:
    a. Provide for grout pours over 5 feet in height.
    b. Provide sufficient size to permit cleaning of cell, positioning of reinforcing, and inspection at bottom of every vertical cell containing reinforcing.
    c. Location: Concealed from view after final construction, unless otherwise approved by Engineer.
    d. After wall has been inspected and approved and prior to grouting, cap cleanouts in a manner that will seal them from grout leakage and provide a flush finish.

3.10 WATER REPELLENT MASONRY SEALER

A. Remove efflorescence prior to applying water repellents. Dispose of waste generated.

B. Apply to weather exposed exterior concrete masonry walls.

C. Repoint loose, cracked, or disintegrating mortar at least 7 days prior to application. Ensure joint sealants and caulking are fully cured and wall surfaces are clean, dry, and free of chemical cleaners, efflorescence, dirt, oils, mortar smears, and other surface contaminants.

D. Follow manufacturer's recommendations for weather conditions during application.

E. Test a 5-foot by 5-foot wall area to assure proper coverage, desired water repellency properties, and desired surface appearance when sealer is fully dried.

F. Apply with spray, brush, or roller following manufacturer's recommendations, at a coverage rate of 50 square feet to 150 square feet per gallon, as determined by testing. Use two coat application where recommended by manufacturer.

3.11 FIELD QUALITY CONTROL

A. Special Inspection of masonry in accordance with IBC Section 1705.4.

B. Masonry shall be tested by testing agency retained by Owner, in accordance with ASTM C1314, Method B, as modified by ACI 530.1/ASCE 6.

C. Masonry test prisms, when required, shall be constructed onsite with same materials and workmanship to be used for Project.

D. Provide adequate facilities for safe storage and proper curing of masonry prisms, mortar samples, and grout samples, as applicable, onsite for first 24 hours, and for additional time as may be required before transporting to test lab.

E. Masonry Testing:

1. Unit Strength Method:
   a. Method and frequency for mortar, grout, and masonry unit sampling and testing in accordance with IBC 2105.2.2.1.
   b. Provide masonry units for test samples required.

F. Corrective Action:

1. If compressive strength tests made prior to construction of permanent structure fail to meet Specifications, adjustments shall be made to mix designs for mortar, or grout, or both, as needed to produce specified strength. Masonry units shall also be tested to verify compliance to requirements of ASTM C90, Type 1.
2. If strength tests performed on materials representative of in-place construction fail to meet Specifications, prisms or cores shall be cut from constructed walls in sufficient locations to adequately determine strength in accordance with IBC 2105.3.

G. Performance Test: Masonry using concrete masonry units and mortar with integral water repellent additives, and water repellent masonry sealer, shall achieve a Class E rating when evaluated in accordance with ASTM E514, with the test extended to 72 hours.

3.12 CLEANING

A. Immediately after completion of grouting, clean masonry surfaces of excess mortar, grout spillage, scum, stains, dirt, and other foreign substances using clean water and fiber brushes.

B. Clean walls not requiring painting or sealing so there are no visible stains.

3.13 PROTECTION OF INSTALLED WORK

A. Do not allow grout and mortar stains to dry on face of exposed masonry.

B. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain or snow is imminent and when the Work is discontinued.

C. Adequately brace walls until walls and roof are completed.

D. Provide sufficient bracing to protect walls against damage from elements, including wind and snow.

E. Protect masonry against freezing for minimum 72 hours after being laid.

F. Protect masonry from damage until final acceptance of the Work. Damaged units will not be accepted.

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: Open-Web Steel Joists, KCS-Series.
   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.
2. Elevation view of each type of joist showing configuration, chord and web member sizes, panel point dimensions, and chord extensions.
3. Connection and bearing details.
4. Special joist reinforcing and connections for supported items, such as monorails and mechanical equipment.
5. Bridging member sizes and connection details.
6. Certificate of Compliance stating that the joists have been designed in accordance with project specifications, signed and sealed by a Professional Engineer registered in the State of Idaho.
7. 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 and bridging 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. Bottom chord bracing and end anchorage for uplift design criteria.
    b. Ceiling extension to within 1 inch of finished wall surface, 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.

2.02 SHOP PRIMER

A. Apply one shop coat of rust-inhibitive primer in accordance with SJI Standard Specifications.

1. Remove loose scale, rust, and slag from welds before painting.
2. Apply primer within 8 hours after surface preparation.

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: SJI Standard Specifications and approved shop drawings.

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

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. Visually inspect field welds in accordance with AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. 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.
3. Repair defective welds as specified in Section 05 05 23, Welding.

B. Special inspection will be provided by Owner where indicated on Drawings and in Specifications.

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):
   a. Inspection of Hot-Dip Galvanized Steel Products.
   b. Quality Assurance Manual.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
5. American National Standards Institute (ANSI).
6. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
7. 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.
8. 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.

9. 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.
10. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
11. 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.
12. 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. Shop Drawings:
   a. Metal fabrications, including welding and fastener information.
   b. Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

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. Ladders: Letter of certification that ladder meets OSHA 29 CFR 1910.27 requirements.
3. Passivation method for stainless steel members.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Adhesive Anchor Installer: Trained to install adhesive anchors in accordance with manufacturer's printed installation instructions.

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.

PART 2 PRODUCTS

2.01 GENERAL

A. 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
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)

Item	ASTM Reference
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

B. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as on the Area Classification and Material Selection Table on Drawings.

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 the Area Classification and Material Selection Table on Drawings.

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. General:

1. AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in the Area Classification and Material Selection Table on Drawings.
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. 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).
      5) Wej-It Corp., Tulsa, OK; ANKRtite CCAT Wedge Anchor (ESR-2777).

5. Undercut Anchors:
   a. When 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) USP Structural Connectors, Burnsville, MN; DUC Undercut Anchor (ESR-1970).
      2) Hilti, Inc., Tulsa, OK; HDA Undercut Anchor (ESR-1546).
      3) Powers Fasteners, Brewster, NY; Atomic+ Undercut (ESR-3067).
      4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Torq-Cut (ESR pending).
6. Self-Tapping Concrete Screw Anchors:
   a. When 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) Powers Fasteners, Brewster, NY; Wedge-Bolt+ (ESR-2526).
      2) Powers Fasteners, Brewster, NY; Vertigo+ Rod Hanger Screw Anchor (ESR-2989).
      3) Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
      4) Hilti, Inc., Tulsa, OK; HUS-EZ Screw Anchor (ESR-3027).
      5) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713).
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. 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.
2. Adhesive:
   a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
   b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
   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.
3. 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 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.
4. 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 PIPE SLEEVES

A. As specified in Section 40 27 01, Process Piping Specialties.

2.06 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.

2.07 FABRICATED UNITS

A. Weir and Baffle Plates: Fabricate plates and associated framing of stainless steel, AISI Type 316, unless indicated otherwise on Drawings.

2.08 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

1. Resists washout.
2. 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.

2.09 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. 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 sewage. 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.

2.10 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, 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, calculations by a registered Professional Engineer, 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.

3.04 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. 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.

3.05 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.

3.06 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.

B. Contractor-Furnished Quality Control:

1. Inspection and testing required in Section 01 45 00, Quality Control.
2. Manufacturer’s Certificate of Compliance per Section 01 61 00, Common Product Requirements, 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 60 01, Seismic Anchorage and Bracing Requirements.

C. Concrete and Masonry Drilled Anchors: Special inspection and testing will be provided by Owner where indicated on Drawings and the Statement of Special Inspections (Plan).

3.07 MANUFACTURER'S SERVICES

A. Anchor Installation: Conduct site training of installation personnel for proper installation, handling, and storage of mechanical and adhesive anchor systems. Notify Engineer of time and place for sessions.

3.08 FASTENER SCHEDULE

A. Unless indicated otherwise on Drawings, provide fasteners as indicated on the Area Classification and Material Selection Table on Drawings.

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 16
ALUMINUM 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 Concrete Institute (ACI) 318, Building Code Requirements for Structural Concrete.
3. American Iron and Steel Institute (AISI).
4. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. E894, Standard Test Method for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
   d. E935, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
   e. E985, Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
5. International Code Council (ICC): International Building Code (IBC).
6. Occupational Safety and Health Act (OSHA): 29 CFR 1910, Code of Federal Regulations.

1.02 DEFINITIONS

A. ICC Evaluation Services Report: ICC report on evaluation of manufactured concrete anchor systems.

B. Railings: This term includes guardrail systems, handrail systems, platform railing systems, ramp-rail systems, and stair-rail systems. Railings may be comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.

C. Special Inspection: As defined by the ICC IBC.

D. Toeboards: Vertical barrier at floor level usually erected on railings along exposed edges of floor or wall openings, platforms, or ramps to prevent miscellaneous items from falling through.

1.03 DESIGN REQUIREMENTS

A. Structural Performance of Railing Systems: Design, test, fabricate, and install railings 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 railing system components.

1. Top Rail: 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 and OSHA.
   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 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 railings.
3. Calculated lateral deflection at top of posts shall not exceed 1 inch.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Project-specific scaled plans and elevations of railings and detail drawings. Include railing profiles, sizes, connections, anchorage, size and type of fasteners, and accessories.
   b. Manufacturer’s literature and catalog data of railing and components.
   c. Design Data: Calculations or test data using specified design performance loads and including the following:
      1) Bending stress in, and deflection of, posts in accordance with ASTM E985 as modified herein.
      2) Design of post base connection.
      3) Documentation that concrete anchors have been designed in accordance with one of the following:
         a) ACI 318, Appendix D.
         b) ICC Evaluation Services Report for selected anchor.

B. Informational Submittals:

1. Manufacturer's assembly and installation instructions.
2. Special Inspection: Manufacturer's instructions for Special Inspection of post-installed anchors.
3. Manufacturer's written recommendations describing procedures for maintaining railings including cleaning materials, application methods, and precautions to be taken in use of cleaning materials.

1.05 QUALITY ASSURANCE

A. Qualifications: Calculations required for design data shall be stamped by a registered civil or structural engineer licensed in state where Project will be constructed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package and wrap railings to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping to the extent possible until railing is completely installed.

B. Delivery:

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 railing pipe and posts with protective plastic wrap.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Thermal Movements: Allow for thermal movement resulting from the following maximum range in ambient temperature in design, fabrication, and installation of railings to prevent buckling, opening up of joints, over stressing of components, connections and other detrimental effects. Base design calculation on actual surface temperature of material as a result of 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: 70 degrees F, ambient; 100 degrees F, material surfaces.

PART 2 PRODUCTS

2.01 ALUMINUM RAILINGS

A. General:

1. Furnish pre-engineered and prefabricated railing systems as shown on Drawings.
2. Railing systems using pop rivets or glued railing construction are not permitted.
3. Sand cast accessories and components are not permitted.
4. Fasteners shall be AISI Type 304 or Type 316 stainless steel, unless otherwise noted.

B. Rails, Posts, and Formed Elbows:

1. Extruded Alloy 6105-T5, 6061-T6, or equivalent.
2. Tensile Strength: 38,000 psi, minimum.
3. Yield Strength: 35,000 psi, minimum.
4. Wall Thickness: 0.145 inch, minimum.
5. Posts and railings shall be nominal 1-1/2-inch diameter (1.90-inch outside diameter).

C. Accessories:

1. Fittings and Accessories:
   a. Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements.
   b. Gauge metal components are not acceptable for load-resisting components.
   c. Fittings shall match color of pipe in railings.
2. Miscellaneous Extruded Aluminum Parts: Alloys 6063-T6, 6061-T6, or 6105 T5 aluminum, or equivalent, and of adequate strength for all loads.
3. Castings for Railings:
   a. Cast Al-mag with sufficient strength to meet load and test requirements.
   b. Anodizable grade finish with excellent resistance to corrosion when subjected to exposure of sodium chloride solution intermittent spray and immersion.
4. Post Anchorages:
   a. Refer to standard details for types of post anchorages and minimum requirements.
   b. Bolts at anchorages shall be minimum 1/2-inch diameter.
5. Wall Brackets: Adjustable wall fitting, with provision for minimum three 3/8-inch diameter AISI Type 304 or Type 316 stainless steel bolts or concrete anchors.

