PROJECT SPECIFICATIONS

PROJECT:

CONSTRUCTION OF THE
NEW SAFARI CAFÉ 2 BUILDING
FOR THE CAPE MAY COUNTY ZOO

CLIENT:

CAPE MAY COUNTY BOARD OF CHOSEN FREEHOLDERS
4 MOORE ROAD
CAPE MAY COURT HOUSE, NJ 08210

ARCHITECT:

T+ ASSOCIATES ARCHITECTS
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PHILADELPHIA, PA 19147

M/E/P ENGINEERS:

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OCTOBER 28. 2019

TABLE OF CONTENTS

ARCHITECTURAL SPECIFICATIONS

DIVISION 01	**GENERAL CONDITIONS**
01330	SUBMITTALS
01770	CLOSE OUT PROCEDURES
DIVISION 03	**CONCRETE**
03300	CAST-IN-PLACE CONCRETE
03550	POLISHED CONCRETE FLOOR
DIVISION 04	**MASONRY**
04220	CONCERTE MASONRY UNIT
DIVISION 05	**METALS**
05100	STRUCTURAL STEEL FRAMING
DIVISION 06	**WOOD**
06010	LUMBER
06200	FINISH CARPENTRY AND MILLWORK
DIVISION 07	**THERMAL AND MOISTURE PROTECTION; ROOFING**
07242	FIRE STOPPING
00000	EPDM ROOFING
DIVISION 08	**DOORS AND WINDOWS**
08100	HOLLOW METAL DOORS AND FRAMES
08700	HARDWARE
00000	ALUMINUM STOREFRONT
DIVISION 09	**FINISHES**
09260	GYPSUM BOARD ASSEMBLIES
09300	CERAMIC TILE
09510	ACOUSTICAL CEILINGS SYSTEMS
09900	PAINTING AND FINISHING
DIVISION 16	**ELECTRICAL**
DIVISION 22	**PLUMBING**
DIVISION 23	**HVAC**

01330

SUBMITTALS

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes administrative and procedural requirements for submitting shop drawings, product data, samples and other submittals.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information that requires Architect's responsive action.

B. Informational Submittals: Written information that does not require Architect's responsive action.

1.3 SUBMITTAL PROCEDURES

A. General: Electronic copies of CAD drawings of the Contract Drawings will be provided by the Architect for the Contractor's use in preparing submittals.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activity that requires sequential action.

2. Coordinate transmittal of different types of submittals for related parts of the work so processing will not be delayed.
   a. The Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related materials are received.

C. Processing Time: Allow enough time for submittal review, including time for resubmittals. Time will commence on Architect's receipt of submittal.

1. Initial Review: Allow seven (3) days for initial review of each submittal

2. Intermediate Review: If intermediate review is necessary, process in the same manner as initial submittal.

3. Resubmittal Review: Allow seven (3) days for review of each Resubmittal

4. Sequential Review: Where sequential review of submittals is required by Architect's consultants, allow fourteen (7) days for initial review of each submittal.

5. Submittals may be rejected for not complying with requirements.

6. No extension of Contract Time will be authorized because of failure to transmit submittals enough in advance of the work to permit processing.

C. Identification: Place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on the label or title block.

2. Provide a 6" by 8" space on the label or beside the title block to record Contractor's review and approval markings and action taken by the Architect.

3. Include the following information on the label:
   a. Project Name
   b. Date
   c. Name and Address of Architect
   d. Name and Address of Contractor
   e. Name and Address of Subcontractor
   f. Name and Address of Supplier
   g. Name of Manufacturer
   h. Submittal number, identified by specification section and unique identifier
   i. Number and Title of appropriate specification section
   j. Drawing number and detail references as appropriate
   k. Other necessary information

D. Deviations: Highlight, encircle or otherwise identify deviations from the Contract Documents on the submittal

E. Number of Submittals: Submit four (4) original copies of each submittal

F. Distribution: The Contractor shall distribute submittals as follows:

1. Initial Distribution: The Contractor shall distribute three (3) original copies to the Architect for review and approval, and one (1) original copy to the Owner's project manager for review and comment.
   a. Any resubmittal of information, based on the Architect's comments shall follow the same procedure as initial distribution.

2. Final distribution: Furnish copies of final approved submittals to manufacturers,

subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others necessary for performance of construction activities. Show distribution on all transmittal forms.

G. Use in Construction: Use only the final approved submittals with marks indicating action taken by the architect in connection with construction. Maintain one (1) copy of each final submittal at the jobsite.

1.4 CONTRACTOR"S USE OF CAD FILES

A. At Contractor's written request, copies of Architect's CAD files will be provided for the Contractor's use.

B. A signed release prepared and approved by the Architect is required, and payment of fee for Architect's time and materials may be required.

C. The Architect retains all copyrights of the drawings. No drawing may be used in part or in whole without the Architect's express written consent.

PART 2 – PRODUCTS

2.1 ACTION SUBMITTALS

A. Product Submittals: Prepare and submit product Submittals as required by individual specification sections. Include all required product data, product samples, color samples, product schedules, shop drawings, wiring diagrams or installation diagrams as required to fully describe the material or product to be supplied and hoe it will be installed.

B. Submittal Log: Submit within 10 days of award of Contract submit a submittal log which identifies all submittals required for the installation of work and identifies all required action approvals or reviews required by the Architect for the installation of work.

1. Provide an updated submittal log for review every two (2) weeks during the course of the project.

C. Subcontractor List: Provide a list of all individuals and firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the name, address, telephone, website address, contact person and email contact. Indicate which products or services they provide by specification section.

2.2 INFORMATIONAL SUBMITTALS

A. Prepare and submit informational submittals as required by individual specification sections. These include, but are not limited to:

1. Certificates and Certifications

2. Warranties
3. Manufacturers Instructions
4. Operational Information
5. Maintenance Requirements
6. Design Data
7. Material Data Safety Sheets
8. Test and Inspection Reports
9. Contractor Qualification Data
10. Material and Product Test Reports
11. Research/Evaluation Reports
12. Insurance Certificates and Bonds
13. Construction Photographs

2.3 DELEGATED DESIGN

A. Where professional design services or certifications by a design professional are required of the Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

B. Delegated Design Submittal: In addition to shop drawings, product data and other required submittals, submit a statement, signed and sealed by the responsible design professional for each product or system to be designed or certified by a design professional.

PART 3 – EXECUTION – NOT USED

3.1 CONTRACTOR REVIEW

A. Review each submittal and check for coordination with other Work in Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with Approval stamp before submitting to architect.

3.2 ARCHITECT'S ACTION

A. Architect will not review submittals that do not bear Contractor's approval stamp, and will be returned without action.

B. Architect will review each submittal, make marks to indicate corrections or modifications as required and return the submittal to the Contractor. Architect will indicate what action is taken as follows:

1. Reviewed and Approved

2. Approved as Noted

3. Revise and Resubmit

4. Rejected and Resubmit

C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements.

D. Partial submittals are not accepted and will be returned without review.

E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

3.3 OWNER'S ACTION

A. The Owner shall review each submittal and provide comments to the Architect to be incorporated as part of the Architect's review and approval process.

END OF SECTION

01770

CLOSE OUT PROCEDURES

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes:

1. Procedures for closeout submittals.
   a. Record Documents.
   b. Warranties and Guarantees.
   c. Operations and Maintenance Manual.
   d. Fire Underwriters Certification
   e. Administrative Requirements

2. Substantial Completion

3. Emergency Repairs

1.2 CLOSEOUT SUBMITTALS

A. After execution of Certificate of Substantial Completion, and prior to submittal of final application for payments, the Contractor shall submit the following documents to the Architect.

B. Record Documents.

1. Conformed Construction Drawings (as-built) in electronic Format
   a. Corrected Auto Cad (2009 or higher) of original construction documents reflecting changes from the original bid documents.
   b. Record Copy of each shop drawing or installation diagram
   c. Construction photographs in electronic format

C. Warranties and Guarantees:

1. Validated warranties for all equipment and materials specified in the contract documents
   a. Manufacturers warranties together with a list of all items of equipment or materials carrying warranty
   b. Contractor or installer warranties together with a list of all items of equipment or materials carrying warranty

2. Notarized Guarantees,
   a. Provide guarantees per form provided by the Owner for all equipment furnished
   b. additional specific guarantees required by the specification of the contract documents

D. Operations and Maintenance Manual:

1. Three (3) sets of Operating and Maintenance Manuals assembled and bound containing:
   a. Cut sheets and explanatory brochures of all equipment
   b. Wiring diagrams
   c. Operating instructions for all equipment.
   d. Maintenance instructions for all equipment and finishes.
   e. Warranty information for all equipment and finishes

E. Fire Underwriters Certification

1. Two (2) “original“ copies of fire underwriters certification where applicable.

F. Administrative Requirements

1. Contractor’s notarized affidavit that all payrolls, bills of material, equipment, and other indebtedness connected with the work have been paid.

2. Notarized certificates of Waiver of Liens for the Contractor, each subcontractor, each material supplier or persons furnishing materials or services to the project.

3. Consent of Surety to Final Payment

4. A complete list of all subcontractors, vendors and major material suppliers including:
   a. Address and phone numbers
   b. website and email contact information
   c. Name of individual to contact

1.3 SUBSTANTIAL COMPLETION

A. Prior to notifying the Architect that the project is complete according to the Contract Documents, the Contractor shall submit completed final punchlists, testing and balancing reports, any prefunctional checklists and functional test reporting required by the Contract Documents.

B. The Contractor shall submit three (3) copies of Certificate of Substantial Completion, A.I.A. Document G704.

1. A.I.A. Document G704 shall be provided by the Owner

1.4 EMERGENCY REPAIRS

A. During the valid warranty period, if the Contractor is unable or unwilling to respond immediately to make emergency repairs under conditions which the Owner may determine to be an emergency situation, the Owner reserves the right, and the Contractor recognizes such right, to make emergency repairs and then to bill the Contractor for a fair and reasonable amount of reimbursement for such repairs.

PART 2 – PRODUCTS – NOT USED

PART 3 – EXECUTION – NOT USED

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.
B. Extent of cast-in-place concrete work is shown on the drawings.
C. Products installed but not furnished under this section:

1. Sleeves and inserts.
2. Column anchor bolts and leveling plate.
3. Dovetail anchor slots.

D. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 5 Section “Structural Steel”.
2. Division 5 Section "Steel Deck" for steel deck construction.

1.3 SUBMITTALS

A. Submit the following for formal review and approval by the Architect according to Conditions of the Contract and Division 1 Specification Sections:

1. Product data for proprietary materials and items, including reinforcement and forming accessories, patching compounds, waterstops, joint systems, curing compounds, and others if requested by Architect.
2. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, laps and splices, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.

a. Show all walls and beams in elevation at 1/4” = 1’-0”, include sections and details as necessary to fully describe the work.

B. Submit the following for review and comment by the Architect according to Conditions of the Contract and Division 1 Specifications Sections. As a performance-based system, design responsibility rests with the Contractor.

1. Concrete mix designs and associated laboratory test reports, standard deviation calculations, materials test results and product data for admixtures.

    a. Submission of material certificates in lieu of material laboratory test reports will be permitted. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers stipulating the amount of chloride contributed to the mix by use of the admixture.

C. Submit the following for information only according Conditions of the Contract and Division 1 Specification Sections. The Architect will review but not approve or disapprove these submittals.

1. Joint systems.
2. Waterstops.
3. Reglets.
4. Vapor retarder.

D. Minutes of preinstallation conference.

1.4 QUALITY ASSURANCE

A. ACI Manual of Concrete Practice, including the following:

1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
2. ACI 318, "Building Code Requirements for Reinforced Concrete."
3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."

B. System Requirements - Formwork

1. Design Requirements:

    a. Establish necessary criteria for removal and reshoring of formwork.
    b. Design, engineering, construction and removal of formwork is solely the Contractor’s responsibility.

C. Concrete Testing Service: The Construction Manager will engage a testing agency acceptable to Architect to perform material evaluation tests and to design concrete mixes.

D. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at Contractor's expense.

E. Mockup: Cast mockup of textured finished face of concrete site retaining wall of size dictated by Architect or as required to demonstrate typical joints, form tie spacing, and proposed

surface finish, texture, and color. Maintain sample panel exposed to view for duration of Project, after Architect's acceptance of visual qualities.

1. Demolish mockup and remove from site when directed by Architect.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings" and the following:

1. At least 35 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:

a. Contractor's superintendent.
b. Agency responsible for concrete design mixes.
c. Agency responsible for field quality control.
d. Ready-mix concrete producer.
e. Concrete subcontractor.
f. Primary admixture manufacturers.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.
2. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms For Exposed Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms For Exposed Textured Finish Face of Concrete Retaining Wall: Units of face design, size, pattern, arrangement, and configuration to match Architect's control sample. Provide solid backing and form supports to ensure stability of textured form liners.