6. Rail Terminals (including Wall Returns): Aluminum wall fitting with provision for three 3/8-inch Type 304 fasteners.
7. Railing System Gate:
   a. Extruded aluminum rail components.
   b. 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) Moultrie Manufacturing Co., Moultrie, GA; Part No. W60006.
8. Toeboards:
   a. Molded or extruded Alloy 6063-T6 or 6061-T6 aluminum.
   b. Provide slotted holes for expansion and contraction where required.
9. Fasteners: Stainless steel.

D. Finishes:

1. 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.

2.02 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

A. Locknuts, Washers, and Screws:

1. Elastic Locknuts, Steel Flat Washers, Round Head Machine Screws (RHMS): AISI Type 304 or Type 316 stainless steel.
2. Flat Washers: Molded nylon.

B. Bolts and Nuts for Bolting Railing to Metal Beams: ASTM A193/A193M and ASTM A194/A194M, Type 304 or Type 316 stainless steel.

C. Concrete Anchors:

1. Stainless steel, AISI Type 304 or Type 316.
2. Post-installed anchors in accordance with Section 05 50 00, Metal Fabrications, unless otherwise specified herein.
3. Bolt Diameter: 1/2-inch, minimum.

2.03 FABRICATION

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. Railing and Post Fittings: Match fittings with color of pipe in railing.

C. Shop Assembly:

1. Shop assemble rails, posts, and formed elbows with a close tolerance for tight fit.
2. Fit dowels tightly inside posts.

D. Repair of Defective Work: Remove stains and replace defective Work.

PART 3 EXECUTION

3.01 GENERAL

A. Field fabrication of aluminum railing systems is not permitted.

B. Where required, provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on actual structure.

C. Install railing with base that provides plus or minus 1/4-inch vertical adjustment inside base fitting. If adjustment is required in 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.

D. Modification to supporting structure is not permitted where railing is to be attached.

E. Mount railings only on completed walls. Do not support railings temporarily by means not satisfying structural performance requirements

F. Protection from Entrapped Water:

1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
2. For 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 plane of rail.

3.02 RAILING INSTALLATION

A. Assembly and Installation: Perform in accordance with manufacturer's written recommendations for installation.

B. 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.

C. Posts and Rails:

1. Surface Mounted Posts:
   a. Bolt post baseplate connectors firmly in place.
   b. Shims, wedges, grout, and similar devices for railing post alignment not permitted.
2. Set posts plumb and aligned to within 1/8 inch in 12 feet.
3. Set rails horizontal or parallel to slope of steps to within 1/8 inch in 12 feet.
4. Install posts and rails in same plane.
5. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail.
6. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.
7. Support 1-1/2-inch rails directly above stairway stringers with offset fittings.

D. Wall Brackets: Support wall rails on brackets spaced maximum 5 feet on centers as measured on the horizontal projection.

E. Toeboard:

1. Provide at railings, except where 4-inch or higher concrete curbs are installed, at gates, or at stairways unless shown otherwise.
2. Accurately measure in field for correct length; after railing post installation cut and secure to posts.
3. Dimension between bottom of toeboard and walking surface not to exceed 1/4 inch.
4. Install plumb and aligned to within 1/8 inch in 12 feet.

F. Railing System 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.

3.04 FIELD QUALITY CONTROL

A. Post-installed anchors supporting railing systems require special inspection.

B. Owner-Furnished Quality Assurance, in accordance with ICC IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection and Testing.

C. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 00, Quality Control.

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 railing manufacturer's recommendations or replace stained railings.

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: 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.

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.
4. 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.
   b. Medium Duty (Type B): 500 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.
   b. Medium Duty: 15/16 inch maximum, center-to-center.
4. Cross Bar Spacing: 4 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. Serrated, unless noted otherwise.
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. Surface: Serrated, Slip resistant (consisting of an applied abrasive finish of aluminum-oxide aggregate), or striated.
   a. 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.
3. Nosings: Integral ribbing and serrated edge on one long axis of tread, or nonslip abrasive on each tread along one long edge.
4. 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 07 11 13
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D41, Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
   b. D449, Standard Specification for Asphalt Used in Dampproofing and Waterproofing.
   c. D1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
   d. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.
   e. D6380, Standard Specification for Asphalt Roll Roofing (Organic Felt).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer's product data for dampproofing materials.

B. Informational Submittals:

1. Manufacturer's current application instructions for dampproofing materials.
2. Manufacturer's Certificate of Compliance.
3. Statement of Qualification: Bituminous dampproofing installer.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Engage experienced installer who has completed bituminous dampproofing work similar in material, design, and extent for Project.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store materials in area where temperatures are not less than 50 degrees F or over 85 degrees F.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Weather: Proceed with dampproofing Work only when existing and forecast weather conditions will permit Work. Do not apply dampproofing in rainy conditions or within 3 days after surfaces become wet from rainfall or other moisture.

B. Temperature:

1. Do not apply materials when ambient temperature is less than 50 degrees F.
2. Do not apply materials when low temperature of 40 degrees F or less is predicted within a period of 24 hours after application.

C. Ventilation: Provide adequate ventilation during application of solvent-based components in enclosed spaces. Maintain ventilation until dampproofing membrane has thoroughly cured.

PART 2 PRODUCTS

2.01 BITUMINOUS DAMPPROOFING, GENERAL

A. Odor Elimination: For interior and concealed-in-wall uses, provide type of bituminous dampproofing material warranted by manufacturer to be substantially odor-free after drying for 24 hours under normal conditions.

2.02 COLD-APPLIED ASPHALT EMULSION DAMPPROOFING

A. Asphalt Emulsion: Asphalt and water emulsion coating, formulated to penetrate substrate and build to moisture-resistant coating.

1. Nonfibrated type liquid asbestos-free emulsion; ASTM D1227, Type III.

B. Manufacturers:

1. Celotex Corp.
2. ChemRex, Inc./Sonneborn Building Products Div.
3. J & P Petroleum Products, Inc.
4. Koch Materials Co.
5. Tremco, Inc.

2.03 MISCELLANEOUS ACCESSORIES

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. Clean surfaces to remove dust, dirt, oil, wax, efflorescence, and other foreign materials, in accordance with dampproofing manufacturer's instructions.

B. Allow 3 days' drying time following washing down of substrate surfaces.

C. Fill cracks, voids, and honeycombs with mortar to provide sound surface for dampproofing.

3.02 APPLICATION

A. Apply dampproofing with a brush, trowel, or low pressure airless spray equipment with a coarse nozzle, as recommended by dampproofing manufacturer.

B. Apply materials at rate and as recommended by the manufacturer and in two coats.

C. Start application at top of wall and work down surface, keeping a wet edge at all times, forming a continuous, unbroken film, free from pinholes and other surface breaks.

3.03 FIELD QUALITY CONTROL

A. Inspection: Examine surfaces to receive dampproofing to assure conditions are satisfactory for application of materials.

B. After dampproofing has dried spray surfaces with water.

C. Recoat, as recommended by manufacturer, surfaces showing water absorption. To prevent blistering, protect surfaces from heat and direct sunlight until dried, then backfill.

3.04 ADJUST AND CLEAN

A. Clean spillage and overspray from adjacent surfaces as recommended by manufacturer.

3.05 APPLICATION SCHEDULE

A. On belowgrade walls apply dampproofing from top of footings to 6 inches below finished grade.

END OF SECTION

SECTION 07 19 00
WATER REPELLENTS

PART 1 GENERAL

1.01 SUBMITTALS

A. Action Submittals: Manufacturer's product data for water repellent.

B. Informational Submittals:

1. Manufacturer's current application instructions for water repellent.
2. Evidence of applicator certification by product manufacturer.
3. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
4. Manufacturer's Certificate of Compliance.

1.02 QUALITY ASSURANCE

A. Qualifications: Applicator certified by product manufacturer.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials in manufacturer's original sealed containers.

B. Storage and Protection: Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

1. Lids must be kept tightly sealed. Do not allow moisture to enter containers.
2. Store containers in a dry place, upright and airtight at temperatures of 45 degrees F (7 degrees C) and not exceeding 100 degrees F (38 degrees C).

1.04 PROJECT CONDITIONS

A. Surface, air, and material temperatures shall not be lower than 40 degrees F or higher than 95 degrees F during application unless otherwise permitted by manufacturer's instructions. Do not apply when temperature is expected to fall below 40 degrees F within 12 hours following application.

B. Weather: Clear with no precipitation during application or expected for 4 hours following application.

C. Provide positive ventilation throughout the application.

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 the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of 10 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: Applied product will retain its water repellent effects during the Special Guarantee period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Harris Specialty Chemicals; Hydrozo, Enviroseal 40.

B. Huls America, Inc.; Chem-Trete BSM 40.

C. Chemprobe Technologies, Inc.; Prime A Pell.

D. Textured Coatings of America; Tex-Cote Rainstopper Series 140.

2.02 WATER REPELLENT

A. Active Alkylalkoxysilane Content: By weight, 40 percent.

B. Not alter appearance of masonry or change the surface texture.

C. No fillers, stearates, or paraffins.

D. Clear color.

E. VOC Content: Less than 350 grams per liter using EPA Method 24.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Verify that surfaces are solid, dry, and free of dirt, efflorescence, oil, wax, frozen matter, loose particles, cracks, pits, laitance, curing compounds, and other foreign matter that would block absorption of water repellent.

B. Verify that curing of sealants is complete.

C. Clean masonry surfaces to make them acceptable for application.

D. Protect and mask adjacent surfaces during application.

3.02 APPLICATION

A. Follow product manufacturer's instructions and recommendations, including application apparatus and techniques, and coverage rates.

B. Provide uniform coverage over entire surface of face brick on exterior and interior of buildings.

3.03 FIELD QUALITY CONTROL

A. Notify Engineer 48 hours prior to application.

B. After water repellent has dried (24 hours, low humidity, medium temperature (70 degrees F to 90 degrees F) and 48 hours, high humidity, low temperature (50 degrees F to 69 degrees F), test surfaces with a water spray. Recoat areas that indicate water absorption.

3.04 CLEANING

A. At completion, remove from the jobsite excess material, debris, and waste. Dispose of water repellent containers according to state and local environmental regulations.

B. Upon completion of Work, clean window glass and other splattered surfaces.

3.05 PROTECTION

A. Protect adjacent shrubs, metal, wood trim, glass, asphalt, and other building hardware from overspray. Do not permit spray mist or liquid to drift onto surrounding properties or parking lots. Avoid contact with automobile paint and windshields. Clean up immediately after application using cleaners approved by product manufacturer.

B. Protect installed product's finish surfaces from damage during construction.

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. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   b. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer's product literature identifying products proposed for use.

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.

PART 2 PRODUCTS

2.01 RIGID INSULATION

A. High performance polyisocyanurate foam core board:

1. Sheet Size: 4-foot by 8-foot.
2. Thickness: 2-inch (R-13) minimum.
3. Manufacturers and Products:
   a. Dow Chemical Co.; Super TUFF-R.
   b. Rmax, Inc.

PART 3 EXECUTION

3.01 RIGID INSULATION

A. Install in accordance with the following:

1. Install boards in location shown on Drawings.
2. Cut insulation with saw, knife, or other sharp tool to fit tightly around obstructions.
3. Butt insulation boards together tightly at joints.

END OF SECTION

SECTION 07 21 40
FOAMED-IN-PLACE MASONRY WALL INSULATION

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Applications of insulation specified in this section include the following: Foamed-in-Place masonry insulation for thermal, sound and fire resistance values.

1.02 QUALITY ASSURANCE

A. Insulation shall be installed as per manufacture's recommendation and must come from the manufacturer pre-mixed to ensure consistency. Upon request, a 1-year product and installation warranty will be issued by both the manufacturer and installer.

B. Engage an experienced dealer/applicator who has been trained and licensed by the product manufacturer and which has not less than 3 years direct experience in the installation of the product used.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Minimum Product Performance Standards:

1. Surface Burning Characteristics: Maximum flame spread, smoke developed and fuel contributed of 0, 5, and 0 respectively.
2. Combustion Characteristics: Must be noncombustible, Class A building material.
3. Thermal Values: "R" Value of 4.91/inch at 32 degrees F mean; ASTM C177.

B. Tailored Chemical Products: Core-Fill 500 (Basis of Design).

C. cfiFOAM, Inc.; Core Foam Masonry Foam Insulation.

D. C.P. Chemical Co., Inc.; Tripolymer PRMIU or 105.

E. Or equal as approved.

PART 3 EXECUTION

3.01 INSTALLATION GUIDELINES

A. Fill all open cells and voids in hollow concrete masonry walls. The foam insulation shall be pressure injected through a series of 5/8-inch holes drilled into every vertical column of block cells (every 8-inch on-center) beginning at an approximate height of 4 feet from finished floor level. Repeat this procedure at an approximate height of 3 feet, 4 feet above the first horizontal row of holes (or as recommended by manufacturer) until the void is completely filled. Patch holes with mortar and score to resemble existing surface.

END OF SECTION

SECTION 07 53 23
ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Wood Preservers' Association (AWPA): U1, Use Category System: User Specification for Treated Wood.
2. ASTM International (ASTM):
   a. C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
   b. D4637, Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
3. FM (Factory Mutual) Global (FM), Loss Prevention Data Sheet:
   a. 1-28, Wind Loads.
   b. 1-49, Perimeter Flashing.
4. National Roofing Contractors Association (NRCA): Waterproofing Manual.
5. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals:

1. Layout of tapered insulation.
2. Project specific details of roof penetrations and perimeter conditions.
3. Layout and details of mechanical fastening system.
4. List of materials proposed for use including roofing materials, accessories, insulation, and fasteners.
5. Manufacturer's specifications selected for use, including a description of the complete system from the deck up.
6. Documentation that anchoring system meets uplift requirements.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance.
2. Manufacturer's installation instructions.
3. A letter or other documentation from roofing materials manufacturer stating that installer has been trained and approved to apply the roof.
4. Sample copy of guarantee to be provided.

5. Operation and Maintenance Data:
   a. As specified in Section 01 76 00, Operating and Maintenance Information.
   b. Include sketches where applicable; recommendations for periodic inspections, care, and maintenance; identify common causes of damage with instructions for temporary patching until permanent repair can be made.
6. Manufacturer's Certificate of Proper Installation.

1.03 QUALITY ASSURANCE

A. Installer:

1. Trained and approved by roof membrane manufacturer.
2. Experience: 3 years, minimum, in the installation of the specific roofing and flashing system specified.

B. Materials, including insulation used in roofing system, shall be furnished by or approved by manufacturer whose roofing system is selected for use.

C. Membrane manufacturer's inspection as required to meet conditions of guarantee.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in their original, unopened containers, clearly labeled with manufacturer's name, brand name, and such identifying numbers as are appropriate.

B. Storage:

1. Store materials at temperatures between 60 degrees F and 80 degrees F. Should they be exposed to lower temperatures, restore to 60 degrees F prior to use.
2. Store rigid roof insulation materials on clean, raised platform.
3. Do not store uncured flashing membrane on roof or at temperatures exceeding 75 degrees F.

C. Protect materials against wetting, moisture absorption, and construction traffic.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Weather: Do not install roofing during precipitation or when it is probable.

B. Temperature:

1. Install roofing when ambient temperature is 50 degrees F or above.
2. When temperature is below 50 degrees F, install only with approval of, and under supervision of, membrane manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carlisle SynTec, Inc.; Sure-Seal Systems.

B. Firestone Building Products; RubberGard EPDM.

C. Johns Manville; EPDM Single Ply.

2.02 ROOFING SYSTEM

A. Complete system including:

1. Rigid Roof Insulation.
2. Membrane.
3. Flashings.
4. Fasteners and Accessory Materials.
5. Nailer.

B. Meeting these specifications and approval of membrane manufacturer to provide a fully adhered EPDM system meeting the following:

1. UL Class A fire resistance rating.
2. FM Loss Prevention Data 1-28 requirements for I-90 wind uplift rating.

2.03 MEMBRANE MATERIALS

A. Membrane: ASTM D4637, Type II, reinforced minimum 0.060-inch thick Ethylene Propylene Diene Monomer (EPDM) compounded elastomer.

B. Membrane Sheet Size: Maximum of 10-foot width, or largest sheet possible, determined by Project conditions.

C. Color: White.

2.04 ACCESSORY MATERIALS

A. Furnish bonding adhesive, splicing primer and cement, mechanical fasteners, self-vulcanizing tape, pourable sealant, lap sealant, water cutoff mastic, night seal, and prefabricated pipe seals approved by membrane manufacturer.

B. Flashings: EPDM, 0.060 inch thick.

2.05 RIGID ROOF INSULATION

A. Average Aged R-Value for Total Thickness of Rigid Roof Insulation: Minimum R=25.

B. Insulation Board:

1. Tapered Board System:
   a. Factory precut or field-tapered insulation board, minimum 1-inch thick with top surface cut to a uniform, continuous slope as shown on Drawings.
   b. Fabricate miters and edges to match abutting blocks.
   c. Maximum aged thermal conductance value "C" at the average thickness of the insulation shall be 0.07 Btu/hr/sq ft/degree F, or as shown.
   d. Manufacturers and Products:
      1) Carlise; Polyisocyanurate HP-H.
      2) Firestone; ISO 95+ Tapered.
      3) Johns Manville; Tapered E'NRG'Y 2 Plus System.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify deck is firm, dry, clean, free of sharp edges, burrs, loose and foreign materials, oil, and grease, and reasonably smooth.

B. Report immediately to Engineer cracks, breaks, holes, or other unusual irregularities in the surface.

C. Correct irregularities to deck/substrate that may cause ponding longer than 48 hours.

D. Nailers:

1. Install wooden nailer at perimeter of each curb flashing, skylights, expansion joints, and similar penetrations.

2. Firmly anchor nailers to resist a force of 75 pounds per linear foot in all directions.
3. Thickness: Such that top of nailer is flush with surface to which membrane is to be applied.
4. Vertical nailer that secures membrane at horizontal plane may be used.

3.02 INSTALLATION

A. Install a complete system of compatible materials that will create a monolithic watertight single-ply roof membrane.

B. In accordance with membrane manufacturer's instructions for installation of complete, warrantable roof system.

C. In accordance with membrane manufacturer's standard details for flashing and termination conditions.

D. Meet FM Loss Prevention Data 1-28 requirements for I-90 wind uplift rating.

3.03 VAPOR RETARDER INSTALLATION

A. On Metal Decking: Install base layer of expanded perlite board, of a minimum thickness adequate to span rib openings, mechanically fastened to deck.

3.04 INSULATION INSTALLATION

A. Install thickness necessary for R-value shown in two or more layers.

B. Provide sumps around roof drains.

C. Fasten insulation so that it will meet uplift requirements of FM Global.

D. Position boards of first layer so end joints are staggered and edges parallel to deck span are supported by roof deck.

E. Install additional layers with joints staggered or offset from those below.

F. On Metal Roof Deck:

1. Mechanically fasten 100 percent with a FM Global approved fastener in pattern and quantity recommended by insulation or mechanical fastener manufacturer to meet FM Global requirements.
2. Provide a minimum of one fastener per 2 square feet of insulation board, unless otherwise specified by manufacturer.

G. Loose lay insulation over substrate with insulation joints 1/4 inch or less in width.

H. Do not install more insulation each day than can be covered with membrane before end of day or start of inclement weather.

3.05 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, and training of Owner's personnel for maintaining specified system.

B. Provide Engineer with copies of inspection reports.

3.06 CLEANUP

A. Remove spots and smears of adhesive, sealant, asphalt, or other material resulting from the Work in this section from flashing and other surfaces not intended to be coated with such material.

B. During removal of spots and smears, ensure no damage will be done to the surfaces.

C. Use solvents, if necessary, to satisfactorily clean the materials.

3.07 PROTECTION OF INSTALLED WORK

A. Limit traffic of personnel and equipment on completed roof to that deemed essential for completion of Project.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

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. A924/A924M Standard Specification for General Requirements
   c. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   d. C920, Standard Specification for Elastomeric Joint Sealants.
2. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): 1793, Architectural Sheet Metal Manual.

1.02 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA 1793. Conform to dimensions and profiles shown, unless more stringent requirements are indicated.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Show joints, types and location of fasteners, and special shapes.
   b. Catalog data for stock manufactured items.
2. Samples: Color Samples for items to be factory finished.

1.04 DELIVERY, HANDLING, AND STORAGE

A. Inspect for damage, dampness, and wet storage stains upon delivery to Site.

B. Remove and replace damaged or permanently stained materials that cannot be restored to like-new condition.

C. Carefully handle to avoid damage to surfaces, edges, and ends.

D. Do not open packages until ready for use.

E. Store materials in dry, weathertight, ventilated areas until immediately before

PART 2 PRODUCTS

2.01 PREFABRICATED METAL SYSTEMS

A. Coping System:

1. Snap-on system, stucco embossed pattern aluminum, 0.050-inch minimum thickness.
2. Include ancillary items, such as mitered and welded corners, and end caps, where shown and as required for complete system.
3. Manufacturers and Products:
   a. W.P. Hickman Co.; Permasnap Coping.
   b. IMETCO; ES-C Sloped Coping.

B. Finish: Factory finished with full strength fluoropolymer coating (Kynar polyvinylidene fluoride resin) in color as selected from manufacturer's standard range of colors.

2.02 ANCILLARY MATERIALS

A. Solder: ASTM B32, alloy composition Sn 50.

B. Soldering Flux: ASTM B32, Type RA.

C. Sealing Tape: Polyisobutylene sealing tape.

D. Isolation Paint: ASTM D1187/D1187M, asphalt.

E. Isolation Tape: Butyl or polyisobutylene, internally reinforced, or 20-mil thick minimum polyester.

F. Plastic Roof Cement: ASTM D4586/D4586M, Type II.

G. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

H. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.

I. Fasteners:

1. Galvanized Steelwork: Steel, galvanized per ASTM A153/A153M or stainless steel fasteners.
2. Zinc or Aluminum Work: Stainless steel or aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify nailing strips and blocking are properly located.

B. Verify membrane termination and base flashings are in place, sealed, and secure.

3.02 INSTALLATION

A. Flashing:

1. General:
   a. Install sheet metal roof flashing and trim to comply with performance requirements and SMACNA 1793.
   b. Provide concealed fasteners where possible, set units true to line, and level as indicated.
   c. Install work with laps, joints, and seams that will be permanently watertight.
2. Isolate metal from wood and concrete and from dissimilar metal with isolation tape or two coats of isolation paint.
3. Use only stainless steel fasteners to connect isolated dissimilar metals.
4. Joints: 10-foot maximum spacing and 2-1/2 feet from corners, butted with 3/16-inch space centered over matching 8-inch-long backing plate with sealing tape in laps.
5. Set flanges of flashings and roof accessories on continuous sealing tape or in plastic roof cement on top of envelope ply of roofing. Nail flanges through sealing tape and at 3-inch maximum spacing. Touch up isolation paint on flanges.
6. Joints, Fastenings, Reinforcements, and Supports: Sized and located as required to preclude distortion or displacement as a result of thermal expansion and contraction.
7. Conceal fastenings wherever possible.
8. Set flashing and sheet metal to straight, true lines with exposed faces aligned in proper plane without bulges or waves.

B. Prefabricated Metal Systems:

1. Follow system manufacturer's printed instructions.
2. Place color variations in pieces so no extremes are next to each other.

3.03 FINISH

A. Exposed Surfaces of Flashing and Sheet Metalwork: Free of dents, scratches, abrasions, or other visible defects, and clean and ready for painting where applicable.

3.04 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

C. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 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.

1.03 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum of 5 years' experience installing sealants in projects of similar scope.

1.04 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.

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 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.

E. 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.

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, 5, or 10
Less than 2"	1
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 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.