1. Products: Subject to compliance with requirements, provide the following:

    a. Splitface Running Bond Block Pattern #16971, manufactured by Fitzgerald Formliners.

D. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

E. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.

1. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615 Grade 60, deformed.

B. Reinforcing Bars for Welding: ASTM A706, Grade 60, deformed and weldable.

C. Steel Wire: ASTM A 82, plain, cold-drawn steel.

D. Welded Wire Fabric: ASTM A 185, welded steel wire fabric furnished in sheets.

E. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bartype supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I.

B. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.

1. Provide Class 1S aggregate for concrete footings, grade beams interior slabs. Provide Class 3S for concrete foundation walls, columns, retaining walls, and for other concrete exposed to weather. Provide Class 5S for exposed architectural concrete.
2. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
3. Fine aggregate: Natural sand with Fineness Modulas between 2.2 and 2.7.

C. Lightweight Aggregates: ASTM C 330.

D. Water: Potable.

E. Admixtures, General: Provide concrete admixtures that contribute not more than 0.1 percent water soluble chloride ions (by weight of cement) to the mix.

F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Air-Mix or Perma-Air, Euclid Chemical Co.
b. Darex AEA or Daravair 1000, W.R. Grace & Co.
c. MB-VR or Micro-Air, Master Builders, Inc.
d. Sika AER, Sika Corp.

G. Water-Reducing Admixture: ASTM C 494, Type A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eucon WR-75, Euclid Chemical Co.
b. Duracem-55, W.R. Grace & Co.
c. Pozzolith Normal or Polyheed, Master Builders, Inc.
d. Plastocrete 161, Sika Corp.

H. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eucon 37, Euclid Chemical Co.
b. WRDA 19 or Daracem, W.R. Grace & Co.
c. Rheobuild or Polyheed, Master Builders, Inc.
d. Sikament 300, Sika Corp.

I. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Accelguard 80, Euclid Chemical Co.

b. Daraset, W.R. Grace & Co.
c. Pozzutec 20, Master Builders, Inc.
d. Plastocrete 161, Sika Corp.

J. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eucon Retarder 75, Euclid Chemical Co.
b. Daratard-17, W.R. Grace & Co.
c. Pozzolith R, Master Builders, Inc.
d. Plastiment, Sika Corporation.

K. Calcium chloride is not permitted.

2.4 RELATED MATERIALS

A. Reglets: Where sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217 inch thick galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized sheet steel, not less than 0.0336 inch thick with bent tab anchors. Fill slot with temporary filler or cover face opening to prevent intrusion of concrete or debris.

C. Form Anchors, Hangers and Inserts:

1. Typical anchors:

a. Use standard types for Project conditions.
b. Minimum factor of safety: Comply with recommendations of ACI 347.

2. Inserts:

a. Wedge-type high grade malleable iron, complete with 3/4 inch diameter askewhead bolts, nuts and washers.
b. Provide other types to suit conditions.
c. Hot-dip galvanize metal inserts in accordance with ASTM B663.

3. Hangers inserts (spot type): Galvanized metal nits of type that finish flush with surface of concrete.

D. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:

1. Polyethylene sheet not less than 8 mils thick.

E. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq.

yd. (305 g/sq. m), complying with AASHTO M 182, Class 2.

F. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper.
2. Polyethylene film.
3. Polyethylene-coated burlap.

G. Liquid Membrane-Forming Curing Compound: Liquid-type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.55 kg/sq. m when applied at 200 sq. ft./gal (4.9 sq. m/L). Verify compatibility of curing compound with floor finish or other treatment to be applied afterwards. Supply evidence of compatibility to Architect.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eucocure, Euclid Chemical Co.
b. L&M Cure R, L&M Construction Chemicals, Inc.
c. Masterkure, Master Builders, Inc.
d. Kure-N-Seal, Sonneborn-Chemrex.

H. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.

1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.
2. Products: Subject to compliance with requirements, provide one of the following:

a. Super Aqua-Cure Vox, Euclid Chemical Co.
b. Dress & Seal WB, L&M Construction Chemicals, Inc.
c. Masterkure 100W, Master Builders, Inc.

I. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eucobar, Euclid Chemical Co.
b. E-Con, L&M Construction Chemicals, Inc.
c. Confilm, Master Builders, Inc.

J. Bonding Agent: Polyvinyl acetate or acrylic base.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Polyvinyl Acetate (Interior Only):

1) Euco Weld, Euclid Chemical Co.
2) Weld-Crete, Larsen Products Corp.

b. Acrylic or Styrene Butadiene:

1) SBR Latex, Euclid Chemical Co.
2) Daraweld C, W.R. Grace & Co. 3) Acryl-Set, Master Builders Inc.

K. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Euco Epoxy System #452 or #620, Euclid Chemical Co.
b. Concresive Standard Liquid, Master Builders, Inc.
c. Sikadur 32 Hi-Mod, Sika Corp.

L. Isolation Joint Filler: Fiber expansion joint filler as manufacturered by W. R. Meadows, Inc. or equal as acceptable to Architect.

M. Control/Construction Joints at Slab:

1. Metal load-transferring type complying with ASTM A525; 20 gage galvanized steel, shaped to form continuous tongue-and-groove load transferring key between concrete slabs; punched for doweling.
2. Precast concrete screed rails are acceptable alternate.
3. Provide complete with stakes and splice plates.
4. Locations: Interior concrete slabs on grade.
5. Acceptable products and manufacturers:

a. Form-A-Key by Cardinal Manufacturing Co.
b. Screed Key by Jahn Division of Superior.
c. Vulco Screed Key by Vulcan Metal Products, Inc.
d. Permaban Screed Rail by Permaban North America, Inc.

2.5 PROPORTIONING AND DESIGNING MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301.

B. For the trial batch method, use an independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

C. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Architect.

D. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:

1. 4000 psi, 28-day compressive strength; water-cement ratio, 0.44 maximum.
2. 3000 psi, 28-day compressive strength; water-cement ratio, 0.51 maximum.

E. Water-Cement Ratio: Provide concrete for following conditions with maximum watercement (W/C) ratios as follows:

1. Subjected to freezing and thawing: W/C 0.45.
2. Subjected to deicers/watertight: W/C 0.40.
3. Subjected to brackish water, salt spray, or deicers: W/C 0.40.

F. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
2. Reinforced foundation systems: Not less than 1 inch and not more than 3 inches.
3. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site-verified 2 - 3 inch slump concrete.
4. Other concrete: Not more than 4 inches.

G. Lightweight Structural Concrete: Lightweight aggregate and concrete shall conform to ASTM C 330. Proportion mix to produce concrete with the minimum strengths and/or other properties indicated on the drawings and a calculated equilibrium unit weight of 110 pcf plus or minus 3 pcf as determined by ASTM C 567. Concrete slump at the point of placement shall be the minimum necessary for efficient mixing, placing, and finishing. Provide air entrainment for concrete exposed to weather according to ACI 301 requirements.

1. Proportion mixes according to ACI 211.1 and ACI 301 to provide concrete with the following properties:

   a. Compressive Strength (28-Day): 4000 psi minimum.
   b. Minimum Cement Content: 660 lbs. per cubic yard.
   c. Maximum Unit Weight: 121 pcf (plastic density)
      115 pcf (air dry density)
   d. Slump: 4” prior to addition of HRWR; maximum 8” slump after addition of HRWR; measure slump at truck discharge.
   e. Air Content: 5.0 percent to 8.0 percent.

2. Pre-saturate light weight coarse aggregate by soaker hose, immersion in water, or vacuum chamber method. Minimum saturation time: 72 hours.

   a. Aggregate shall have a minimum absorbed moisture content (14% internal moisture content) as recommended by aggregate manufacturer prior to batching.

H. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in Work.

2.6 ADMIXTURES

A. Use water-reducing admixture in all concrete. Use high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability, subject to the acceptance of the Architect.

B. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F.

C. Use air-entraining admixture in exterior exposed concrete. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1 percent within the following limits:

1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:

   a. 5.0 percent for 3/4 inch maximum aggregate.
   b. 5.5 percent for 1/2 inch maximum aggregate.

2. Other concrete not exposed to freezing, thawing, or hydraulic pressure: 2 to 4 percent air.

D. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.

1. Addition of water to the batch will not be permitted for material with insufficient slump.
2. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
3. Batch Tickets: Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

3.2 FORMS

A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:

1. Provide Class A tolerances for concrete surfaces exposed to view.
2. Provide Class C tolerances for other concrete surfaces.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.

D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.3 VAPOR RETARDER INSTALLATION

A. General: Place vapor retarder sheeting in position with longest dimension parallel with direction of pour.

B. Lap joints 6 inches and seal with manufacturer's recommended mastic or pressuresensitive tape.

3.4 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.

1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect.

D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Lap adjoining sheets of WWF at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Architect.

B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.

C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise.

D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

E. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's printed instructions.

F. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

G. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-ongrade to form panels of patterns as shown. Use saw cuts 1/8 inch wide by one-fourth of slab depth or inserts 1/4 inch wide by one-fourth of slab depth, unless otherwise indicated.

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/4" wide joints into hardened concrete when cutting action will not tear, abrade, or otherwise damage surface and before development of random contraction cracks.

   a. Perform sawcutting with "Soff-cut" system using rigid straightedge, to a depth of 1-1/4" as soon as possible after final finishing and not later than 2 hours after the last finishing operation.

2. Premolded Joints: Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
3. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
4. If joint pattern is not shown, provide joints not exceeding 15 ft. in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
5. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

3.6 INSTALLING EMBEDDED ITEMS

A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.

B. Install dovetail anchor slots in concrete structures as indicated on drawings.

C. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

D. Equipment Bases and Foundations:

1. Provide machine and equipment bases and foundations as indicated.
2. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

E. Sleeves and Pipes Passing Through Concrete Elements:

1. Locate and place penetrating items following restrictions shown on structural drawings.
2. Do not cut, bend or displace reinforcement; install additional reinforcing at all penetrations.
3. Do not place items between concrete surface and reinforcement.

4. Do not place items with outside diameter more than 1/3 slab thickness horizontally in slabs.

3.7 PREPARING FORM SURFACES

A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, formcoating compound before placing reinforcement.

B. Do not allow excess form-coating material to accumulate in forms or come into contact with reinforcing steel or in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

1. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.8 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Provide testing/inspection agency 24 hours notice to inspect reinforcing steel after reinforcing steel is in place. Concrete placement shall not commence until reinforcing placement has been approved. Where there is a delay in depositing concrete, reinforcement shall be reinspected and, when necessary, cleaned.

C. Before placing concrete, debris shall be removed from spaces to be occupied by concrete and forms thoroughly oiled or wetted as herein before specified. In inaccessible spaces, debris shall be removed by compressed air or vacuum cleaners.

D. Protect moisture retarder from damage before and during concrete placement.

E. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.

F. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

G. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into

preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

H. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.

1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
3. Maintain reinforcing in proper position on chairs during concrete placement.
4. Where finish floor flatness/levelness is specified at F_F-20/F_L-20 or less, bullfloats may be used after screeding. For flatness/levelness greater than F_F-20/F_L-20, straightedges shall be used to smooth and straighten the surface, instead of bullfloats. Use highway straightedges with minimum length of 10 feet.

I. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   a. Concrete shall be maintained continuously at this temperature or higher for period of seven days or until concrete has attained 75% of it's design strength. In no case shall temperature protection be discontinued earlier than three days after concrete placement.
   b. Heat in conjunction with proper enclosure, shall be used to maintain temperatures in accordance with ACI 306; accelerating/anti-freeze admixture may be used as an added measure to protect concrete from freezing and maintain minimum temperatures.
   c. Temperatures shall be taken from surface to concrete at least three (3) times per 24-hour period.
   d. Minimum temperatures for pouring; 20 deg. F and rising. Preheat forms two hours prior to pouring.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

J. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F. Mixing water may be chilled or chopped ice may be used to control

temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

3.9 FINISHING FORMED SURFACES

A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

C. Smooth-Rubbed Finish: Provide smooth-rubbed finish on scheduled concrete surfaces that have received smooth-formed finish treatment not later than 1 day after form removal.

1. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Grout-Cleaned Finish: Provide grout-cleaned finish on scheduled concrete surfaces that have received smooth-formed finish treatment.

1. Combine one part portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard portland cement and white portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.
2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 MONOLITHIC SLAB FINISHES

A. General

1. Verify with each trade type of slab finish required for areas to receive applied finishes such as: epoxy terrazzo, ceramic or slate tile, resilient flooring, paint and other types of floor finishes.
2. Some of these finish flooring materials will require fine broom finish, scratch finish, power or hand float finishes or steel trowel finishes.
3. Do not proceed with slab finishes until types of finishes required are verified with trades involved.