3.05 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 Floor Slabs (except for water-holding Structures)	5
Slabs Subject to Vehicle and Pedestrian Traffic	5
Masonry Walls	1, 5, or13
Material Joints At:	
Metal Door, Window, and Louver Frames (Exterior)	1 or5
Metal Door, Window, and Louver Frames (Interior)	1 or 5
Wall Penetrations (Exterior)	1 or 5
Wall Penetrations (Interior)	1 or 5
Floor Penetrations	5
Ceiling Penetrations	1 or5
Roof Penetrations	5

Joint Locations	Sealant Type(s)
Other Joints:	
Threshold Sealant Bed	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. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   b. 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.
3. Builders Hardware Manufacturers Association (BHMA): A156.115, Hardware Preparations in Standard Steel Doors and Frames.

1.02 SUBMITTALS

A. Action Submittals:

1. Applicable information for each type of door and frame, including:
   a. Frame conditions and complete anchorage details, supplemented by suitable schedules covering doors and frames.
   b. 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.

B. Hollow Metal Frames:

1. Products of hollow metal door manufacturer.
2. ANSI 250.8, except as modified herein.
3. Frames for Doors: 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. 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. U-Value: 0.157.

2.03 MISCELLANEOUS ITEMS

A. 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 (Wipe Coat galvanized coating is not acceptable).

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.

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.

3.02 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 Drawings.

END OF SECTION

SECTION 08 51 14
ALUMINUM WINDOWS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Architectural Manufacturers Association (AAMA):
   a. 101, Standard Specification for Windows, Doors, and Unit Skylights.
   b. 612, Voluntary Specification, Performance Requirements and Test Procedures for Combined Coatings of Anodic Oxide and Transparent Organic Coatings on Architectural Aluminum.
   c. 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
2. ASTM International (ASTM):
   a. C509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
   b. C1036, Standard Specification for Flat Glass.
   c. E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s product data on materials supplied.

B. Informational Submittals: Manufacturer’s literature showing standard details and certified test reports.

1.03 QUALITY ASSURANCE

A. Quality certified label of AAMA is required on units furnished.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store window units upright off the ground and protected.

PART 2 PRODUCTS

2.01 MATERIALS

A. Frame Extrusions: Aluminum alloy 6063-T5.

B. Finish: Anodized AAMA 612.

C. Hardware: Manufacturer's standard.

D. Weatherstripping: Closed cell ASTM C509 neoprene, or closed cell elastomer.

E. Glass: As specified in Section 08 80 00, Glazing.

2.02 WINDOW UNITS

A. General: Meet requirements of AAMA 101 for each window type meeting the following performance class and grade:

1. Commercial: C30 (30 psf).

2.03 FABRICATION

A. Windows and Window Systems: Conform to AAMA 101.

2.04 MANUFACTURERS

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

1. Kawneer; an Alcoa Company:
   a. Basis of Design: TR-9500.
2. EFCO Corporation.
3. TRACO.
4. DeSCO Windows.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify openings dimensions; do not proceed with installation until opening dimensions are correct.

3.02 INSTALLATION

A. In accordance with manufacturer's instructions.

B. Set units with top side up, plumb, level, and true to line without warp or rack of frames or sash.

C. Anchor securely to surrounding construction.

3.03 CLEANING

A. Clean glass and aluminum surfaces of dirt, film, sealants, and other foreign materials.

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.

B. Informational Submittals: Operation and Maintenance Data as specified in Section 01 76 00, Operating and Maintenance Information.

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.

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: Nonremoveable pin.

F. Joint Tolerance: 0.012 inch maximum, gauged in CLOSED position.

G. Finish: Satin chromium-plated brass or bronze No. 626.

H. Types and Manufacturers:

No.	Type Description	Stanley	Mc-Kinney	Lawrence	BHMA
H4	Extra heavy-weight, four ball races, full mortise, stainless steel	FBB199-32D	T4B3386	BB5151-A	A5111

2.04 LOCKS AND LATCH SETS

A. Mortise Locks: BHMA A156.13, Series 1000, Grade 1.

1. Materials: Brass or stainless steel.
2. Trim: Wrought or forged lever handles and roses.
3. Core Cylinders: Interchangeable, removable; minimum of six pins.
4. Bolt Throw: 5/8 inch minimum.
5. Lever Backset: 2-3/4 inches.
6. Manufacturers and Products:
   a. Sargent; LNJ.
   b. Schlage; 03.

B. Finish:

1. Satin chromium-plated No. 626.
2. Coat exterior levers with Teflon.

C. Types and Manufacturers:

No.	Type Description	Best	Sargent	Schlage	BHMA
L3	Mortise latch with lever handle	45H0N3H	8215-LNJ	L9010-03	F01
L16	Lock by exit device manufacturer; furnish cylinders for keying to other locks as required				

D. Keying:

1. Lock Cylinders: Operate by grand master key system that allows for future expansion.
2. Keylocks: As indicated in Drawings.
3. Keys: Two per lock; tag with schedule information.
4. Master Keys: Four; send by registered mail to Owner.

2.05 CONSTRUCTION KEY SYSTEM

A. Removable construction core system for locks.

B. See Article Manufacturer's Services under Part 3, Execution.

2.06 EXIT DEVICES

A. BHMA A156.3.

B. Furnish fire exit devices and mullions at fire-rated doors.

C. Trim:

1. Levers: Sargent ETJ; Von Duprin 03.

D. Finish:

1. Exit Device: Satin chromium-plated No. 626.

E. Types and Manufacturers:

No.	Type Description	Sargent	VonDuprin	BHMA
X2	Rim type, exit only	8810	99EO	Type 1 01

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 chromium-plated No. 626.

D. Types and Manufacturers:

No.	Type/Description	LCN	Sargent	BHMA
C1	Regular arm	4010 Series	351 Series	C02011

2.08 STOPS AND HOLDERS

A. BHMA A156.16.

B. Machine Screws: In threaded anchors at concrete or masonry.

C. Finish: Satin chromium-plated No. 626.

D. Types and Manufacturers for Each Leaf:

No.	Type Description	BBW or GJ	Baldwin	BHMA
S1	Floor stop	F121X	4086	L02131

2.09 BOLTS

A. BHMA A156.16.

B. Finish: Bright nickel No. 645.

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 0.05 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: Dark bronze anodized aluminum, unless indicated otherwise.

D. Types and Manufacturers:

No.	Type Description	Pemko	Reese
T6	Panic exit saddle	2005DV	S483DV

2.12 WEATHERSTRIP

A. Finish: Dark bronze 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 MISCELLANEOUS ITEMS

A. Provide as indicated in Door and Hardware Schedule:

M7	Coordinator:		
		GJ	**Ives**
	Model	COR-65	469

2.14 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.

2.15 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.

2.16 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.

2.17 SECURITY SYSTEM HARDWARE

A. General:

1. Security system shall be Lenel OnGuard (no or-equal).
2. Security system shall communicate with plant's existing security system.
3. Doors shall remain locked unless approved key card is in proximity to the card reader.
4. When communication to the plant's security system is broken. Security system shall remain functional.

B. Security Controller:

1. Communication: Ethernet 10/100.
2. Communication Port: RJ45.
3. Suitable for Controlling:
   a. Two door lock systems.
   b. Two proximity card readers.
   c. Two "request to exit" sensors.

4. Enclosure: Wall-mounted, NEMA 250 Type 12, painted enclosure.
5. All security equipment shall be provided power from the controller enclosure. Provide power supply as required. 120Vac branch circuit will be provided to controller enclosure as shown on electrical drawings.
6. Manufacturer and Product: Lenel; Model 2220.

C. Card Reader:

1. Allegion aptiQ MT15; compatible with Lenel OnGuard.
2. Suitable for outdoor installation.

D. Request For Exit Sensor: Compatible with Lenel system and door hardware.

E. Security Conductors: Provide security conductors for control and power as required for a complete system. Route conductors within conduit as shown on electrical drawings.

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. 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.

E. Stops and Holders: Set to allow doors to open as far as possible.

F. Wall Mounted Hardware: Install over solid structural backing or solid blocking in hollow walls.

G. Thresholds:

1. Cope ends neatly to profile of jamb.
2. Set in sealant and seal ends to jambs.

H. Security Controller Cabinet: Install where shown.

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.

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 SECURITY SYSTEM COMMISSIONING

A. Provide Lenel Security technician to install, test, demonstrate, and document that the security system is functional:

1. Communicates with plant security system.
2. Allows access to approved personnel.
3. Operates correctly when communication is lost.

B. Security technician shall coordinate with City to incorporate the new security hardware into their existing system.

C. Commissioning testing shall be witnessed by an engineer.

D. Document commissioning with a testing form that is signed by technician and witnessing engineer.

3.06 DOOR AND HARDWARE SCHEDULE

A. Door and Hardware on Drawings is guide to functional requirements of each opening.

B. Provide finish hardware as scheduled. Sizes omitted shall be as recommended by manufacturer.

3.07 HARDWARE SETS

HDW-1:	Item	Type
	2 Pair butts	H4
	(2) Exit devices (rim type) with QEL Electronic Latch Retraction	
	1 Removable mullion	X1
	2 Closers	C1
	2 Floor stops	S1
	2 Metal kickplates	K1
	1 Threshold	T6
	1 Set weatherstrip	W1
	1 Coordinator	M7
	1 Astragal	
	Dust Proof Strike	
	Request to Exit Sensor	
	Card Reader	
	Electric Strike	

HDW-2:	Item	Type
	1-1/2 Pair butts	H4
	1 exit device with exterior dummy lever trim	X2
	1 Closer	C1
	1 Floor stop	S1
	1 Metal kickplate	K1
	1 Threshold	T6
	1 Set weatherstrip (narrow stop)	W1
	Request to Exit Sensor	
	Card Reader	
	Electric Strike	

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. ASTM International (ASTM):
   a. C864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
   b. C920, Standard Specification for Elastomeric Joint Sealants.
   c. C1036, Standard Specification for Flat Glass.
   d. C1115, Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.
   e. C1193, Standard Guide for Use of Joint Sealants.
   f. E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
2. Glass Association of North America (GANA):
   a. Glazing Manual.
   b. Sealant Manual.

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. Glass Provide structural, physical, and thermal and solar optical performance characteristics, size limitations, special handling or installation requirements.
   b. Glazing Sealants, Compounds, and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors where exposed.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing Work of this section with minimum 3 years' 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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products of the following manufacturers, that meet these Specifications, may be used on this Project:

1. PPG Industries, Inc.
2. Guardian Industries, Corp.
3. Viracon, Inc.
4. ACH Glass Operations.
5. AFG Industries, Inc.
6. Pilkington North America, Inc.

2.02 GLAZING MATERIALS

A. Solar-Control Low-e Insulating Glass Units (I.G.-S.C.):

1. Basis-of-design Product: PPG Solarban 80 or a comparable product from one of the following:
   a. Pilkington.
   b. Biracon.
   c. Guardian.

2. Thickness:
   a. Lite: 6 mm.
   b. Overall Unit: 25 mm.
3. Outdoor Lite: Ultra Clear.
4. Indoor Lite: Ultra Clear.
5. Low-e Coating: Sputtered on second.
6. Visible Light Transmittance: 48 percent minimum.
7. Winter Nighttime U-Factor: 0.29 maximum.
8. Summer Daytime U-Factor: 0.27 maximum.
9. Solar Heat Gain Coefficient: 0.24 maximum.
10. Outdoor Visible Reflectance: 33 percent maximum.

2.03 GLAZING SEALANTS

A. Elastomeric Glazing Sealants: Materials compatible with adjacent materials including glass, laminated glass core, 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. Interior Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

B. Dense Gaskets:

1. Resilient extruded shape to suit glazing channel retaining slot; black.
2. Neoprene: ASTM C864.
3. EPDM: ASTM C864.
4. Silicone: ASTM C1115.

C. Preformed Glazing Tape:

1. Size to suit application.
2. Preformed butyl compound; 10 to 15 Shore A durometer hardness; coiled on release paper; black color.
3. Butyl Corner Sealant: ASTM C920 single component non-skinning butyl compatible with glazing tape; color to match tape.
4. Interior Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

2.04 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. Verify functioning weep system is present.

F. 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.
   Cutting:
   a. Make concealed edges clean, straight cut, and free from chips and fissures.
   b. Shop cut all glass. Nipping glass on job not allowed.
   c. Allow for maximum grip on all edges.
2. Positioning Glass:
   a. Set glass with equal bearing on entire width of pane.
   b. Position sheets of glass with setting blocks of hardness, chemically compatible with sealants used, and sizes recommended by glass and sealant manufacturers.
   c. Set tong marks of tempered glass at bottom of installed sheet.
   d. Orient pattern and draw of glass pieces in same direction.
   e. Place glass waves parallel or horizontal to floor.
3. Glass shall not move or rattle.

3.04 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.

3.05 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.

3.06 SCHEDULE

A. Exterior Windows: Type I.G-S.C.

END OF SECTION

SECTION 08 90 00
LOUVERS

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. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
   b. 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 of 20 pounds per square foot.

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.
2. Samples: Manufacturer's standard finishes and colors.

B. Informational Submittals:

1. Factory test data.
2. Certificates of AMCA ratings.
3. Installation instructions.
4. Parts list, if applicable.
5. Maintenance procedures.
6. 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 47 percent free area and 800 fpm maximum velocity through free area.

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 COMBINATION LOUVER/DAMPER (TYPE LD)

A. Frame: Extruded aluminum channel, 0.081 inch thick, 6 inches deep.

B. Blades: Extruded aluminum, minimum 0.081 inch thick, outside fixed, inside operating blades resting in normally closed position.

C. Pressure Loss: AMCA certified rating of no greater than 0.10-inch WC.

D. Sizes: As scheduled on Drawings.

E. Screen: Inside-mounted, 1-inch, Type 304 stainless steel.

F. Finish: Baked enamel or thermosetting acrylic coating in color as scheduled or selected.

G. Electric Damper Operators:

1. Performance as follows:
   a. 120V, 60-Hz, two-position,24V, 60-Hz, two-position.
   b. Fail Position: Open.
2. Mounting: External side plate.
3. Ample power to overcome friction of damper linkage and air pressure acting on damper blades.

4. Furnished with external adjustable stops to limit stroke.
5. Operators on modulating dampers that are to be sequenced with other control devices shall have full relay type pilot positioner and interconnecting linkage to provide mechanical feedback that will accurately position and control damper.
6. Operating Torque:
    a. Provide multiple independent damper sections, each with separate actuator, as needed to provide minimum of 120 percent of operating torque required by damper(s).
    b. Required damper operating torque for actuator sizing calculations shall include friction of damper linkage and 1-inch WC air pressure on damper blades:
        1) Opposed-Blade Dampers: Minimum 5 inch-pounds per square foot of damper area, unless higher values are recommended by damper manufacturer.
        2) Parallel-Blade Dampers: Minimum 7 inch-pounds per square foot of damper area, unless higher values are recommended by damper manufacturer.
7. Manufacturers:
    a. Belimo.
    b. Neptronic.
    c. Siemens Building Technologies
    d. Johnson Controls.
    e. Honeywell.

H. Manufacturers and Products:

1. Ruskin ELC6375DAX.
2. Or approved equal.

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 ADJUSTING AND CLEANING

A. Set adjustable louver blades for uniform alignment in OPEN and CLOSED positions.

B. Adjust louvers so moving parts operate smoothly.

C. After erection, protect exposed portions from damage by machines, paint, lime, acid, cement, or other harmful compounds.

D. Remove protective materials and clean with plain water, water with soap, or household detergents.

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. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   c. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
5. Occupational Safety and Health Act (OSHA).
6. 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.

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. PDS: 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 Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS 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.
2. Coating Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
4. Manufacturer's written verification that submitted material is suitable for the intended use.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
6. 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.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other

applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

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

2.02 MANUFACTURERS

A. 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. Akzo Nobel (Devoe/International).
2. Carboline Coatings.
3. PPG.
4. Sherwin Williams.
5. Tnemec.

2.03 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.

2.04 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
Bituminous Paint	Single-component, coal-tar pitch based
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
Epoxy Primer—Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
Epoxy Primer—Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading

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.

2.06 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.

B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment Specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

D. Pipe:

1. Ductile Iron Pipe:
   a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
   b. The surface preparation and application of the primer shall be performed by pipe manufacturer.
   c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
   d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.

PART 3 EXECUTION

3.01 GENERAL

A. Provide Engineer minimum 7 days' advance notice to start of field 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.

3.02 EXAMINATION

A. Factory Finished Items:

1. Schedule inspection with Engineer before repairing damaged factory-finished items delivered to Site.
2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: 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. The more stringent requirements shall apply.

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.

3.04 SURFACE PREPARATION

A. Field 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.

B. Surface Contamination Testing:

1. A surface contamination analysis test shall be performed every 1,000 square feet 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.
   b. 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:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. 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.
3. 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.
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:

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. 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.
    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 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for new, interior and exterior 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. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
6. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
7. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
8. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
9. Keep paint materials sealed when not in use.
10. 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:

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. Prime Coat: May be thinned to provide maximum penetration and adhesion.
    a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type 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.
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. System No. 2 Submerged Metal—Domestic Sewage:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	Prime in accordance with manufacturer's recommendations	
	Coal-Tar Epoxy -OR- High Build Epoxy	2 coats, 16 MDFT 2 coats, 16 MDFT

1. Use on the following items or areas:
   a. Metal surfaces new below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface that are a part of immersed equipment, and the following specific surfaces:
      1) Interior surfaces of steel piping noted in the Piping Schedule.
      2) Interior and exterior surfaces of vertical turbine pump columns and interior of discharge heads.
      3) Interior and exterior of submersible pumps.
      4) Carbon steel pipe, pipe supports, or structural steel and steel. ductile iron or cast iron equipment below walkway elevation in the aeration basins.

C. System No. 4 Exposed Metal—Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	High Build Epoxy	1 coat, 4 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces, new located in underground vaults.

D. System No. 5 Exposed Metal—Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces, new located inside or outside of structures and exposed to weather or in a highly humid atmosphere, such as pipe galleries and similar areas, and the following specific surfaces:
      1) All exposed ferrous metals associated with mechanical equipment, including, but not limited to, pipe, pumps, valves, fittings, and other appurtenances, and structural components associated with equipment.
      2) Structural steel.
      3) All other exposed metal not otherwise specified to be painted in other paint systems.
      4) Hollow metal doors and frames.

E. System No. 7 Concrete Encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Coal-Tar Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas:
   a. Use on concrete encased ferrous metals including wall pipes, pipe sleeves, access manholes, gate guides, and thimbles; and the following specific surfaces:

F. System No. 8 Buried Metal—General:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Coal-Tar Epoxy	2 coats, 16 MDFT

1. For steel pipe and fittings, follow AWWA C209 and AWWA C214.
2. Use on the following items or areas:
   a. Buried, belowgrade portions of steel items, except buried stainless steel or ductile iron.

G. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer—Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:
   a. Galvanized surfaces requiring painting.
   b. After application of System No. 10, apply finish coats as required for exposure.

H. System No. 25 Exposed FRP, PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

1. Use on the following items or areas:
   a. All exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

I. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete.

J. System No. 29 Fusion Bonded Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT

1. For steel pipe and fittings, meet all requirements of AWWA C213.
2. Use on valves and fittings specified to be fusion bonded epoxy coated.

3.08 COLORS

A. Provide as shown on the Drawings.

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 or indicated. 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.
3. Pipe Supports: Painted light gray, as approved by Engineer.

3.09 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
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, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
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.

B. Testing:

1. Thickness and Continuity Testing:
    a. Measure coating thickness specified in mils with a magnetic type, 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 SP0188.
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 SP0188.
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.

3.10 MANUFACTURER'S SERVICES

A. In accordance with Section 01 43 33, Manufacturers' Field Services, 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.

3.11 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.

3.12 SUPPLEMENTS

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

1. Paint System Data Sheet (PSDS).
2. Product Data Sheet (PDS).

END OF SECTION

PAINT SYSTEM DATA SHEET

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

Complete and attach manufacturer's Technical Data Sheet to this PDS 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 REFERENCES

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

1. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
2. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
3. Occupational Safety and Health Act (OSHA).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
   b. Manufacturer's literature showing letter sizes and styles, sign materials, and standard mounting details.
2. Samples: One full size for each type of nameplate, sign, and label specified.

B. Informational Submittals: Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 SIGNS

A. Plastic Sign (Type A):

1. Exterior: Laminated plastic subsurface image type, 3/16 inch thick with high-gloss finish.
2. Interior: Plastic, 1/8 inch thick with nondirectional matte finish and engraved letters.
3. Rounded corners.

B. Metal Sign (Type B):

1. Material: Baked enamel finished 20-gauge (minimum) steel or 18-gauge (minimum) aluminum signs.

2. Manufacturers:
   a. Seton Identification Products.
   b. Nutheme Illustrated Safety Co.

C. Fiberglass Sign (Type C):

1. Material: Three-ply laminated fiberglass, minimum 1/8 inch thick, with contrasting color core message layer between two clear weather-resistant surface layers.
2. Manufacturers:
   a. Best Manufacturing Co.
   b. Brady Signmark.

2.02 WARNING LABELS

A. Electrical Room.

B. Location: PEPS Electrical Building exterior doors.

C. Sign Type: Type A.

D. Text: (first line) “WARNING” (second line) “HIGH VOLTAGE”, (third line) “UNAUTHORIZED PERSONNEL”, (fourth line) “KEEP OUT”

2.03 IDENTIFICATION LABELS

A. Pipe Labels:

1. Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.
2. Provided with ties or straps for pipes of 6 inches and over diameter.
3. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.
4. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.
5. Letters and Arrows: Black on OSHA safety yellow background.
6. Color Field and Letter Height: Meet ASME A13.1.
7. Message: Piping system name as indicated on Piping Schedule.
8. Manufacturers and Products:
   a. Brady Signmark; B-915 BradySnap-On and Strap-On Pipe Markers.
   b. Seton Identification Products; Ultra-mark Pipe Markers.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers, where specified.
2. Letters: White engraved, 3/4 inch minimum high.

3. Background: Black.
4. Materials: Rigid laminate.
5. Furnish 1-inch margin with holes at each end of label, for mounting.
6. Size:
   a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 inches maximum long.
   b. Furnish same size base dimensions for all labels.
7. Message: Equipment names and tag numbers as used in sections where equipment is specified.
8. Manufacturers:
   a. Brady Signmark.
   b. Seton Identification Products.

2.04 ANCILLARY MATERIALS

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

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

C. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

A. In accordance with manufacturer's recommendations.

B. Mount securely, plumb, and level.

3.02 SIGNS

A. General:

1. Fasten to walls or posts, or hang as scheduled.
2. Anchor in place for easy removal and reinstallation with ordinary hand tools.

B. Information, Exit, and Safety Signs: Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.

3.03 IDENTIFICATION LABELS

A. Pipe Labels:

1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.
2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
4. Apply to pipe after painting in vicinity is complete, or as approved by Engineer.
5. Install in accordance with manufacturer's instructions.

B. Equipment Labels:

1. Locate and install on equipment or concrete equipment base.
2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

3.04 SUPPLEMENTS

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

1. Sign Schedule: Tabulation of characteristics and mounting information for each sign on Project. Provide items as scheduled. Meet requirements of Occupational Safety and Health Act (OSHA).