B. Scratch Finish: Apply scratch finish to monolithic slab surfaces where required for applied finishes such as concrete floor topping or mortar setting beds for tile, portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.

1. After placing slabs, finish surface to flatness/levelness tolerances to of F_F 15 (floor flatness) and F_L 13 (floor levelness) measuredaccording to ASTM E 1155.
2. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

C. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and as a final finish for slabs to receive certain types of flooring or water proofing such as membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to flatness/levelness tolerances of F_F 18 (floor flatness) and F_L 15 (floor levelness) measured according to ASTM E 1155.
2. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

D. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with certain types of flooring such as resilient flooring, carpet, paint, or another thin film-finish coating system.

1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to flatness/levelness tolerances of F_F 20 (floor flatness) and F_L 17 (floor levelness) measured according to ASTM E 1155.
2. Grind smooth any surface defects that would telegraph through applied floor covering system.

E. Trowel and Fine Broom Finish: Certain types of flooring such as ceramic or quarry tile that is to be installed with thin-set mortar, require a trowel finish as specified, followed immediately by slightly scarifying the surface with a fine broom.

F. Floor Finishes Tolerances

1. Levelness F_L tolerances specified shall not apply to slabs which are elevated, or otherwise supported (i.e., structural) that require shoring or similar formwork during construction.

G. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.12 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

C. Curing Methods: Cure concrete by curing compound, by moist curing, by moistureretaining cover curing, or by combining these methods, as specified.

D. Provide moisture curing by the following methods:

1. Keep concrete surface continuously wet by covering with water.

2. Use continuous water-fog spray.
3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4 inch lap over adjacent absorptive covers.

E. Provide moisture-retaining cover curing as follows:

1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

F. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:

1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

G. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

H. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.

1. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

3.13 SHORES AND SUPPORTS

A. General: Comply with ACI 347 for shoring and reshoring and as specified.

B. Extend shoring from ground to roof for structures four stories or less.

C. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to support work without excessive stress or deflection.

D. Keep reshores in place a minimum of 15 days after placing upper tier, or longer, if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

3.14 REMOVING FORMS

A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.15 REUSING FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Architect.

3.16 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.

B. Mix dry-pack mortar, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.

1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
2. For surfaces exposed to view, blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Architect.
4. Repair defective areas, except random cracks and single holes not exceeding 1 inch (25 mm) in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4 inch (19 mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

E. Perform structural repairs with prior approval of Architect for method and procedure, using specified epoxy adhesive and mortar.

3.17 QUALITY CONTROL TESTING AND INSPECTION DURING CONSTRUCTION

A. General: The Owner will employ a testing agency to perform tests and inspections, and to submit reports.

B. Formwork and Reinforcing Steel Inspection

1. Inspect formwork prior to concrete placement for conformance to Shop Drawings, specified tolerances, and to verify that forms are free of foreign material.

C. Sampling and testing for quality control during concrete placement will may include the following, unless directed otherwise by Architect.

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below, when 80 deg F and above, and one test for each set of compressive-strength specimens.
d. Compressive Strength Tests: ASTM C39, a compressive strength test is defined as a test on two cylinders cast at the same time from a given batch of concrete and tested at the same age. The strength test result shall be the average value of the two tests.
e. Compression Test Specimens: ASTM C31, prepare one(1) set of six (6) standards cylinders for each days pour up to 50 cu. yd. of each class of concrete placed in any one day. Mold and store cylinder for laboratory-cured test specimens.
f. Field-cured Specimens: When tests of field-cured specimens are required by the Architect of Building Official or are desired by the Contractor for purposes of early strength determination for formwork removal, they shall be in addition to the numbers of laboratory-cured specimens called for above.
g. Testing of Specimens: For each set of compression test specimens called for above, perform one strength test (two (2) specimens) at seven (7) days, one (1) strength test (two (2) specimens) at 28 days and retain the remaining two specimens for later testing if required.

2. When frequency of testing specified above will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
3. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
5. Strength level of concrete will be judged on the 28-day strength tests and will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.

D. Submit reports in writing to Architect, Structural Engineer, ready-mix producer, and Contractor within 24 hours after performance. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

1. Formwork and reinforcing steel inspection reports shall state compliance, or if noncompliance was observed, whether corrections were made.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

F. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION

SECTION 033510
SPECIAL CONCRETE FLOOR FINISHES:
DRY POLISHED CONCRETE SURFACES

1.1 SUMMARY

A. Section Includes: All equipment labor, tools and training for the contracted work.
B. Base Bid:
   1. Polished Concrete – Floorcare USA/L&M-FGS PermaShine Dry Concrete Polishing System at designated areas.
   2. Five resin-bound, sequential diamond grit passes, last grit level to be determined by owner. Additional passes may be required if floor does not meet floor finish criteria.
   3. Two coat application of penetrating sealer/hardener/densifier FGS Hardener Plus.
   4. Alternate: Dyed & Polished Concrete. Contractor shall provide an alternate price for Dyed & Polished Concrete in lieu of polished concrete.
C. Related Sections: 03 30 00 Cast-in-place concrete
   1. Minimum concrete compressive strength of 23MPa (3500 psi)
   2. Normal weight concrete and no lightweight aggregate
   3. Non-air entrained
   4. Natural concrete slump of 114.3 to 127-mm (4.5 to 5 in.) admixtures may be used.
   5. Flatness requirements: ASTM International E115; minimum (laser screed installed is preferred to achieve best results)
      a. Overall FF50 or higher
      b. Local FF35 or higher
      c. Overall FL not required
      d. Local FL not required
   6. Tight hard troweled (three passes) concrete. No burn marks. Reference American Concrete Institute (ACI) 302.1 R, Guide for Concrete Floor and Slab Construction, class 5 or class 6 floor.
   7. Curing options
      a. ASTM International C 309, Standard Specification for liquid membrane-forming compounds for curing concrete. Preferred curing compound: L&M Cure
      b. No acrylic curing and sealing compounds
      c. ASTM C 171, Standard Specification for sheet materials for curing concrete.
      d. Damp curing, seven-day cure; with concrete being properly cured at optimum temperatures and atmospheric conditions if in a controlled environment (high water to cement mix ratio design MUST BE AVOIDED)
   8. Confirmation of minimum concrete specifications being met
      a. GC or Concrete Contractor must provide concrete polisher

written confirmation from independent, 3rd party test firm that the slab meets minimum stated guidelines and quality standards prior to implementing polishing process.

1. Section 07 92 16 Semi-Rigid Joint Sealants

D. Allowances: Refer to Section 01 21 00 for allowances involving the work in this section.

1.2 REFERENCES

A. Valid and current certificate of training for FGS PermaShine installer
B. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute
C. ACI 301 – Specifications for Structural Concrete for Buildings; American Concrete Institute
D. ACI 302.1R – Guide for Concrete Floor and Slab Construction; American Concrete Institute
E. ASTM C 779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces, procedure A.
F. ASTM E 1155 - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers; 1996
G. NFSI Test Method 101-A - National Floor Safety Institute Standard for evaluating high traction flooring materials, coatings and finishes. www.nfsi.org.

1.3 SUBMITTALS

A. General: Submit in accordance with Section 01 33 00
B. Product Data:
    1. Submit manufacturer's descriptive literature and product technical data sheet, product specifications and Material Safety Data Sheets (MSDS) for each product.
    2. Submit a letter of certification from the National Floor Safety Institute confirming the system has been tested and passed phase two level of certification when tested by method 101-A.
    3. Preparation and concrete grinding procedures.
    4. Confirm two applications of the FGS Hardener Plus liquid.
    5. Joint filing, crack repair and/or surface repair products and protocols.
    6. Maintenance Data: provide data on maintenance renewal of applied treatments.
    7. Colored Concrete, Dye selection guides.
    8. Current Certified FGS PermaShine Installer documentation.

C. Shop Drawings:
    1. Indicate typical layout including dimensions and floor grinding schedule.
    2. Plan view of the floor and joints clearly marked for the work and the sealer.
    3. Indicate areas to receive colored surface treatment.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualification: Company specializing in products and procedures specified in this Section with three years experience.

B. Installer Qualifications: Acceptable to Manufacturer with documented current FGS certificate and performance on projects of a similar nature.

C. Mock up
    a. Construct mock-up area under conditions similar to those which will exist during actual placement, at least 100 square feet, with curing methods and treatments applied.
    b. Locate where directed.
    c. Mock-up may remain as part of the Work if satisfactory and protected from damage.

D. Protection: The Concrete floor finish is the final finish. General Contractor responsible for, but not limited to:
    a. Protect from all petroleum stains during construction
    b. Diaper all hydraulic powered equipment.
    c. Do not park vehicles on inside slab.
    d. No pipe cutting machines will be used on inside floor slab.
    e. Do not place reinforcing steel on interior slab, to avoid rust stains.
    f. Do not use acids or acidic detergents on slab.
    g. Inform all trades that the slab is to be protected at all times.
    h. Mechanically scrub floor with approved cleaner, FGS Conditioner, once a day for 7 days immediately prior to final acceptance per floor system manufacturer.

1.5 PRE-INSTALLATION MEETING

A. General contractor will convene all parties and conduct pre-installation meeting in accordance with Section 01 31 00.

B. Convene pre-installation meeting a minimum of seven days prior to placement of concrete for work of this section. Assure purchase of specified materials for fielding sample work or mock- ups.

C. Review Pre-installation Check list.

1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with requirements of Section 01 65 00 and Section 01 66 00.

B. Protect packaging and product and from damage, loss and freezing.

C. General Contractor shall assure proper materials and amounts have been procured and applied to the project. Written confirmation shall be submitted prior to issuance of warranty.

1.7 WARRANTY

A. Comply with provisions of Section 01 78 00.
B. Warrant installed units to be free from defects in material and workmanship for one year.
C. Include coverage for the use of FGS Conditioner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Floorcare USA and L&M Construction Chemicals, Inc. 14851 Calhoun Road, Omaha, NE 68152 Toll Free (800) 362-3331, 402-453-6600, www.lmcc.com, www.fgs-permashine.com
B. Substitutions: Not permitted

2.2 MANUFACTURERS AND PRODUCTS

A. Acceptable Products and Manufacturers:

1. FGS Hardener Plus, liquid type, hardener, sealer, and densifier by L&M Construction Chemicals, Inc. Omaha, NE
2. Joint Tite 750, plural component, polyurea polymer, semi-rigid joint filler by L&M Construction Chemicals, Inc. Omaha, NE
3. Petrotex, Oil repellent sealer by L&M Construction Chemicals, Inc. Omaha, NE
4. Vivid Concrete Dyes, by L&M Construction Chemicals, Inc. Omaha, Nebraska.
5. FGS Concrete Conditioner, liquid type, by L&M Construction Chemicals, Inc., Omaha, Nebraska.

B. Substitutions: Not permitted

2.3 EQUIPMENT

A. Only as approved by the L&M/FGS system manufacturer.
B. Includes: Elliptical and/or planetary grinding and polishing equipment
C. High Performance, Pulse vacuum units, with heppa filters.
D. Mechanical plural component pumps for joint and crack filler material.

2.4 FINISHES

The degree of polish and finish level, as well as the number of passes to be

determined by condition of the floor and by the Approved Applicator and the owner's representative on field mock up.
Levels of possible finish to be determined: i.e.,

(Note to specifier: Select one of the following, depending upon aesthetic requirements. Finish appearance greatly influenced by the condition and the quality of the concrete finish.)

A. 800 grit finish- Low Gloss
B. 1500 grit finish- Medium Gloss
C. 3000 grit finish- High Gloss
D. Two applications of FGS Hardener Plus liquid as applied by certified FGS installers after final polish step is completed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions and proceed with work in accordance with Section 01 71 00
B. Verify that concrete surfaces are acceptable to receive the work of this section.Concrete shall have been cured a minimum of 28 days, or shall attain a minimum of 3,500 psi prior to beginning any part of the L&M/FGS system. Exceptions must be confirmed in writing by L&M /FGS System manufacturer.

3.2 PREPARATION

A. Examine the surface to determine soundness of the concrete for polishing
B. Remove all surface contamination to permit effective polishing

3.3 FLOOR FINISHING

A. Finish concrete floor surfaces in accordance with ACI 302.1R. Paragraph 8.3.11. Class 5 and class 6 floors.
B. Concrete surfaces that are scheduled to be polished require a hard steel-trowel finish (three passes) during placement.

3.4 FLOOR SURFACE TREATMENT

A. Install FGS Hardener Plus in accordance with manufacturer's printed instructions.
B. Install with dry polishing and airborne concrete dust-free conditions.