END OF SECTION

Sign Schedule

Sign									Lettering					
			Size			Mounting								
No.[1]	Type[2]	Format[3]	Width	Height	Color	Location	Method	Height to Top	Height	Style	Color	Message	Faces	Other Requirements
A1	A	1014-013	7"	3"	Brown	Wall	Bolts	18"	0.75"	Helvetica	Black	OVERFLOW DRAIN	1	Provide at PEPS electrical building
A2	A	1014-014	7"	3"	Brown	Wall	Bolts	18"	0.75"	Helvetica	Black	ROOF DRAIN	1	Provide at PEPS electrical building
B1	B	1014-015	18"	5"	White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	PEPS Electrical Building	1	Provide at PEPS electrical building
B2	B	1014-016	18"	5"	White	Wall	Bolts	5'-6"	1" min.	Helvetic	Black	Aeration Basin 3	1	Provide at Aeration Basin 3
C-1	C	1014-002	20"	14"	Yellow	Hanging	Chain	5'-6"	1" min.	Helvetica	Black	CAUTION Equipment Starts Automatically	1	Provide at PEPS
D-7	B	1014-001	20"	14"	White	Pipe Post	Bolts	3'-6"	1" min.	Helvetica	Black	DANGER Nonpotable Water Not for Drinking	1	Provide at exterior No. 4 hose valves
D-11[3]	C	1014-001	10"	7"	White	Door or Hatch	Screws	5'-6"	1" min.	Helvetica	Black	DANGER CONFINED SPACE AUTHORIZED EMPLOYEES ONLY	1	Provide at valve and flow meter vaults and pump wet wells

Sign Schedule

Sign									Lettering					
			Size			Mounting								
No.[1]	Type[2]	Format[3]	Width	Height	Color	Location	Method	Height to Top	Height	Style	Color	Message	Faces	Other Requirements
E-1	A	1014-002	20"	14"	Yellow	Outside Face of Door	Screws	5’-6”	1” min	Helvetica	Red	WARNING HIGH VOLTAGE UNAUTHORIZED PERSONNEL KEEP OUT	1	Provide at PEPS electrical building

[1]Numbers refer to a particular sign type with a particular message.
[2]Letters refer to sign types specified in this section.

[3]Verify requirements for this sign with Laws and Regulations in state where Project is located.

SECTION 10 44 00
PORTABLE FIRE AND SAFETY EQUIPMENT

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):
   a. 10, Standard for Portable Fire Extinguishers.
2. Occupational Safety and Health Act (OSHA).
3. Underwriters Laboratories Inc. (UL): Fire Protection Equipment List.

1.02 PERFORMANCE REQUIREMENTS

A. Conform to NFPA 10.

B. Provide extinguishers classified and labeled by Underwriters Laboratories Inc. for purpose specified and indicated.

1.03 SUBMITTALS

A. Action Submittals:

1. Fire Extinguishers: Submit manufacturer's product data for each item, including sizes, ratings, UL listings, or other certifications, and mounting information.
2. Product Data: Submit extinguisher operational features, color and finish, anchorage details.

B. Informational Submittals:

1. Manufacturer's Installation Instructions: Special criteria and wall opening coordination requirements.
2. Operation and Maintenance Data: Submit test, refill or recharge schedules and recertification requirements.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with State of Idaho, City of Nampa standards as approved by the Authority Having Jurisdiction.

PART 2 PRODUCTS

2.01 PORTABLE FIRE EXTINGUISHERS

A. Manufacturers and Products:

1. JL Industries.
2. Larsen's Manufacturing Co.
3. Nystrom Products Co.
4. Potter Roemer.
5. Or equal.

B. General:

1. Conform to NFPA 10 for fire extinguishers.
2. Furnish fire extinguishers and brackets from one manufacturer.
3. UL listed, charged and ready for service.

C. Carbon Dioxide Hand Extinguisher (F. Ext-2):

1. Carbon dioxide.
2. Pressurized, red enameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Agent propelled through hose and spreader nozzle.
5. For use on B and C class fires.
6. Minimum UL Rating: 10B:C, 15-pound capacity.

2.02 ACCESSORIES

A. Extinguisher Brackets: For hand extinguishers not located in cabinets, furnish heavy-duty brackets.

B. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.

1. Metal expansion shields for machine screws at concrete and masonry.
2. Interior: Rust-resistant.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install where indicated or directed and following manufacturer's recommendations.

B. Provide adequate backing for mounting surfaces.

C. Place extinguishers on wall brackets.

D. Position extinguisher signage as required by authorities having jurisdiction.

3.02 PORTABLE FIRE EXTINGUISHERS

A. Provide at locations shown or as directed by Engineer.

B. Mount hangers securely in position, following manufacturer's recommendations.

C. Top of Extinguisher: No more than 54 inches above floor.

D. Install wall brackets, maximum 48 inches from finished floor to top of extinguisher handle.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.
3. Associated Air Balance Council (AABC): National Standards for Field Management and Instrumentation Total System Balance.
4. National Environmental Balancing Bureau (NEBB):
   a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
   b. Procedural Standards for Measuring Sound and Vibration.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

1.02 SUBMITTALS

A. Informational Submittals:

1. Documentation of experience record of testing authority.
2. Documentation of current AABC or NEBB certifications for those technicians in responsible charge of the work under this Contract.
3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
4. Written verification of calibration of testing and balancing equipment.
5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.03 QUALITY ASSURANCE

A. Air Balancing and Test Agency Qualifications:

1. Certification by AABC of NEBB for testing, adjusting and balancing of HVAC systems.
2. Corporately and financially independent organization functioning as an unbiased testing authority.
3. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.

4. Have a proven record of at least five similar projects.
5. Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.

B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust and balance air systems in accordance with standard procedures and recognized practices of the AABC or SMACNA.

B. Adjust and balance the following systems:

1. Supply, return and exhaust air systems.
2. Cooling, condenser.

3.02 ADJUSTING AND BALANCING AIR SIDE

A. Preparation: Prior to beginning the Work, perform the following activities:

1. Review shop drawings and installed system for adequate and accessible balancing devices and test points.
2. Recommend to Engineer dampers that need to be added or replaced in order to obtain proper air control.
3. Verify proper startup procedures have been completed on the system
4. Verify controls installation is complete and system is in stable operation under automatic control.
5. Verify test instruments have been calibrated to a recognized standard and are within manufacturer’s recommended calibration interval before beginning the Work.

B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Re-adjust as necessary.

2. Lock and mark final positions of balancing dampers with permanent felt pen.
3. Correct fan and airflow measurements for Site elevation.

C. Equipment Data: Collect the following data and included in final report:

1. Type of unit.
2. Equipment identification number.
3. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
4. Motor data (frame, hp, volts, FLA rpm, and service factor).
5. Sheave manufacturer, size, and bore.
6. Belt size and number.
7. Sheave centerline distance and adjustment limits.
8. Starter and motor overload protection data.
9. Include changes made during course of system balancing.

D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
    a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10 percent minus 0 percent.
    b. After final adjustments, do not operate motor above nameplate amperage on any phase.
    c. After final adjustments, do not operate fan above maximum rated speed.
    d. Perform airflow test readings under simulated or actual conditions of full cooling, full outside air and exhaust, and full return air.
4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.
5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.
6. Read and record motor amperage on all phases for each test condition.

E. Air Terminal Devices:

1. Terminal Airflow Calibration: Calibrate and set the flow coefficients in terminal controller units to ensure controller readings are identical to measured values. This shall be a one-point calibration at maximum flow conditions. Record coefficient values.
2. Test each terminal flow device at minimum and maximum flow conditions. Ensure terminal controller is under control at time of each test.
3. Adjust air volumes on each terminal to quantity shown, with allowable variation of plus 10 percent minus 5 percent.

F. Air Outlets and Inlets:

1. In each system at least one air path from fan to final branch duct termination shall have dampers fully open.
2. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus or minus 10 percent.
3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.
4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

3.03 FIELD QUALITY CONTROL

A. General: Perform functional tests as required by Section 01 75 00, Testing, Equipment Startup, and Commissioning.

B. Balancing Log Report Requirements:

1. Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control set point.
2. Log and record operational information from every test for each system, as necessary to accomplish services described.
3. Include equipment data for units tested.
4. Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.
5. Indicate recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
6. Include separate section in log, if necessary, describing operating difficulties in air system that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of condition and its effect on building, and describe corrective actions attempted and recommended.

C. Quality Control Verification: After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:

1. Air balancing procedures, vibration tests, and verification of test results.
2. Perform tests on a 100 percent of total diffusers and grilles with measuring equipment used in original tests.
3. Results of this test shall agree with balance logs within plus or minus 10 percent. Where this accuracy cannot be verified, rebalance portions of system as requested by Engineer.
4. At completion of rebalance procedures, perform another test if required to verify results.

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 3/8-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.
3. Operation and Maintenance Data as specified in Section 01 76 00, Operating and Maintenance Information.

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.

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. Provide size recommended by refrigeration equipment manufacturer.
3. Refrigerant Accumulator: Shall be furnished with the unit. Coordinate the size and location of the unit.

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.

2.03 REFRIGERANT PIPE INSULATION

A. 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.

B. Aluminum Jacket:

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.

C. 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.

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 free of sags and bends.
9. Install fittings for changes in direction and branch connections.

10. Install refrigerant piping in protective conduit where installed belowground.
11. Install accumulator in suction line near condensing unit.
12. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
13. 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.
7. Seal penetrations through fire and smoke barriers according to Section 07 84 00, Firestopping.

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 PIPE INSULATION

A. Application of Piping Insulation:

1. Install insulation products in accordance with manufacturer’s written instructions, and in accordance with recognized industry practices.
2. Apply insulation over clean, finish painted, and dry surfaces.
3. Install insulation after piping system has been pressure tested and leaks corrected.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. 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.
6. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
7. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic.

8. 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.
9. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.
10. Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation.
11. Insulate valve bodies, flanges, and pipe couplings.
12. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
13. Do not insulate flexible pipe couplings and expansion joints.
14. Do not allow insulation to cover nameplates or code inspection stamps.
15. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
16. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.
17. Placement:
    a. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
    b. Insulate valves and fittings with sleeved or cut pieces of same material.
    c. Seal and tape joints.
18. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.
19. Vapor Barrier:
    a. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
    b. Install vapor barrier jackets with pipe hangers and supports outside jacket.
    c. Do not use staples and screws to secure vapor sealed system components.

B. Piping Insulation Requirements:

1. Refrigeration Suction:
    a. 1/2-inch thickness for pipe sizes up to 1 inch.
    b. 3/4-inch thickness for pipe sizes over 1 inch.
2. Refrigeration Hot Gas Reheat: 3/4-inch thickness.
3. Pipe Hangers:
    a. Elastomeric: Rigid insulation section with 9-inch-long, 16-gauge galvanized steel saddle.

C. Insulation Finish Requirements:

1. Piping Insulation (Exposed to View, Indoors): Aluminum jacket.
2. Piping Insulation (Outdoors): Paint.

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

3.06 EQUIPMENT CONNECTIONS

A. Connect refrigerant piping to mechanical equipment in the manner shown, and comply with equipment manufacturer's instructions where not otherwise indicated.

3.07 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.

3.08 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 controllers to system design temperature.
3. Perform following adjustments according to manufacturer's written instructions before operating refrigeration system:
   a. Verify compressor oil level is correct.
   b. Open compressor suction and discharge valves.
   c. Open refrigerant valves, except bypass valves that are used for other purposes.
   d. 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. Duct, plenum, and casing abutments to building structures.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Rectangular and Rigid Round:
      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: 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:
   1) Fittings and volume control damper installation (both manual and automatic) details.
   2) Duct liner.
   3) Sealing materials.
   4) Dampers; include leakage, pressure drop, and maximum back pressure data.
   5) Flexible ducts.
   6) Sheet metal fasteners.

2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 60 01, Seismic Anchorage and Bracing Requirements.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 60 01, Seismic Anchorage and Bracing Requirements.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing.
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. If fabricated sound-lined ductwork gets wet during installation, remove and dispose of ductwork from the Site.

C. 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.

D. 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.

E. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 PRODUCTS

2.01 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 thinner than 26-gauge will not be allowed.

D. 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.
4. For ductwork that is required to be reinforced, use only external reinforcing.

2.02 SHEET METAL MATERIALS

A. Construct metal duct systems from aluminum.

B. Where no specific ductwork materials are indicated in Specifications or on Drawings, aluminum sheet metal shall be basis of Contract.

C. Aluminum Ductwork:

1. Comply with ASTM B209.
2. Aluminum Sheet: Alloy 3003-H14, unless indicated otherwise.
3. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or equivalent.

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.

2.03 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.

C. Solvent-Based Sealants:

1. Ultraviolet light resistant.
2. Mildew resistant.
3. Flashpoint: Greater than 70 degrees F, SETA CC.
4. Manufacturers and Products:
   a. Hardcast, Inc.; Versagrip 102.
   b. Rectorseal; AT-33.
   c. Childers CP-140.

D. Water-Based Sealants:

1. Listed by manufacturer as nonflammable in wet and dry state.
2. Manufacturers and Products:
   a. Foster; Series 32.
   b. Childers; CP-145A, 146.
   c. Rectorseal; Airlok 181.

2.04 FIRESTOPPING

A. Refer to Section 07 84 00, Firestopping.

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. Aluminum Ductwork System:
   a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Type 410 stainless steel, complete with bonded metal and fiber washer for dielectric separation.
   b. Manufacturers:
      1) DB Building Fasteners Inc., Santa Fe Springs, CA.
      2) Clark Craft Fasteners, Tonawanda, NY.

2.06 DUCTWORK PRESSURE CLASS

A. Construct duct systems to pressure classifications indicated as follows:

1. Supply Ducts: 3-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. Air Handling Unit Discharge Ductwork: Ductwork extending from variable air volume air handling units up to and including first elbow or terminal tap outside air handling unit room shall be constructed of 16-gauge, minimum sheet metal, same material as remainder of system.

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 or with factory fabricated, field installed taps, with spin-in or mechanical fastened tap to main duct connections.

2.10 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.

E. Ductwork seams of Snaplock type shall not be used.

2.11 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.

2.12 ROUND DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections (taps) to round duct mains shall be made using factory fabricated fittings.

2.13 ROUND DUCTWORK INSULATION LINER

A. Location: Provide round ductwork with internal insulation liner on all outside air, fresh air, and exhaust airstreams.

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 inch or greater thickness.

D. R-Value: Minimum 4.3 hour foot squared degrees F per Btu, or greater.

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.

2.14 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
7. Flexible ductwork shall be a maximum of 2 feet in length except if specifically indicated on Drawings.

C. Environment: Suitable for continuous operation at temperature range of minus 20 degrees F to plus 200 degrees F.

D. Manufacturers:

1. Flex-Master.
2. Thermaflex.
3. Hart & Cooley.

2.15 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. Aluminum Ductwork Indoors and Outdoors:
   a. Refer to Area Classification and Material Selection Table drawing in the General drawing sheets..
   b. Nonmetallic pad between lower attachment and ductwork, to achieve dielectric separation.

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.

2.16 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:

1. Ductmate; PROflex, Commercial.
2. Ventfabrics.
3. Duro-Dyne.

2.17 MISCELLANEOUS ACCESSORIES

A. 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.

B. 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.

2.18 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. Nomenclature: Include the following:

1. Direction of air flow.
2. Duct service (supply, return, exhaust).

C. 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 lighting and similar finished work.
4. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

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 tape 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 Wall Supply and Return System Joints:
   a. Less than 36 Inches: Slip coupling.
3. Single 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: Maximum length of low-pressure flexible duct (construction pressure class up to 2-inch WC) to be 2 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.

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 DUCT SEALING

A. Seal duct seams and joints as follows:

1. 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.

3.08 FIRESTOPPING

A. Refer to Section 07 84 00, Firestopping.

3.09 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: Assemble and install ductwork with maximum leakage limited as follows:

1. Constant Volume Systems:
   a. Outside Air, Fresh Air, Exhaust Air, 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.

3.10 BALANCING OF AIR SYSTEMS

A. Perform air balancing in accordance with requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.11 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.

3.12 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.

END OF SECTION

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. Capacities and ratings.
   f. Construction materials.
   g. Drive assembly horsepower rating.
   h. Sheave horsepower rating.
   i. Power and control wiring diagrams, including terminals and numbers.
   j. Factory finish system.
2. “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. Recommended procedures for protection and handling of products prior to installation.
2. Manufacturer's installation instructions.
3. Test reports.
4. Operation and maintenance data in conformance with Section 01 76 00, Operating and Maintenance Information. Include as-built version of equipment schedules.

1.04 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.

1.05 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following special tools:

Item	Quantity
Special tools required to maintain or dismantle	One complete set for each different size unit

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES

A. Some specific equipment requirements are listed in Equipment Schedule. Refer to Drawings

2.02 GENERAL

A. Operating Limits: Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408.

2.03 ENERGY RECOVERY UNIT (3099ERU1)

A. Energy Transfer:

1. The ERU shall be capable of transferring both sensible and latent energy between airstreams.
2. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air.

B. Passive Frost Control:

1. The ERU core shall perform without condensing or frosting under normal operating conditions.
2. Occasional more extreme conditions shall not affect the usual function, performance or durability of the core.

C. Positive Airstream Separation:

1. Water vapor transfer shall be through molecular transport by hydroscopic resin and shall not be accomplished by “porous plate” mechanisms.
2. Exhaust and fresh airstreams shall travel at all times in separate passages and airstreams shall not mix.

D. Construction:

1. The energy recovery component shall be of fixed-plate cross-flow construction, with no moving parts.
2. The unit case shall be constructed of 24-gauge steel, with lapped corners and zinc plated screw fasteners.
3. The case shall be finished with textured, powder coat paint (GR90 case shall be constructed of G90 galvanized steel).
4. Access doors shall provide easy access to blowers, ERV cores and filters.
5. Doors shall have an airtight compression seal using closed cell foam gaskets.
6. Case walls and doors shall be fully insulated with 1-inch, expanded polystyrene foam insulation faced with a cleanable foil face on all exposed surfaces.
7. The ERV cores shall be protected by a MERV-8 rated, spun polyester, disposable filter in both airstreams.
8. Unit shall have hardwired line voltage connection and be controlled by line voltage controls provided by others.

9. Standby power draw shall not exceed 1 watt for the unit along with an optional automatic control.

2.04 FILTER HOUSING

A. General:

1. Air filtration section, complete with filter media and filter racks.
2. Designed for static pressure ranges of minus 3 inches WC to plus 3 inches WC.
3. Design temperature not to exceed 200 degrees F.
4. Leakage at rated airflow upstream to downstream of filter frame shall be less than1 percent at 3 inches WC. Leakage in to or out of housing shall be less than 0.5 percent at 3 inches WC.
5. Flanged units suitable for installation in a duct and for space indicated.
6. Housing to fit standard nominal filter sizes, either 24 inches by 24 inches or 24 inches by 12 inches.
7. Maximum 500 fpm face velocity across filters.
8. Filters arranged in a suitable leak-tight frame and enclosure.

B. Housing:

1. Permanent reusable, side-loading aluminum frame and retainer.
2. Housing to be supported on a structural steel frame.
3. Doors:
   a. Provide hinged, quick-opening doors for access, service and removal of filters.
   b. Side access doors to be locked closed and opened without use of tools.
   c. Plastic door hardware to be made of UV-resistant materials.
   d. Provide doors on one side of unit.
4. Provide upstream and downstream outwardly turned flanges of same material as housing.
5. Provide gaskets for filter tracks and doors for positive sealing. Filter track gaskets to be replaceable.
6. Treat cabinet and accessory surfaces inside and out with rust-inhibitive surface coating and painted with prime and finish coat of machinery enamel.
7. Provide upstream and downstream static pressure taps, with 1/4-inch diameter tube connections for measuring pressure drop across filters.
8. Provide lifting lugs suitable for lifting and assembled housing and filters.
9. Provide housing hanging brackets of same material as housing suitable to supporting complete filter housing assembly.

C. Filters:

1. Filter Media Thickness: 2 inches.
2. Arrangement: Angled V-bank.
3. Filters shall be constructed of a carbon filled polyester nonwoven media.
4. Carbon granules shall be thermally bonded to polyester fibers to prevent release of carbon particulate into the air stream.
5. The carbon granules shall be 30 by 50 US Mesh with a carbon tetrachloride rating of 90 percent
6. The carbon media shall be pleated without the use of a support structure and sealed within a 22-point moisture-resistant beverage board frame.

D. Accessories:

1. Filter Pressure Gauge: Furnish each filter bank with magnahelic gauge (Dwyer Series 2000) with connecting polypropylene tubing and adjustable signal flag.

E. Manufacturer and Product:

1. V-Bank Filter Housings:
   a. Flanders FCP Carbon Pleat.
   b. Or approved equal

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. Shaft Type: Solid, carbon steel.
7. Mounting: As required for fan arrangement.
8. Service Factor: 1.15.

2.06 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 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 black enamel filled equipment identification number and letters 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.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install fans level and plumb.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Scroll Drains: Pipe drain connection through running trap to floor drain.

D. 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.

E. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

F. Equipment Support and Restraints:

1. Install floor-mounted units on concrete bases.
2. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.

G. Connections:

1. Refer to Section 23 31 13, Metal Ducts and Accessories.
2. Isolate duct connections to fans.
3. Install ductwork adjacent to fans to allow proper service and maintenance.

H. Controls: Mechanical contractor shall be responsible for the installation of all control wiring, power wiring, conduit, sensors, dampers, damper actuators, and all other devices as required to make the system complete and operational. Mechanical contractor shall be responsible to review the documents and coordinate with other trades to insure the system is complete and operational.

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. Manufacturer's Representative: Present at site or classroom designated by Owner for minimum 1 person-day listed below, travel time excluded:

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.

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.

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. 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 Drawings.

2.02 SUPPLY GRILLES AND REGISTERS

A. High Capacity Supply Grilles and Registers (SG1):

1. Construction: Refer to Equipment Schedule.
2. SR Register Accessories:
   a. Gang-operated opposed-blade volume control damper.
   b. Material to match grille.
3. Industrial type, rectangular shaped.
4. 1-1/4-inch minimum flat rectangular frame.
5. Individually adjustable front horizontal and rear vertical airfoil shaped extruded aluminum blades on 3/4-inch centers.
6. Continuous sponge rubber gasket at face flange.
7. Manufacturer and Product: Titus; AeroBlade Series.

PART 3 EXECUTION

3.01 INSTALLATION

A. 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): 9001, Quality Management Systems - Requirements.
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. LED: Light Emitting Diode.
6. PSC: Permanent Split Capacitor.
7. SPST: Single Pole, Single Throw.
8. TXV: Thermostatic Expansion Valve.
9. UV: Ultraviolet.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. 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.
   b. Manufacturer's standard finish color selection for enclosure finishes.
   c. 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.
   d. Air Pressurization Unit: Documentation that media filter modules are UL rated Class 1.
   e. Factory dip-applied protective coating product data.

B. Informational Submittals:

1. Manufacturer's documentation that media filter modules rated UL Class 1.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for, air-conditioning units, and motors.
3. Manufacturer's Certificate of Compliance, in accordance with all codes specifically stated in this specification.

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 76 00, Operating and Maintenance Information.
    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.

E. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by the International Energy Code (IFCC) 2012.

F. Unit shall be in accordance with the International Mechanical Code (IMC) 2012.

G. Air Pressurization Unit Manufacturer Qualifications:

1. Manufacturer shall have a minimum of 10 years' experience in design, fabrication and testing of systems that are 99.95 percent efficient in removal of these gases.
2. Manufacturer shall be a single source provider of equipment, media, and testing services, and certified to ISO 9001 standards or adhere to quality standards equal to ISO 9001.
3. Welding procedure qualifications and welder performance qualifications shall conform to the requirements of ASME BPVC Section IX. Welder's performance qualification records shall be made available to Engineer upon request.

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
Filters	One complete set per unit.

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

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. Requirements:

1. Cooling only.
2. R-410A refrigerant.
3. Hinged access doors with lockable handles.
4. Dual refrigerant circuits with at least one variable capacity digital scroll compressor for a range of cooling conditions.