3.5 FIELD QUALITY CONTROL

A. General: Comply with requirements of Section 01 45 00
B. Inspection by manufacturer's representative for proper installation

3.6 ADJUSTMENTS:

The following may incur additional charges over and above the contract amount.

A. Polishing to higher gloss as the work requires
B. Filling of joints to ensure smooth traffic passage over joints

3.7 CLEANING

A. Prior to final acceptance, the FGS Treated floor shall be mechanically scrubbed for seven days with soft to medium pads (white or red pads) with approved cleaning solution.
B. Cleaning solution is FGS Concrete Conditioner liquid by L&M Construction Chemicals, Inc. Omaha, NE.

3.8 ALTERNATE FOR DYED AND FGS POLISHED CONCRETE

A. All the above information applies to this application.
B. Special attention needs to be made for transition from dyed and polished concrete to other finishes. A straight-line transition shall occur in these areas. Verify the exact location for the demarcation line.
C. Procedure for dyed polished concrete
    a. Polish concrete to one step prior to final finish level. (i.e., 400 grit resin level if the final desired finish is 800 grit.) See section 2.04.
    b. Apply selected diluted L&M Vivid Dyes to concrete prior to final polish and finish level.
    c. Allow dye to dry. Remove residue with dry mechanical buffer. Reapply as necessary for desired result.
    d. Commence final polishing step to obtain desired gloss level.
    e. Apply two coats of hardener/sealer/densifier, FGS HARDENER PLUS, in accordance with manufacturer's written instructions.

END OF SECTION

1: GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including Division 1 Specification section, apply to work of this section.

1.2 SUMMARY

A. Section includes:

1. Concrete unit masonry

1.3 QUALITY STANDARDS

A. Provide experienced, well-trained workers competent to complete the work as specified.

B. Unless approved by the Architect, provide all related products and accessories from one manufacturer.

1.4 UNIT MASOMRY STANDARDS

A. Comply with ACI 530.1/ASCE 6 "Specifications for Masonry Structures," except as otherwise indicated.

B. System Performance Requirements:

1. Provide unit masonry that develops the installed compressive strengths (f'm) indicated.

1.5 SUBMITTALS:

A. Product data for each different masonry unit including accessory and manufactured product.

1.6 EVALUATION CRITERIA:

A. Mortar composition and properties will be evaluated per ASTM C 780.

B. Grout compressive strength will be tested as per ASTM C 1019.

1.4 MATERIALS HANDLING

A. Provide all materials required to complete the work as shown on drawings and specified herein. Deliver, store, and transport materials to avoid damage to the product or to any other work. Return any products or materials delivered in a damaged or unsatisfactory condition. Materials and products delivered will be certified by the manufacturer to be as specified.

B. Store masonry off the ground, protected from dirt, ground moisture, contaminants, and weather.

1.5 PRECONSTRUCTION PROJECT PREPARATION

A. Examine and verify that job conditions are satisfactory for speedy and acceptable work. Use agreed schedule for installation and for Architect's field observation.

PART 2 – PRODUCTS

2.1 CONCRETE MASONRY UNITS:

A. General: Comply with requirements indicated below apllicable to each form of concrete masonry unit required

B. Concrete unit masonry units shall comply with ASTM standards: Concrete bricks, ASTM C55. Hollow load-bearing units, ASTM C90. Hollow non-load-bearing units, ASTM C129. Solid load-bearing units, ASTM C145.

C. Grades and types: Hollow, load-bearing units Grade N, Type I, Medium Weight for exterior. Hollow, load-bearing units Grade S, Type II, Lightweight for interior.

D. Pattern and sizes shown on the Drawings. Nominal size: 8" x 16" units as shown on drawings.

2.2 MORTAR AND GROUT MATERIALS

A. As follows:

1. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for coldweather construction. Provide natural color or white cement as required to produce required mortar color.
2. Masonry Cement: ASTM C 91.
3. For colored pigmented mortars, use premixed colored masonry cements of formulation required to produce color indicated.
4. For colored aggregate mortars, use masonry cement of natural color or white as required to produce mortar color indicated.
5. Hydrated Lime: ASTM C 207, Type S.
6. Aggregate for Mortar: ASTM C 144, except for joints less than 1/4 inch use aggregate graded with 100 percent passing the No. 16 sieve.
7. White Mortar Aggregates: Natural white sand or ground white stone.
8. Colored Mortar Aggregates: Ground marble, granite, or other sound stone, as required to match Architect's sample.
9. Aggregate for Grout: ASTM C 404.

2.3 MORTAR AND GROUT MIXERS:

A. Do not add admixtures unless otherwise indicated. Do not use calcium chloride in mortar or grout.

B. Mortar for Unit Masonry:

1. ASTM C 270, Proportion Specification, for types of mortar indicated below:

2. ASTM C 270, Property Specification for job-mixed mortar and ASTM C 1142 for ready-mixed mortar, of types indicated below:

PART 3 -- CONSTRUCTION AND INSTALLATION

3.1 WORK PREPARATION AND CONDITIONS

A. Complete work in a timely fashion, without interferring with , or delaying the work of other trades

B. Prepare all work according to the applicable codes and regulations and the standards and specifications of the Masonry Institute of America

C. Moisture and climate control shall be as per standards of the Masonry Institute of America

D. Prepare a work layout to establish and assure correct course and openings. Space and coordinate expansion/cpntraction joints to match building frame and thru-joints.

E. Use raked or struck joints for interior and / or weather protected walls

3.2 UNIT MASONRY INSTALLATION AND MORTAR APPLICATION

A. Install metal ties for bonding as per details and reference trade standards. Assure compliance inm types, sizes, spacing, depth of anchoring an corrosion resistance

B. Install reinforcing as per details and refernce trade standards

3.3 GROUTING

A. Complete required building department inspections of masonry before grouting. Complete grout mix testing and certification before grouting.

B. Install inserts, anchors bolts, straps, dowels and bars as per detail drawings

C. Follow grout manufactures instructions for grouting, vibration, rodding, and protection when stopped Work for an hour or more

3.4 PARGING AND WATERPROOFING

A. Parge and waterproof where shown in the drawings, Use waterproofing manufacturer’s recommended curing procedures.

3.5 WORK PROTECTION AND CLEANING

A. Clean all surfaces and work area prior to work shifts and immediately upon completion,

B. Prrotect tops of uncompleted wall sections at the end of each full work shift

3.6 REPAIR AND TOUCH-UP

A. After installation, inspect all work for improper installation or damage. Repair or replace any work damaged during installation. Make repair work undetectable.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 1 Specification Sections, apply to this Section.

B. Related Specification Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section “Quality Control” for independent testing agency procedures and administrative requirements.
2. Division 3 Section “Reinforced Concrete.”
3. Division 4 Section “Unit Masonry” for masonry anchors.
4. Division 9 Section “Painting” for surface preparation and priming requirements.

1.2 SUMMARY

A. Extent of structural steel work is shown on drawings, including schedules, notes and details to show size and location of members, typical connections and type of steel required.

B. Products furnished but not installed under this section:

1. Anchor bolts for installation into masonry or concrete.
2. Loose base plates and bearing plates set on masonry or concrete.
3. Loose lintels.

1.3 SUBMITTALS

A. Submit the following for formal review and approval by the Architect according to Conditions of the Contract and Division 1 Specification Sections:

1. Product Data: Submit manufacturer's specifications and installation instructions for the following products:
   a. High-strength bolts (each type), including nuts and washers.
   b. Structural steel primer paint.
   c. Shrink resistant non-metallic grout.
   d. Composite metal shear studs.

2. Shop Drawings:
   a. Prepared under direct supervision of registered professional engineer, including:

1) Complete erection drawings, details and schedules for fabrication and shop assembly of members,
2) Details, schedules, procedures and diagrams showing sequence of erection.

b. Indicate profiles, spacing and locations of members, including:
1) Fabrication details.
2) Size and weight of members.
3) Location of shop and field connections.
4) Locations and details of anchors, base/bearing plates and leveling plates.
5) Details of holes, cuts, camber and splices.
6) Layout and location of composite shear studs.
7) Identify high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.

c. Indicate welds by standard AWS A2.1 and A2.4 symbols distinguishing between shop and field welds; and show size, length and type of each weld.

d. Provide setting drawings, templates and directions for installation of anchor bolts and other anchorage to be installed as work by other sections.

e. Obtain detailed drawings of the Work by other trades including locations and sizes of openings in floors and roofs and the Work requiring holes in structural steel, mounting brackets, and supports attached to the structural steel.

f. Submit shop drawings in the phases, to coordinate with requirements of the Work. Identify phasing of the Work in Submittal Schedule as required by General Conditions and Supplementary Conditions.

3. Test Reports: Submit copies of required quality control test reports and inspections specified including tests conducted on shop and field bolted and welded connections. Include data on type(s) of tests conducted and test results.

B. Submit the following for information only according to Conditions of the Contract and Division 1 Specification Sections. The Architect will review but not approve or disapprove these submittals.

1. Mill Certificates: Provide fabricator's certification that the structural steel furnished for this Project complies with the requirements of the Contract Documents.

2. Mill Test Reports: Provide certified mill test reports of chemical analysis and physical test for each heat number of structural steel.

3. Welder's Certificates: Provide welder's certificates for welders employed for this Work, veriflying current AWS qualifications.

4. Galvanized Steel: Certification that steel to be galvanized contains elements within the ranges listed below: a. carbon < 0.25%
b. phosphorus < 0.05%
c. manganese < 1.35%
d. silicon within the range 0 to 0.04% or 0.15 to 0.25%

5. Qualification Data: Submit fabricator and installer qualifications verify years of successful experience; including list of completed projects with similar scope of work identified by name, location, date, Architect and Structural Engineer and their phone numbers.

1.4 PERFORMANCE REQUIREMENTS

A. Interface with other systems:

1. Coordinate primer with finish paint and fireproofing.

2. Provide templates and instructions for installing anchors in other Work.

B. Structural Performance: Engineer structural steel connections required by the Contract Documents to be selected or completed by the fabricator to withstand design loadings indicated.

C. Source Quality Control: Materials and fabrication procedures are subject to inspection and tests in mill, shop and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the latest editions of the following, except as otherwise indicated:

1. AISC Manual of Steel Construction - ninth edition (ASD) including the AISC "Code of Standard Practice for Steel Buildings and Bridges." except the following:
   a. Paragraph 4.2.1 of the above code is hereby modified by deletion of the following sentence: "This approval constitutes the owner's acceptance of all responsibility for the design adequacy of any connections designed by the fabricator as a part of this preparation of these shop drawings".
   b. Section 7.9 of the above code is hereby deleted.

2. AISC "Allowable Stress Design Specification for the Design, Fabrication and Erection of Structural Steel for Buildings", including "Commentary" and Supplements thereto as issued.

3. AISC "Specifications for Architecturally Exposed Structural Steel".

4. AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.

5. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel".

6. ASTM A6 “General Requirements for Delivery of Rolled Steel Plates, Shapes, sheet Piling and Bars for Structural Use”.

7. Hot-dip galvanizing fabrication practices: Conform to the requirements of ASTM A143, A384 and A385 unless otherwise specified.

8. SSPC “Steel Structures Painting Manual”.

B. Designer/Engineer Qualifications: Connections not specifically detailed on the Contract Drawings are to be designed under the direct supervision of a Registered Professional Engineer, licensed in the Project jurisdiction, specializing in structural steel engineering.

C. Installer Qualifications: Minimum fo 5 years documented, successful experience with work comparable to the Work of this Project.

D. Fabricator Qualifications: Company specializing in structural steel fabrication having a minimum of 5 years documented, successful experience with work comparable to the Work of this Project.

E. Galvanizing Applicator: Company specializing in hot-dip galvanizing after fabrication having a minimum of 5 years documented, sucessful experience and approved by the manufacturer and/or fabricator.

F. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

1. If recertification of welders is required during extent of this Project, retesting will be Contractor's responsiblity.

1.6 CONNECTION DESIGN AND MEMBER DETAILING

A. Member Detailing and Design of Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site without causing delay in the work.

1. Promptly notify Architect whenever design of members and connections for any portion of structure are not clearly indicated.

B. Design connections as “Framed Beam Connections: in accordance with Part 4 of the AISC Manual, except as otherwise indicated.

1. For noncomposite beams, reaction shall be end reaction on member, as defined in the AISC “Uniform Loaded Beam Tables”, or reaction shown on the Drawings, whichever is greater.

2. For composite beams, use reaction shown on the Drawings.

3. Single sided connections for spandrel beams are not acceptable.

4. Bolts: A325 or A490. Connections may be designed using Type N Bolts, except at hanger connections and where other slip-critical connections (designated as SC) are indicated on the Drawings; design slip-critical connections using Type SC bolts.