C. Manufacturers:

1. Aaon.
2. Carrier.
3. Lennox International.
4. Trane.
5. Or approved equal

2.02 EQUIPMENT SCHEDULES

A. Refer to Drawings.

2.03 SPLIT SYSTEM AC INDOOR UNIT (3097FCU1, 3098CU1) DUCTED

A. General:

1. Indoor air handling unit shall include filter rack, filters, supply fan, DX evaporator coil, and unit controls.
2. Unit shall have a draw-through supply fan configuration and discharge air horizontally.
3. Unit shall be factory assembled and tested including leak testing of the DX coil, and run testing of the supply fans and factory wired electrical system. Run test report shall be supplied with the unit.
4. Furnish with stand-alone controls that are capable of external communication.
5. Unit shall be capable of stable operation including starting and stopping of the unit from -10 degrees F to 110 degrees F.
6. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
7. Unit components shall be labeled including pipe stub outs, refrigeration system components, and electrical and controls components.
8. Do not furnish unit with an economizer because of H2S in the outside air stream.

B. Construction:

1. Unit construction shall be double wall with G90 galvanized steel on both sides of insulation and a thermal break.

2. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610 degrees F.
3. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
4. Access to filters, cooling coil, supply fans, and electrical and controls components shall be through hinged access doors.
5. Access doors shall be flush mounted to cabinetry. Coil access door and supply fan access door shall include quarter-turn lockable handles. Supply fan access door shall include removable pin hinges.
6. Units with a cooling coil shall include sloped Type 304 stainless steel drain pan. Drain pan connection shall be on the right hand side of unit.
7. Cooling coil shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.
8. Unit shall be painted with standard factory paint.

C. Supply Fan:

1. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
2. Blower and motor assembly shall be dynamically balanced.
3. Blower and motor assembly shall be isolated with neoprene gasket.
4. Motor shall be a high efficiency electronically commutated motor (ECM).

D. DX Evaporator Coil:

1. Minimum six-row configuration, copper tube with aluminum fins and stainless steel tube sheets.
2. Fins bonded to tubes by mechanical expansion.
3. Refrigerant piping sweat connections.
4. Coil shall use two circuits and interlaced circuitry.
5. Coil shall be 6-row high capacity and 10 fins per inch.
6. Coil shall be furnished with factory installed thermostatic expansion valves. The sensing bulbs shall be field installed on the suction line immediately outside the cabinet.
7. Liquid and suction connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing.

8. Condensate Drain Pan:
   a. High-impact thermoplastic, insulated, with primary and secondary brass drain fittings.
   b. Double sloped to prevent standing water from accumulating.

E. Refrigeration System:

1. Air handling unit and matching condensing unit shall be capable of operation as a dual circuited R-410A split system air conditioner.
2. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control, accumulator size as required by the factory.

F. Controls:

1. Unit shall be provided with an external digital control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Control panel shall be field mounted.
2. Controller shall include nonvolatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
3. Constant Volume Controller: Unit shall modulate cooling with constant airflow to meet space temperature cooling loads.
4. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD touchscreen. LCD shall be wall-mounted and the digital control panel shall be unit mounted. LCD remote panel shall be capable of configuring the unit of all setpoints.
5. Controller shall be capable of communicating and integrating with a LonWorks or BACnet network. Coordinate with Owner the preferred interface.

G. Air Filters:

1. Disposable 2-inch thick with pleated nonwoven fabric media.
2. Filter access from either the right or left side of the unit.

H. Accessories: Provide as scheduled in Equipment Schedule.

2.04 SPLIT SYSTEM AC OUTDOOR UNITS

A. General:

1. Condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, and unit controls.

2. Unit shall be factory assembled and tested, including leak testing of the coil and run testing of the completed unit.
3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
4. Unit components shall be labeled including pipe stub outs, refrigeration system components, and electrical and controls components.
5. Installation, Operation and Maintenance Manual shall be supplied within the unit.
6. Condensing unit shall be constructed of either aluminum or stainless steel. No galvanized steel or plain steel will be allowed on this product due to corrosion by hydrogen sulfides present in the air.

B. Unit Cabinet:

1. Constructed of either aluminum or stainless steel, phosphatized and coated with a baked enamel finish.
2. Removable access panels for access to internal components.
3. Outdoor Compartment: Isolated, with acoustic lining to ensure quiet operation.
4. Unit shall be completely factory assembled, piped, and wired and shipped in one section.

C. Condenser Fans:

1. Direct-drive propeller type shall discharge air vertically and shall blow air through outdoor coil.
2. Fan blades shall be constructed of aluminum or stainless steel.
3. Motors:
   a. Totally enclosed, with Class B insulation and permanently lubricated bearings.
   b. Fan motor shall be weather protected, single-phase, direct drive, and open drip proof.
   c. Thermal overload protection.
4. Stainless steel shaft construction.
5. Fan blades shall be statically and dynamically balanced.
6. Equip openings with stainless steel or aluminum protection grille over fan and coil.

D. Compressor:

1. Dual -circuit refrigeration system
2. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit which shall be capable of modulation from 10 to 100 percent of its capacity. The second circuit shall be on/off control.
3. Each compressor shall be furnished with a crankcase heater.
4. Equipped with oil system, operating oil charge, and motor.

5. Internal overloads shall protect compressor from over-temperature and overcurrent.
6. Motor: NEMA rated, Class F, suitable for operation in a refrigerant atmosphere.
7. Scroll compressors shall have high discharge gas temperature protection.
8. Installed on rubber vibration isolators and shall have internal spring isolation.

E. Condenser Coil:

1. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings.
2. Coils shall be designed for a minimum of 10 degrees F of refrigerant sub-cooling.
3. Coil shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat.

F. Refrigeration Components:

1. Brass external liquid line service valve with service gauge port connections.
2. Suction line service valve with service gauge connection port.
3. Service gauge port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps.
4. Suction Line: Accumulator shall be furnished for each refrigerant circuit. Accumulators shall be sized by the factory.
5. Pressure relief.

G. Controls:

1. Factory selected, assembled, and tested. All controls shall be incorporated in the overall operation of the HVAC unit.
2. Refrigerant metering.
3. Automatic restart on power failure.
4. Three-pole contactors.
5. Time delay control sequence shall be provided standard through control board on indoor units.
6. High pressure and liquid line low pressure switches.

7. Automatic outdoor fan motor protection.
8. Safeties:
    a. Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
    b. Safety lockout if an outdoor unit safety is open.
    c. High condensing temperature protection.
    d. System diagnostics.
    e. Compressor motor current and temperature overload protection.
    f. High pressure relief.
    g. Outdoor fan failure protection.
9. Standard Terminal Block: Unit shall be provided with a terminal block for field installation of controls.

H. Accessories: Provide as scheduled in Equipment Schedule and as follows:

1. Low-Ambient Cooling Kit:
    a. Solid state condenser fan motor fully modulating speed controller; responds to saturated condensing pressure/temperature of unit.
    b. Maintains a saturated condensing temperature of 100 degrees F plus or minus 10 degrees F with outdoor temperatures down to minus 10 degrees F.
    c. Includes winter start control package, to bypass low-pressure switch temporarily to allow compressor start during low load conditions.
    d. Includes ball bearing condenser fan motor.

2.05 UNITARY EQUIPMENT CONTROLS

A. Electric Thermostat:

1. Two-position electric type.
2. Temperature Scale: Furnish 50 degrees F to 90 degrees F scale.
3. Adjustments external to units.
4. Adjustable sensitivity.
5. Nonlocking cover.
6. Insulating back, where exterior mounting is indicated.

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 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 number and letters 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. Isolate sheet metal duct connections from portions of unit not internally spring-isolated from fans, or other vibrating or rotating equipment.

C. Inspect internal casing insulation, seal exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

D. 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.

E. Lubricate unsealed bearings prior to startup.

F. Mechanical contractor shall be responsible for the installation of all control wiring, power wiring, conduit, sensors, dampers, damper actuators, and all other devices as required to make the system complete and operational. Mechanical contractor shall be responsible to review the documents and coordinate with other trades to insure the system is complete and operational.

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, 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 as defined in Section 01 77 00, Project Closeout.

END OF SECTION

SECTION 23 82 00
TERMINAL HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Moving and Conditioning Association (AMCA): 300, Reverberant Room Method for Sound Testing of Fans
2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90.1 IP/SI, Energy Standard for Buildings, Except Low-Rise Residential Buildings.
3. ASTM International (ASTM):
   a. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   b. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
4. Electrical Test Laboratories (ETL).
5. National Electrical Manufacturer's Association (NEMA).
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
7. Sheet Metal and Air Conditioning Contractors' National Assoc., Inc. (SMACNA): Ducted Electric Heat Guide for Air Handling Systems.
8. Underwriters Laboratories Inc. (UL): Product Directories.

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. hp: Horsepower.
6. ODP: Open Drip Proof.
7. PSC: Permanent Split Capacitor.
8. SWSI: Single Width, Single Inlet.
9. TEFC: Totally Enclosed, Fan Cooled.
10. UV: Ultraviolet.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings.
2. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.
3. Performance data, including sound power level data (ref. 10 watts to 12 watts) at design operating point, shall be based on AMCA 300.

B. Informational Submittals:

1. Manufacturer's test reports for the following:
   a. Cabinet unit heater electric heating coil.
2. Recommended procedures for protection and handling of equipment and materials prior to installation.
3. Operation and Maintenance Data: As specified in Section 01 76 00, Operating and Maintenance Information.

1.04 QUALITY ASSURANCE

A. Heating Equipment: Minimum operating efficiencies, specified in International Energy Conservation Code 2012.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Equipment Schedules: Refer to Drawings.

2.02 UNIT HEATER, ELECTRIC (3108UH1), SUSPENDED

A. Characteristics:

1. Factory assembled including casing, heater elements, fan wheel, drive assembly, motor, controls and accessories.
2. UL listed.
3. Meet requirements of National Electrical Code.
4. Three phase heaters shall have balanced phases.
5. Casing:
   a. Heavy gauge steel casing.
   b. Baked enamel finish.
   c. Individual adjustable discharge louvers.
   d. Protective air inlet louvers or fan guards.

6. Heating elements shall be one of the following types:
   a. Aluminum finned, copper clad, steel sheath.
   b. High mass, all steel tubular finned type, copper brazed, in fixed element banks.
   c. Nickel-chromium wire elements enclosed in powder filled aluminum coated steel tubes with permanently fused fins.
   d. Steel tubes with nickel chromium resistance wire embedded in a dielectric with steel fins crimped and brazed to the tube.
   e. Corrosion-resistant steel fins brazed to tubular heating elements.
7. Fan and Motor:
   a. Totally enclosed motor.
   b. Direct drive fan.
   c. Sealed bearings. Permanently lubricated.
8. Controls:
   a. Thermal overload protection with automatic reset.
   b. Controls, transformers, and contactors shall be factory assembled.
   c. Furnish with an integral unit-mounted thermostat with dial type adjustment.

B. Accessories and Features: Provide as scheduled in Equipment Schedule.

C. Manufacturer and Product:

1. Qmark; Type MUH.
2. Or approved equal.

2.03 ELECTRICAL

A. General:

1. Units shall include high and low voltage terminal block connections.
2. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.

B. Motors:

1. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.
   a. Enclosure: ODP, unless specified otherwise.
   b. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
   c. Winding Thermal Protection: Manufacturer’s standard.
   d. Space Heater: Manufacturer’s standard.
   e. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer’s standard.

2.04 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 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 black enamel filled equipment identification number and letters indicated in this Specification and as shown on Drawings.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.05 SOURCE QUALITY CONTROL

A. Functional Test:

1. Perform manufacturer's standard factory test on equipment.
2. Test equipment identical to that furnished.
3. Equipment with Electric Resistance Heating Coils: Test with 2,000-volt dielectric test.

PART 3 EXECUTION

3.01 INSTALLATION

A. Electric Unit Heaters, All Types:

1. Install in strict compliance with manufacturer's instructions. Maintain clearances around unit as listed in manufacturer's recommendations.
2. Bottom of unit shall be a minimum of 8 feet above finish floor, unless indicated otherwise.
3. Heater shall be permanently mounted in position indicated with a fixed power supply.
4. Install so obstructions do not block heater air inlet or outlet.
5. Mechanical contractor shall be responsible for the installation of all control wiring, power wiring, conduit sensors, dampers, actuators, and all other devices as required to make the system complete and operational. Mechanical contractor shall be responsible to review the documents and coordinate with other trades to insure the system is complete and operational.

3.02 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified equipment.

END OF SECTION

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