C. Shop and Field Connections:

1. Shop connections are to be welded unless indicated otherwise on the Drawings.

2. Bolt field connections with high-strength bolts except where welded connections or other connections are indicated.

3. Bolts: 3/4 inch diameter minimum.

4. Fillet welds: 1/4 inch minimum, unless otherwise noted.

D. Except where seated connections are shown or required, frame beams and girders into columns. Reinforce beam webs at seated connections for stability and to prevent buckling.

E. Moment Connections:

1. Where a moment connection is noted on plans, provide a moment connecton at the beam to column connection or supporting beam to beam framing connection.

2. Unless noted otherwise or as a wind moment connection, the moment connection is to develop the full strength of the beam in bending. Use plates, top and bottom of the beam, to accomplish development.

3. Cantilevers require full moment connections “thru” column or supporting beam, unless beam rides over supporting member or column.

4. For moment connections “thru” columns, add beam stiffener plates minimum 3/8 inches thick. When the beam is parallel to the column web, the stiffener plates are to be equal to the flange thickness of the column and installed in line with the column flanges. When the beam is perpendicular to the column web, the stiffener plates are to be equal to the web thickness and installed in line with the column web. In addition, when beam is perpendicular to the column web, install column cap plate stiffeners equal to the column web thickness. The cap plate stiffeners are to be installed on both sides of the column web in line with the beam web.

5. Where a moment connection is indicated at a beam to beam connection, the supporting beam is to be continuous and a full moment and shear connection provided for the terminated beam.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site at such intervals to insure uninterrupted progress of work.

1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.

B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry or attached to other construction, in ample time to not-delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Do not store materials on the structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8 TEMPORARY BRACING

A. The steel erector/contractor is responsible for the design, strength, adequacy, safety and means and methods of construction of shoring and temporary bracing of Structural Steel Work at all stages of erection, until such time that permanent members and construction are in place and final connections are completed.

1.9 PROJECT CONDITIONS

A. Field verify all existing measurements and elevations prior to beginning fabrication process. Architect will not review or take responsibility for any existing dimensions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Metal Surfaces, General: For fabrication of work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names and roughness in accordance with the AISC “Specifications for Architecturally Exposed Structural Steel”. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.

B. Structural Steel Shapes, Plates and Bars: ASTM A 36.

C. Structural Steel Tubing:

1. Cold-Formed: ASTM A 500, Grade B.
2. Hot-Formed: ASTM A501.

D. Pipe: ASTM A53, Type E or S, Grade B.

E. Carbon-Steel Castings: ASTM A 27, Grade 65-35, medium-strength carbon steel.

F. High-Strength Steel Castings: ASTM A 148, Grade 80-50.

G. Headed Stud-Type Shear Connectors: ASTM A108, Grade 1015 through 1020, forged steel, headed-stud type, uncoated cold-finished carbon steel, AWS D1.1, Type B.

H. Bolts, Nuts, and Washers:

1. Unheaded Rods: ASTM A 36 (ASTM A 36M).

2. Unheaded Rods: ASTM A 572, Grade 50 (ASTM A 572M, Grade 345).

3. Anchor bolts: ASTM A307, nonheaded type unless otherwise indicated.

4. Standard threaded fasteners:
   a. Plain washers: ANSI B27.2, Type A.
   b. Beveled washers: ANSI B27.4.
   c. Nuts and bolts: ASTM A307, Grade A.

5. High-Strength Threaded Fasteners: Quenched and tempered medium-carbon steel.
   a. Bolts: Heavy hexagon ASTM A325.
   b. Nuts: Heavy hexagon ASTM A563, Grade DH.
   c. Washers: Hardened ASTM F436.
      (1) beveled at channel flanges

6. Direct Tension Indicator Fasteners: Load indicator washers to conform to ASTM F959, or tension control bolts may be used.

I. Electrodes for Welding: Comply with AWS Code.

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

J. Structural Steel Primer Paint: SSPC - Paint 13.

1. Acceptable products:
   a. Glidden 5205 Glid-Guard Red Alkyd Metal Primer.
   b. Southern Coatings Enviro-Guard Heavy Duty Primer 1-2900.
   c. Con-Lux Ferrox 25.
   d. MAB Rust-O-Lastic Shop Primer Red Alkyd 24-R-181 or Rust-Oleum 7669.

2. Where faying surfaces of slip-critical joints are permitted by Architect to be painted, provide Class A paint (providing a minimum slip coefficient of 0.33) in accordance with Test Method to Determine Slip Coefficient for Coatings used in Bolted Joints, in Appendix A of the RCSC Specification for Structural Joints. Manufacturer's certification shall include a certified copy of the test report.

K. High Performance Primer Paint: Polyurethane coating system equivalent to Series 66 Hi-Build Epoxoline by Tnemec Company, Inc. to receive epoxy field coat as specified in Section 09900.

L. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds and repair painting galvanized steel, complying with Military Specifications DOD-P-21035 (Ships) or SSPCPaint-20.

M. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404, Size No. 2. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

N. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and

water-reducing agents, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time.

1. Pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives.

2. Acceptable products:
   a. Euco N.S. by Euclid Chemical Co.
   b. Five Star Grout by Five Star Grout Corp.
   c. Masterflow 713 by Master Builders.

2.2 FABRICATION

A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final approved shop drawings. Provide camber in structural members where indicated.

B. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.

C. Where finishing is required, complete structural steel assemblies, including welding of units, before starting shop-priming of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs and other defects.

D. Fabricate architecturally exposed structural steel with exposed surfaces smooth, square, and free of survface blemishes, including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness.

1. Remove blemishes by filling, grinding, or by welding and grinding, prior to cleaning, treating , and shop priming.

2. Comploy with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for architecturally exposed structural steel.

E. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded.

F. Finishing: Accurately mill ends of columns and other members trnasmitting loads in bearing.

G. Shear Connectors: Prepare steel surfaces as recommended by manufactuerer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and mnaufacturer's printed instructions.

H. Connections:

1. Welded Connections: Comply with AWS D1.1 Code for procedures, appearance and quality of welds and methods used in correcting welding work.
   a. Join members with continuous welds, except where bolted connections are indicated.
   b. Stress relieve welded assemblies by heat treatment.
   c. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.
   d. Grind welds smooth.

2. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds 1/2 inch and larger. Grind flush butt welds. Dress exposed welds.

3. Bolted connections: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints Using ASTM A325 or A490 Bolts" (RCRBSJ).
   a. Shear-bearing connections: Bolts in connections not within slip-critical category, nor subject to tension loads, nor required to be fully tensioned bearing type connections shall be installed in properly aligned holes, tightened to snug-tight condition. Snug-tight condition is defined as tightness that exists when all plies in a joint are in firm contact. This may be attained by a few impacts of an impact wrench or full effort of a man using an ordinary spud wrench.
   b. Slip-critical Connections: Connections subject to direct tension, and fully pretensioned bearing connections, fasteners, together with washers of size and quality specified, shall be installed in properly aligned holes and tightened by one of methods described in Subsections 8(d) (1) through 8(d) (4), of referenced standard, to at least minimum tension specified when all fasteners are tight.

I. Bolt field connections, except where welded connections or other connections are indicated.

1. Provide high-strength threaded fasteners for all bolted connections, except where unfinished bolts are indicated.

J. Holes for Bolted Connections and Other Work:

1. Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on final shop drawings.

2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning.

3. Drill holes in bearing plates.

4. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.

K. Masonry Anchors:

1. Provide anchors welded to steel columns and beams for support of masonry abutting and masonry adjacent to structural steel.

2. Space anchors 24 inches on center vertically for columns and 32 inches on center horizontally for beams.

3. Acceptable product: Equivalent to No. 315 by Heckmann Building Products.

4. Coordinate with Work of Section 4810 UNIT MASONRY in welding channel slots for masonry anchorage to steel.

2.3 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel indicated for galvanizing according to ASTM A 123.

B. Fabricate structural steel in accordance with Class I, II, or III guidelines as described in AGA's Recommended Details for Galvanized Structures.

C. Use fabrication practices for products in accordance with applicable portions of ASTM A143, A384 and A385, except as specified herein. Avoid fabrication techniques which could cause distortion or embrittlement of steel.

D. Consult Architect regarding potential warpage problems or potential handling problems during the galvanizing process which may require modification of design before fabrication proceeds.

E. Remove welding slag and burrs prior to delivery for galvanizing.

F. Provide holes and/or lifting lugs to facilitate handling during the galvanizing process that are suitable to Architect and fabricator.

G. Remove, by blast cleaning or other methods, surface contaminants and coatings which would not be removable by normal chemical cleaning process in galvanizing operation.

H. Application of Coating:

1. All exterior exposed structural steel shall be galvanized including all exterior wall lintels.

2. Steel members, fabrications and assemblies: Comply with ASTM A123.

3. Bolts, nuts and washers and iron and steel hardware components: Comply with ASTM A153.

4. Coating weight: Conform with paragraph 5.1 or ASTM A123 or Table 1 of ASTM A153, as appropriate.

5. Provide post-galvanizing treatments as recommended by AGA for conditions applicable to Work.

2.4 SHOP FINISH

A. Shop Painting:

1. General: Shop paint structural prime steel, except those members or portions of members as otherwise specified the following:
   a. Do not paint surfaces which are to be field welded or high-strength bolted in slip-critical type connections.
   b. Do not paint members or portions of members which are shown to be embedded in concrete.
   c. Do not paint surfaces which are shown to receive sprayed-on fireproofing.
   d. Do not paint top flange surfaces of beams to receive composite metal shear studs. e. Galvanize surfaces.

2. Surface Preparation: After inspection and before shipping, clean steelwork to be painted. Remove loose rust, loose mill scale and spatter, slag or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) as follows: a. SP-1 "Solvent Cleaning".
   b. SP-3 "Power Tool Cleaning".

3. Painting: Immediately after surface preparation, apply structural steel primer paint in accordance with Manufacturer's instructions and at a rate to provide dry film thickness of not less than 1.5 mils. Use painting methods which result in full coverage of joints, corners, edges and exposed surfaces.
   a. Apply 2 coats of paint to surfaces which are inaccessible after assembly and erection. Change color of second coat to distinguish it from first.
   b. Paint embedded steel which is partially exposed on exposed portions and initial 2" of embedded areas only.

B. Shop Painting Galvanized Metal with High Performance Paint:

1. Clean by SSPC-SP1 "Solvent Cleaning", followed by SSPC-SP2 "Hand Tool Cleaning" or SSPC-SP3 "Power Tool Cleaning" to remove oil and grease, soil, cement spatter, and other surface dirt.

2. Cleaned surfaces are to be rinsed thoroughly, and allowed to dry completely before coating.

3. Apply prime coat as soon as possible after cleaning. Provide smooth, uniform dry film thickness of 4.0 to 6.0 mils.

2.5 SHOP QUALITY CONTROL

A. Contractor's Responsibilities:

1. Visual inspection:
   a. Perform visual inspection of all welds.

b. Inspect bolted connections in accordance with AISC Specifications for “Structural Joints Using ASTM A325 or A490 Bolts”.

2. Repair all discrepancies in dimensional tolerances of connection assembly and defects requiring corrective procedures.

B. Testing and Inspection Agency Responsibilities:

1. Shop Welding: Inspect and test during fabrication of structural steel assemblies, as follows:
   a. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
   b. Perform visual inspection of all welds.
   C. In addition to visual inspection, shop-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency’s option.
      (1) Liquid Penetrant Inspection: ASTM E 165.
      (2) Magnetic Particle Inspection: ASTM E 709, performed o roof pass and on welded finish. Cracks or zones of incomplete fusion or penetration will not be accepted.
      (3) Radiographic Inspection: ASTM E 94 and ASTM E 142, minimum quality level “2-2T”
      (4) Ultrasonic Inspection; ASTM E 164

2. Shop-bolted connections will be tested and inspected according to RCSC’s “Specification for Structural Joints Using aSTM A 325 or A 490 Bolts.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and adjoining construction, and conditions under which Work is to be installed. Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Surveys: Employ a registered professional engineer or land surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies in writing to Architect within 48 hours. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with Architect.

B. Temporary Shoring and Bracing:

1. The steel structure is a self-supporting steel frame and is dependent upon diaphragm action of the metal roof deck and an attachment to a series of moment frames for stability and for resistance to wind and seismic forces.

2. Provide temporary supports required for stability and for resistance to wind and seismic forces until these elements are complete and are capable of providing this support.

3. Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads.

4. Do not remove temporary members and connections until permanent members are in place, final connections are made and concrete slabs are cured.

5. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds.

C. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete work.

D. Setting Base and Leveling/Bearing Plates:

1. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces.

2. Clean bottom surface of base and bearing plates.

3. Set loose and attached base plates and bearing plates for structural members on wedges, shims, or setting nuts, or other adjusting devices.

4. Tighten anchor bolts after supported members are positioned and plumbed.

5. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or leveling/bearing plate prior to packing with grout.

6. Pack non-shrink grout solidly between bearing surfaces and bases or plates so that no voids remain. Comply with grout manufacturer's instructions.

3.3 ERECTION

A. Field Assembly:

1. Set structural frames accurately to lines and elevations indicated.

2. Align and adjust various members forming part of complete frame or structure before permanently fastening.

3. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly.

4. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

5. Level and plumb individual members of structure within specified AISC tolerances.

6. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.

7. Splice members only where indicated and accepted on final approved shop drawings.

8. Complete field connections prior to loading member.

9. On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

10. Do not enlarge unfair holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

11. Gas Cutting: Do not use gas thermal cutting torches in field during erection for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members which are not under stress, as acceptable to the Architect. Finish gas-cut sections equal to a sheared appearance when permitted.

12. Direct Tension Indicator: Bolts shall be installed in all holes of the connection and brought to snug tight condition. All fasteners shall then be tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners prior to final twist-off or yielding of the control or indicator element of the individual devices. Proper tensioning of the bolts may require more than a single cycle of systematic tightening.

B. Comply with AISC Specifications for bearing, adequacy of temporary connections, alighment and removal of paint on surfaces adjacent to field welds.

C. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

1. Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.

D. Touch-Up Galvanizing:

1. Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

3.4 FIELD QUALITY CONTROL

A. The Construction Manager will engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.

B. Testing agency shall conduct and interpret tests and state in each report whether test specimens and Work evaluated comply with requirements, and specifically state any deviations therefrom.

1. Reports:
   a. Provide daily written reports.
   b. Describe areas inspected.
   c. Note problems.
   d. Describe compliance with Contract Documents.
   e. Include tests conducted and results.

C. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.

D. Testing agency may inspect structural steel at plant before shipment; however, Architect reserves right, at any time before final acceptance, to reject material not complying with specified requirements.

E. Correct deficiencies in structural steel work which inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as may be necessary to reconfirm any non-compliance of original work, and as may be necessary to show compliance of corrected work.

F. Structural steel erection shall be inspected while the Work is in progress.

1. Field Bolted Connections: General
   a. The torque of 10 percent of the bolts, but not less than 2 bolts, selected at random in each connection are to be tested with an inspecting wrench calibrated with the job torque.
   b. Load indicator washers delivered for use in a specific application are to be tested at the job site to demonstrate that they do, in fact, provide a proper indication of bolt tension, and that they are properly used by the bolting crews.
   c. Bolts together with the load indicator washer plus any other washers required by Specification should be installed in all holes of the connection and the bolts tightened to approximately one-half the specified tension. Only after the initial tightening operation should the bolts be fully tensioned in a systematic manner.
   d. The use of load indicator washers are to be observed by the inspection agency at the job site and the devices and the installation procedure routinely monitored during the work in progress to assure that the specified procedure is followed.

2. Slip-critical or direct tensioning connections:
   a. Observe calibration procedures for specific fastener tightening method employed;
   b. Monitor installation of bolts to determine that plies of connected material have been drawn together;
   c. Assure that accepted tightening procedure is subsequently followed to achieve minimum fastener pretension.

3. Connections which are not slip-critical or in direct tension:
   a. Assure that plies of connected elements have been brought into snug contact (usually attained by a few impacts of an impact wrench or full effort of a man using an ordinary spud wrench);

b. Assure that washers are used in outer plies of slotted holes or as otherwise required.

4. Visually inspect field welds for conformance with AWS criteria and the Drawings, except as follows:
   a. Full penetration welds done in the field shall be inspected by ultrasonic testing.

5. Visually inspect composite steel stud welds and perform bend tests in accordance with AWS D1.1, Section 7.8.

6. Inspect metal deck installation, fasteners, openings, etc., for conformance with approved Shop Drawings.

G. Testing agency shall confirm that the structure is square, plumb and level in accordance with AISC tolerances.

END OF SECTION

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 Summary

A. Section includes Kawneer Architectural Aluminum Windows including perimeter trims, stools, accessories, shims and anchors, and perimeter sealing of window units.
   1. Types of aluminum windows include:
      a. Kawneer Series 8400TL Thermal Windows
      b. Model 8410TL Fixed Window
      c. 4" (101.6 mm) frame depth
      d. AW-PG100-FW

1.3 Definitions

A. Definitions: For fenestration industry standard terminology and definitions refer to American Architectural Manufactures Association (AAMA) – AAMA Glossary (AAMA AG).

1.4 Performance Requirements

A. General Performance: Aluminum-framed window system shall withstand the effects of the following performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Window System Performance Requirements:

   1. Performance Requirements: Provide aluminum windows of performance indicated that comply with AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS)
      a. Performance Class and Grade: AW-PG100-FW

   2. Air Infiltration: The test specimen shall be tested in accordance with ASTM E 283 at a minimum window size of 60" x 99" (1524 x 2515 mm). The air infiltration rate shall not exceed 0.10 cfm/ft^2 at a static air pressure differential of 6.24 psf (300 Pa).

   3. Water Resistance: The test specimen shall be tested in accordance with ASTM E 547 and ASTM E 331 at a minimum window size of 60" x 99" (1524 x 2515 mm). There shall be no leakage as defined in the test method at a static air pressure differential of 12 psf (574 Pa).

   4. Uniform Load Deflection: A minimum static air pressure difference of 100 psf (4788 Pa) shall be applied in the positive and negative direction in accordance with ASTM E 330. There shall be no deflection in excess of L/175 of the span of any framing member.

   5. Uniform Load Structural Test: A minimum static air pressure difference of 150 psf (7182 Pa) shall be applied in the positive and negative direction in accordance with ASTM E 330. The unit shall be evaluated after each load.

   6. Component Testing: Window components shall be tested in accordance with procedures described in AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS).

   7. Thermal Transmittance Test (U-Factor): When tested in accordance with AAMA 1503, the conductive thermal transmittance (U-Factor) shall not be more than .48 BTU/hr/sf/°F or (___) BTU/hr/sf/°F per AAMA 507 or NFRC 100 when using project specified glass.

   8. Condensation Resistance Test (CRF): When tested in accordance with AAMA 1503 with 1" (25,4 mm) insulating clear glass, the condensation resistance factor shall not be less than (CRF_f 67) frame and (CRF_g 66) glass.

   9. Sound Performance: When tested in accordance with ASTM E 90 and E 413, the sound transmission loss (STL) shall not be less than 39.

   10. Thermal Barrier Tests: Testing shall be in general accordance with AAMA 505 Dry Shrinkage and Composite Thermal Cycling test procedure, AAMA TIR-A8, Structural Performance of Composite Thermal Barrier systems.

1.5 Submittals

A. Product Data: Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.

B. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances and installation details.

C. Samples for Initial Selection: For units with factory-applied color finishes including samples of hardware and accessories involving color selection.

D. Samples for Verification: For aluminum windows and components required.

E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for each type, class, grade, and size of aluminum window. Test results based on use of downsized test units will not be accepted.

1.6 Quality Assurance

A. Installer Qualifications: An installer which has had successful experiences with installation of the same or similar units required for this project and other projects of similar size and scope.

B. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by inclusion of test reports, and calculations.

C. Source Limitations: Obtain aluminum windows through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of aluminum windows and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements." Do not modify size and dimensional requirements.
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup for type(s) of window(s) indicated, in location(s) shown on Drawings.

F. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 Project Conditions

A. Field Measurements: Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 Warranty

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty.
   1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by manufacturer.

B. Insulating Glass: Warranted to be free from defects (excluding breakage) for a period of five (5) years.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Basis-of-Design Product:
   1. Kawneer Company Inc.
   2. Series 8400TL Thermal Windows
   3. Model 8410TL Fixed Window
   4. 4" (101.6 mm) frame depth
   5. AW-PG100FW

.Substitutions: Refer to Substitutions Section for procedures and submission requirements.
   6. Pre-Contract (Bidding Period) Substitutions: Submit written requests ten (10) days prior to bid date.
   7. Post-Contract (Construction Period) Substitutions: Submit written request in order to avoid window installation and construction delays.
   8. Product Literature and Drawings: Submit product literature and drawings modified to suit specific project requirements and job conditions.
   9. Certificates: Submit certificate(s) certifying substitute manufacturer (1) attesting to adherence to specification requirements for window system performance criteria, and (2) has been engaged in the design, manufacturer and fabrication of aluminum windows for a period of not less than ten (10) years. (Company Name)
   10. Test Reports: Submit test reports verifying compliance with each test requirement required by the project.
   11. Samples: Provide samples of typical product sections and finish samples in manufacturer's standard sizes.

B. Substitution Acceptance: Acceptance will be in written form, either as an addendum or modification, and documented by a formal change order signed by the Owner and Contractor.

2.2 Materials

A. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070" (1.78 mm) wall thickness at any location for the main frame and sash members.

B. Thermal Barrier:
   1. Thermal Barrier: The thermal barrier shall be Kawneer IsoLock™ with a nominal 3/8" (6.5 mm) separation consisting of a two-part, chemically curing high density polyurethane which is mechanically and adhesively bonded to the aluminum.

C. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.

D. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

E. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

F. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

2.3 Window System

A. Series 8400TL Thermal Windows - Fixed Window.

2.4 Glazing

A. Glass and Glazing Materials: Refer to Division 08 Section “Glazing” for glass units and glazing requirements applicable to glazed aluminum window units.

B. Glazing System: Glazing method shall be a wet/dry type in accordance with manufacturer’s standards. Exterior glazing shall be silicone back bedding sealant. Interior glazing shall be snap-in type glazing beads with an interior gasket in accordance with AAMA 702 or ASTM C864.

2.5 Hardware

A. General: None required.

2.6 Accessories

A. General: None required.

2.7 Fabrication

A. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fit joints; make joints flush, hairline and weatherproof.
3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

B. Window Frame Joinery: Mitered and mechanically clipped and/or staked, factory sealed frame and vent corner joints.

C. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

D. Fabricate aluminum windows that are re-glazable without dismantling sash or framing.

E. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

F. Sub frames: Provide sub frames with anchors for window units as shown, of profile and dimensions indicated but not less than 0.093-inch (2.4-mm) thick extruded aluminum. Miter or cope corners, and join with concealed mechanical joint fasteners. Finish to match window units. Provide sub frames capable of withstanding design loads of window units.

G. Factory-Glazed Fabrication: Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section “Glazing” and with AAMA/WDMA/CSA 101/I.S.2/A440-08 (NAFS).

H. Glazing Stops: Provide snap-on glazing stops coordinated with Division 08 Section “Glazing” and glazing system indicated. Provide glazing stops to match frame.

2.8 Aluminum Finishes

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Factory Finishing:

1. Kawneer Permanodic™ AA-M10C21A31, AAMA 611, Architectural Class II Clear Anodic Coating (Color #17 Clear) (Standard).

PART 3 - EXECUTION

3.1 Examination

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, levelness of sill plate and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weather tight window installation.
   1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
   2. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches (76.2 mm) of opening.
   3. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.

B. Install aluminum framed window system level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weather tight construction.

D. Install aluminum framed window system and components to drain condensation, water penetrating joints, and moisture migrating within system to the exterior.

E. Separate aluminum from dissimilar materials to prevent corrosion or electrolytic action at points of contact.

3.3 Field Quality Control

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
   1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows shall take place as follows:
   1. Testing Methodology: Testing Standard shall be per AAMA 502 including reference to ASTM E 783 for Air Infiltration Test and ASTM E 1105 for Water Penetration Test.
      a. Air Infiltration Test: Conduct test in accordance with ASTM E 783 at a minimum uniform static test pressure of 1.57 psf (75 Pa) for CW or 6.24 psf (300 Pa) for AW. The maximum allowable rates of air leakage for field testing shall not exceed 1.5 times the project specifications.
      b. Water Infiltration Test: Water penetration resistance tests shall be conducted in accordance with ASTM E 1105 at a static test pressure equal to 2/3 the specified water test pressure.
   2. Testing Extent: Architect shall select window units to be tested as soon as a representative portion of the project has been installed, glazed, perimeter caulked and cured. Conduct tests for air infiltration and water penetration with manufacturer's representative present.
   3. Test Reports: Shall be prepared according to AAMA 502.

3.4 Adjusting, Cleaning, And Protection

A. Adjust operating sashes, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weather tight closure. Lubricate hardware and moving parts.

B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

C. Clean glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.

D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

E. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

DISCLAIMER STATEMENT

This guide specification is intended to be used by a qualified construction specifier. The guide specification is not intended to be verbatim as a project specification without appropriate modifications for the specific use intended. The guide specification must be used and coordinated with the procedures of each design firm, and the particular requirements of a specific construction project.

END OF SECTION 085113

PART 1 -- GENERAL

1.1 WORK

A. Provide and install wood framing and finish carpentry as shown on the Drawings and as specified herein. Work includes all connectors, and related hardware and materials.

B. Provide and install Cedar wood decking and cedar wood fence on roof level as shown on drawings.

B. Where additional instructions are required, work shall be as directed by the Architect.

1.2 SUBMITTALS

A. Provide all tests, certificates, and affidavits necessary to verify materials are as specified.

1.3 QUALITY STANDARDS AND TOLERANCES

A. Provide a work force that is sufficient in number for the quantity of work and time schedule. Workers shall be skilled, trained, experienced, and competent to do the work as specified.

B. Unless otherwise directed by the Architect, all work shall be as per building code and the Manual for Wood Frame Construction, American Forest and Paper Association (NFPA), National Design Specifications for Wood Construction of the NFPA, Plywood Specifications and Grade guide of the American Plywood Association.

C. Tolerances: Vertical framing shall be plumb within 1/4" per 10 linear feet and horizontal framing shall be level within 1/4" per 10 linear feet.

D. Moisture content of framing lumber shall be 19% or less by weight. Tests will be conducted on all newly shipped lumber to confirm moisture content. Kiln-dried or other lumber requiring lower moisture content shall be as specified.

E. Follow applicable lumber grading agency standards in accepting or rejecting delivered lumber. Reject special, required lumber that is not marked and certified as preservative-treated or kiln-dried.

1.4 MATERIALS HANDLING AND STORAGE

A. Reject any delivered framing lumber that is not grade-stamped and certified by a bona fide grading agency. Identify framing lumber by grade, and store each grade separately.

B. Do not accept or use lumber that deviates from grade standards or has excessive moisture content or other defects. Remove unstamped or defective lumber from the job site.

C. Handle lumber to avoid damage during transport, unloading, and moving on the job site. Handle chemically treated lumber and panels strictly according to manufacturer's instructions.

D. Store framing lumber and wood panels to prevent damage and moisture absorption. Store metal connectors that are subject to damage in weathertight wrapping and in safe locations away from traffic or other sources of damage. Store chemically treated lumber and wood panels outdoors until installation. Keep chemically treated lumber and wood panels well ventilated if moved indoors.

PART 2 -- MATERIALS

2.1 FASTENERS, CONNECTORS, AND SUPPORTS

A. Use hot-dip galvanized steel for exterior, high humidity, and treated wood locations.

B. Nails shall be common wire or spike nails as shown on nailing schedule. Follow all nail size requirements and nail spacings required by the governing building code.

C. Power-driven nailing: Comply with standards of the International Staple, Nail and Tool Association.

D. Machine bolts shall comply with ASTM A307. Lag bolts to comply with Federal Spec FF-N-1. Drill holes 1/16" larger than bolt diameters. Use washers under all nuts and bolt heads.

E. Hangers, connectors, and crossbridging shall be:

"Teco, Simpson, or equal as approved by the Architect."

2.2 LUMBER

A. S4S, S-Dry unless otherwise indicated, grade marked complying with the following:

Girder framing species and grade: #1 and #2 common spruce

Joist framing species and grade: #1 and #2 common spruce

Studs (2 to 4 inches thick or wide, 10 feet in length or shorter) Grade: "Stud" or No. 3 Structural Light Framing.

Non-structural light framing species and grade:
: Grade: Standard or better. No Utility grade.

Sill boards: Pressure treated or redwood sill grade.

Structural light framing: No. 2 or better.

Lumber for miscellaneous applications shall be Standard grade unless noted otherwise.

B. Wood Decking materials: 5/4 x 6” Coomon grade Cedar planks.

C. Wood Fence materials: Commom cedar w/alternating pickets 6’-0” high.

2.3 SHEATHING AND UNDERLAYMENT: MATERIALS

A. Sheathing and underlayment:

Plywood sheathing: Use APA rated, PS-1 or APA PRP-108.

Particleboard: Exterior Type 2-M.

Hardboard: ANSI/AHA A135.6.

Oriented Strand Board (OSB).

Subflooring: APA rated plywood sheathing, Exterior Grade.

Roof sheathing: APA rated plywood, Exterior Grade.

Underlayment: APA rated underlayment, Exterior; or Particleboard, Oriented Strand Board, or waferboard with waterproof resin binder.

B. Related construction and materials:

Sill gasket atop foundation wall: Glass fiber strip with width equal to plate.

Sill flashing: Galvanized steel or aluminum.

Subfloor glue: APA AFG-01, solvent base, waterproof.

Building paper: No. 15 asphalt felt (or spun-bonded polyethylene).

Vapor barrier: 6 mil polyethylene.

Termite shield: Galvanized sheet steel or aluminum.

2.4 WOOD TREATMENT

A. Provide wood preservative as follows:

Type: Penetrating waterproof sealant

Color: clear

Pressure treatment: AWPA Treatment C.

Waterborne preservative with 0.25 percent retainage, rated for specific uses noted on Drawings.

PART 3 -- INSTALLATION

3.1 WOOD FRAMING: PREPARATION AND PRECONSTRUCTION

A. Examine and verify that job conditions are satisfactory for speedy and acceptable work.

B. Maintain and refer to the latest trade standards. Coordinate and complete rough plumbing before starting framing. Crosscoordinate plumbing, electrical, and HVAC requirements with framing plan.

C. Identify actual dimensions of all required rough openings in framing.

D. Provide framing and shoring plan and schedule. Provide lifts or cranes to assist high-level framing. Verify that materials are stored so as to not overload or interfere with construction.

3.2 ROUGH CARPENTRY, WOOD FRAMING -- AT GRADE AND FOUNDATIONS

A. Apply termite prevention where untreated wood will be within 8" of finish grade of soil. Use foundation grade or preservative-treated lumber near soil or where otherwise potentially exposed to moisture.

B. Completed mudsills shall be straight with a side variation tolerance of 1/4" per 10 linear feet and level within 1/4" per 10 linear feet.

3.3 ROUGH CARPENTRY, FRAMING MEMBERS

A. Install all framing members as per framing plan, details, and building code requirements.

B. Install joist hangers as per Drawings, manufacturer's instructions, and building code requirements.

3.4 SUBFLOOR SHEATHING

A. Install plywood subflooring as per framing drawings and building code requirements.

B. Glue and secure subflooring to floor joists with screw-type nails. Subfloor-to-joist connections must be sufficient to totally prevent any squeaking of flooring. Floor squeeking will be remedied as directed by the architect at the contractor's expense.

C. Completed subflooring shall be level within 1/4" per 10 linear feet. Free of depressions or humps and patched to repair holes, splits, or construction damage.

3.5 SHEATHING, SIDING, AND FINISH-UP WORK

A. Install plywood shear wall construction as per the Drawings and as required by building code. Install wall sheathing panels so that edges have full bearing on framing. Include 1/8" expansion joints between sheathing panels.

B. Prepare plywood surfaces for paint or stain according to paint or stain manufacturer's instructions.

3.6 WOOD FRAMING: COORDINATION

A. Coordinate electrical stub-ups with the framing plan. Coordinate girders, floor joists, and stud walls with plumbing, HVAC ducts and vents. Recess floor joists to allow for changes in floor elevations and surfaces.

B. Supply and coordinate in-wall fixture and equipment supports such as in-wall blocking, anchors, brackets, grounds, curbs, and other supports.

C. Install plaster grounds as detailed and as per trade association standards.

D. Provide joints and connectors at non-wood construction to allow for shrinkage, expansion and other movement of the wood. Provide clearances between framing and other construction that may be subject to differential movement.

E. Set and prepare framing as required for tile or other waterproof wall finishes. Provide waterproofing sealing as detailed. Prepare framing for waterproof finishes where waterproofing required.

F. Combine thermal insulation with framing as shown on Drawings.

G. Combine soundproofing with framing as shown on Drawings. Install sound barrier materials, gaskets, and clips as per manufacturers' instructions. Do not allow any sound transfer connections within soundproof party wall construction.

H. Provide fire protection facilities and all necessary fire protection precautions during construction. Install required concealed fireproofing such as under enclosed stairs. Provide openings for inspection of concealed work before closing in.

3.7 WOOD FRAMING: BETWEEN PHASES AND AT CONCLUSION OF FRAMING

A. Check and verify correctness of each stage of framing before installing subsequent framing: Remove all unusable wood scraps from site weekly at minimum and between each phase of framing. Call for Architect and/or building department inspection before closing up concealed work.

3.8 FASTENERS, CONNECTORS, AND SUPPORTS: INSTALLATION

A. Where not shown on nailing schedule, nails shall penetrate not less than 1/2 the length of nail. Exception: 16d nails may connect two pieces of 2" thickness. Remove and replace split framing members.

B. Use nailing machines or power hammers according to manufacturer's requirements. Provide correct sizes and types of nails for use in nail guns.

C. Check and tighten all bolt connections after they're installed. Recheck and retighten all bolt connections before final construction is completed.

D. Install joist hangers and bridging as per Drawings and manufacturer's instructions.

END OF SECTION

08100

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Provide hollow metal doors and frames, and interior partition window frames, as indicated and specified herein.

1. Included are hollow metal doors, and frames, reinforcement for hardware and weather-stripping.

B. Related Work Specified Elsewhere.

1. Finish Hardware. Section 8

2. Glass and Glazing. Section 8

3. Sealants and Caulking. Section 7

1.3 QUALITY ASSURANCE

A. Provide doors and frames complying with the Steel Door Institute Recommended Specifications for Standard Steel Doors and Frames' (SDIlOO) and as herein specified.

B. Field Measurements. Take field measurements to ensure proper fitting of the work. Allow for trimming and fitting.

C. Inserts and Anchorages. Furnish inserts, reinforcing members and anchoring devices which must be attached to metal stud and drywall partitions or built into masonry for the installation of metal frames and related work. Provide setting drawings, instructions and directions for installation of anchoring devices. Coordinate delivery with other work to avoid delay.

1.4 SUBMITTALS

A. Shop drawings shall show fabrication and erection of hollow metal work. Include details of each frame type, elevation of door design types, conditions at openings, details of construction, locations and installation requirements of finish hardware and reinforcements, and details of joints and connections. Provide fabrication, erection and anchorage details showing anchorage and accessory items.

B. Catalogue data shall include finishes and other descriptive data.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work cartoned or crated to provide protection during transit and job storage.

B. Inspect hollow metal work upon delivery for damage. Remove and replace damaged items.

C. Store hollow metal units on raised platforms in vertical positions with blocking between units to allow air circulation. Keep stored material covered and protected from damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Hot-Rolled Steel Sheets and Strip

1. Commercial quality carbon steel, pickled and oiled, complying with ASTM A569-72 and ASTM A568-74.

B. Cold-Rolled Steel Sheets

1. Commercial quality carbon steel, complying with ASTM A366-72 and ASTM A568-74.

C. Galvanized Steel Sheets

1. Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A526-71, with 1.25 oz. commercial zinc coating, mill phosphatized, complying with ASTM A525-73.

D. Supports and Anchors

1. Fabricate of not less than 16 gauge sheet steel. Galvanize after fabrication units to be built into exterior walls, complying with ASTM A153-73, Class B.

E. Inserts, Bolts, and Fasteners

1. Manufacturer's standard units, except hot-dip galvanized items to be built into exterior walls, complying with ASTM A153-73, Class 0 or D as applicable.

F. Shop-Applied Paint

1. For steel surfaces, use rust-inhibitive enamel or paint, either air-drying or baking, suitable as a base for specified finish paints.

2. Paint galvanized surfaces with zinc dust-zinc oxide primer.

2.2 FABRICATION, GENERAL

A. Fabricate hollow metal units to be rigid, neat in appearance and free from defects, warp, or buckle. Accurately form metal to required sizes and profiles. Fit and assemble units in the manufacturer's plant. Weld exposed joints continuously, grind, dress, and make smooth, flush, and invisible. Metallic filler to conceal manufacturing defects is not acceptable.

B. Exposed Fasteners

1. Unless otherwise indicated, provide countersunk flat Phillips or Jackson heads for exposed screws and bolts.

C. Finish Hardware Preparation

1. Prepare hollow metal units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 "Specifications for Door and Frame Preparation".

2. Reinforce hollow metal units to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.

3. Locate finish hardware as shown on final shop drawings, or if not shown, in accordance with "Recommended Locations for Builders' Hardware", published by the National Builders' Hardware Association.

D. Shop Painting

1. Clean, treat, and paint surfaces of fabricated hollow metal units, including galvanized surfaces, whether concealed or exposed in the finished work.

2. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before the application of the shop coat of paint.

3. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive field-applied paint.

2.3 HOLLOW METAL DOORS

A. Provide 1-3/4" thick, seamless hollow metal doors complying with SDI 100, minimum materials, sound insulation, reinforcements and construction requirements.

B. Form doors of 18 gauge cold-rolled steel sheets with stretcher lever degree of flatness.

2.4 HOLLOW METAL FRAMES

A. Provide hollow metal frames of the types and styles indicated on the drawings or schedules and complying with SDI 100, for minimum materials, reinforcements, anchors, and construction requirements; minimum 16 gauge with welded reinforcement for door closers..

B. Provide hollow metal frames for doors and windows as shown on the drawings. Conceal all fastenings unless otherwise shown.

C. Fabricate frames of fully welded construction for exterior applications, and for interior window frames in gypsum partitions.

D. Fabricate door frames knocked-down, for field assembly at interior applications in gypsum drywall partitions.

E. Form exterior frames of hot dip galvanized steel sheets with stretcher level degree of flatness, and either cold or hot rolled sheet steel for interior.

1. Gauge: not less than 14, for exterior openings, and interior openings greater than 4'-0" wide.

2. Gauge: not less than 16, for interior openings up to 4'-0" wide.

F. Head Strut Supports. Where partitions extend to roof construction above, provide 3/8" x 2" vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to construction at each jamb. Bend top of struts to provide flush contact for securing to support construction above. Provide adjustable bolted anchorage to frame jamb members.

G. Rubber Door Silencers. Drill stops to receive three silencers on strike jambs of single-swing frames and four silencers on heads of double-swing frames. Install plastic plugs to keep holes clear during construction.

H. Plaster Guards. Provide 26 gauge steel plaster guards or mortar boxes, welded to the frame, at the back of all finish hardware cutouts where mortar or other materials might obstruct hardware operation.

I. Weatherstripping. Apply to al exterior door head and sill frame stops no. 91 extruded bronze housing by Zero Weatherstripping Co. Inc. or approved equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which door and frames and related items are to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install hollow metal units and accessories in accordance with the final shop drawings, manufacturer's data, and as specified herein.

B. Setting Anchorage Devices. Provide anchorage devices where required for securing hollow metal frames to in-place to exterior metal stud framing and EIWS construction.

C. Placing Frames

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

a. In exterior EIWS construction, locate at least three wall anchors per jamb at hinge and strike levels. Coordinate with Hardware Supplier.
b. At in-place EIWS construction, set frames and secure in place with machine screws and proper anchorage devices, as required with framing and blocking components.
c. In metal stud partitions, install at least three wall anchors per jamb at hinge and strike levels. In closed steel stud partitions, attach studs to wall anchors with tapping screws.

D. Door Installation

1. Fit hollow metal doors accurately in their respective frames, within clearances specified in SDI 100 and 105.

2. Finish hardware installation is specified under Finish Hardware and Carpentry sections.

3.3 FINAL ADJUSTMENTS

A.. Check and readjust operating finish hardware items in hollow metal work just prior to final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames which are warped, bowed or otherwise damaged.

3.4 PRIME COAT TOUCH-UP, CLEANING, AND REMOVALS

A. Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

D. Clean exposed surfaces of doors, frames and hardware, touch-up minor scratches and other finish imperfections using materials and methods recommended by the door and frame manufacturer.

C. Remove from the project site all debris resulting from the work of this section.

END OF SECTION

08700-01 GENERAL

1.1 Applicable provisions of Divisions C and Division 1 govern this section.

8700-02 SCOPE

2.1 See General Conditions, Article 1.13 and 1.2 and modifications thereto.

2.2 Architect will select the Finish Hardware and Contractor shall include in his base proposal the cost to purchase and install the frame.

A. The contractor's cost shall include the cost of packing, tagging, delivery to Site and all sales or use taxes.

2.3 This work includes, but is not limited to, the following:

A. All door hardware installed on all doors and frames.

B. Weather-stripping of exterior doors in hollow metal frames.

C. Exterior thresholds – all doors to the exterior.

08700-03 RELATED WORK SPECIFIED ELSEWHERE

3.1 Rough Hardware – provided and installed under "ROUGH CARPENTRY".

3.2 Installation of Finish Hardware included under "FINISH CARPENTRY".

3.3 Hardware for windows provided and installed under "ALUMINUM WINDOWS".

3.4 Hardware for aluminum doors installed under "ALUMINUM FRAMES AND ENTRANCES".

3.5 Hardware for any cabinets specified will be provided under "FINISH CARPENTRY".

3.6 Weather-stripping of aluminum entrance doors provided and installed under "ALUMINUM FRAMES AND ENTRANCES".

3.7 Electric door openers at front entrance (and elsewhere if required) as specified Under “ELECTRICAL”.

08700-04 HARDWARE

4.1 Generally, hardware will include both concealed and surface-mounted type closing Devices, panic locks, cylinder locks, door bumpers and holders, together with Standard hardware devices.
All lock cylinders are to be provided under this Section.

4.2 Provide templates for hinges, locksets and other necessary information for Reinforcing and attaching to various items to receive hardware.

08700-05 PACKING, MARKING, RECEIVING

5.1 Each item of hardware shall be packaged, separately, complete with necessary screws, keying instructions and required templates and identified in accordance with the Hardware Schedule.

5.2 The Contractor shall receive and care for all hardware until used and provide adequate protection until acceptance of building. Hardware must be clean and free of blemishes at times of final inspection of project.

08700-06 KEYING

6.1 Locks shall be master-keyed as determined at time of approval of samples.

08700-07 HARDWARE LOCATION

7.1 Unless otherwise required, locate hardware:

A. Doorknobs, Interior Doors: 3’ 1-1/2” above finished floor. Exterior Doors: 3’ 1-1/4” above finished floor.

B. Push plates: 50” from finished floor to plate center.

C. Protection Plates: 42” from finished floor to plate top if used.

D. Stretcher plates: 42” from finished floor to plate top if used.

E. Door pulls 40” from finished floor to grip center.

F. Cylinder Dead Lock: 55” from finished floor to cylinder center.

G. Thumb Piece of Entrance Handle: 39” from finished floor to thumb piece.

08700-08 QUALITY ASSURANCE

8.1 Codes and Regulations: Comply with applicable requirements of governing Authorities having jurisdiction.

8.2 Standards: Manufacturers and model numbers listed are to establish a standard of Quality. Similar items by approved manufacturers that are equal in design, function and quality may be accepted, upon prior approval of the Architect and provided required written data, proof of equality and physical samples are submitted at least ten (10) working days prior to receipt of bids.

8.3 Fire-rated Openings: Provide hardware for fire-rated openings in compliance with American (NBFU) pamphlet No. 80 and National Fire Protection Association (NFPA) standard No. 80. Provide only hardware that has been tested and listed By Underwriter's Laboratories for types and sizes of doors required, and complies with requirements of door and frame labels. Where panic exit devices are required on fire-rated doors, provide UL label on exit devices indicating

"Fire Exit Hardware".

8.4 The hardware supplier must be regularly engaged in contract hardware, be staffed to expedite the work efficiently and must be a certified Architectural Consultant or have in his employ a certified Architectural Consultant or person of equivalent Training to periodically inspect and direct the setting, applying and adjusting of all hardware. It is not required that he remains constantly on the site, but he shall be Accessible to the Architect at all times.

08700-09 REFERENCES

9.1 The following is a list of reference documents that may be used in whole or in part in preparing this section of the specifications or which may be used by the Hardware supplier.

A. National Fire Protection Association
Fire Doors and Windows. (NFPA 80)

B. National Fire protection Association
Life Safety Code (NFPA 101)

C. Underwriters Laboratories
Building Materials Directory

D. Warnock Hersey (ITS)
Factory Laboratories Listing

E. Door and Hardware Institute (DHI)
Hardware for Labeled Fire Doors

F. Door and Hardware Institute (DHI)
Sequence & Format for the Hardware Schedule

G. Door and Hardware Institute (DHI)
Keying Procedures

08700-10 GENERAL REQUIREMENTS

10.1 Hardware supplier shall verify the suitability and adaptability of all items specified in relation to all details and surrounding conditions. The Architect's attention shall be directed to any item, which is not shown, and to any typographical or other error so that corrections may be made before hardware schedule is written for submittal.

10.2 Manufacturers and model numbers listed are to establish a standard of quality. The Architect reserves the right to reject any items, which, in his opinion is not equivalent in quality designs or function to the specified standards.

10.3 Blemished or defective hardware will be rejected even though set in place before defects are discovered. Remove and replace with new hardware and repair any resultant damage to other work.

08700-11 LISTED MANUFACTURERS

11.1 The numbers listed are taken from the following manufacturer catalogs:

Stanley	New Britain, CT
Markar	Lancaster, NY
Precision	Romulus, MI
Ryobi	Wayne, MI
ABH	Elks Grove Village, IL
Rockwood	Rockwood, PA
Zero	Bronx, NY
Hunter Operators	New Britain, PA
RCI	Virginia Beach, VA
HUFCOR	Janesville, WI
Johnson Hardware	Elkhart, IN
Schlage Locks	San Francisco, CA
TACO	Philadelphia, PA

08700-12 MATERIALS

12.1 HINGES:

A. Where hinges are called for, they shall be as per Stanley, Series FBB179 4 1/2 X 4 1/2 For all 1-3/4" doors up to 36" wide. Doors over 36"wide shall have Series FBB168 4 1/2 X 4 1/2 (NRP & stainless steel to be provided as/or where required by conditions etc.).

B. Furnish one pair of hinges for doors up to 60" high. Furnish one additional hinge for every 30" additional or fraction thereof. Exterior doors shall be furnished with hinges of non-ferrous metal. All exterior doors, which open at reverse bevel, shall be furnished with NRP hinges.

C. On doors with electric modification to the lock furnish one "CE" type Electric hinge.

D. Hinges shall have leaves of sufficient width to clear all trim at the maximum opening. Hinges shall be certified by an independent testing agency to be in compliance with ANSI/BHMA product standards in accordance with A156.1 – 1997.

E. Concealed bearings are to be engineered polymer material with PTFE and Aramid fiber.

F. All hinges shall be 5 Knuckle concealed bearing construction, or continuous hinges, as indicated. Unless otherwise specified, sizes for hinges for doors shall be as follows:

Up to 3' in width FBB179 OR 4-1/2 x 4-1/2
(.134)
3' to 3'6" in width FBB168 5 x 4-1/2 (.180)
Above 3'6" in width: CONTINUOUS HINGE AS SPECIFIED.

12.9 CONTINUOUS HINGES ALUMINUM

A. Door hinge to be Continuous hinge in anodized aluminum, unhanded and finished as required. Hinge shall be a pin less assembly of three interlocking extrusions applied to the full height of the door and frame without mortising.

B. The door leaf and jamb leaf shall be geared together for the entire length of the hinge, and joined by a channel. All unexposed working metal surfaces shall be coated with dry lubricant.

C. Vertical door loads shall be carried on bearings through a full 180-degree. Screw holes shall be concentrated at the ends of the hinge and proportionately spaced along its full length. Hardened steel fasteners to be furnished. Hinge joint to be monolithic in Appearance. Hinges with visible knuckle separations are not acceptable.

D. Continuous hinges are supplied with "standard" number of bearings, and with double the Number of bearings per length. DB hinges are recommended for heavy – duty or high Traffic doors.

E. Dynamic and static load test for compliance with ANSI A156.1 (BMHA 101) for 350,000Cycles at 15 cycles per minute.

12.10 CONTINUOUS HINGES STAINLESS STEEL

A. Continuous hinges shall be full height piano-type hinge providing full height door Support.

B. Supports weights up to 600lbs. 4'0" maximum door width.

C. Material to be 14 gage, 304 stainless steel.

D. .25 diameter 304 stainless steel pin

E. Exterior barrel diameter .438 (7/16)

F. Each knuckle 2", including split nylon bearing at each separation for a quite, smooth, self-lubricating operation.

G. Finish: 304 S.S. No. 4 (US32D), or Polished Stainless (US32)

H. Non-Handed

I. All hinges shall be furnished with manufacturer's recommended hardware pack per specific model application.

J. Must be able to carry Warnock Hersey Int. or UL for fire rated doors and frames up to 3 hours.

K. Hinges shall meet 1,5000,000 cycle test (ASTM A156.26)

L. Symmetrically templated hole pattern.

M. All Continuous Hinges shall carry a 10-Year Warranty.

12.11 Mechanical locksets and Latch sets:

A. Locksets and latch sets of other acceptable manufacturers must conform to Requirements herein.

B. Mortise Type: Schlage L Series, Cylindrical Type: Schlage D Series where specified and TACO CL-DX-LSV Series where specified.

C. Locksets and latch sets shall be heavy-duty mortise type with hinged, anti-friction, 3/4" (19 mm) throw latch bolt with anti-friction piece made of self-lubricating stainless steel. Functions and design as indicated in hardware groups. Deadbolt functions shall be 1" (25 mm) projection with two hardened steel roller pins. Latch bolt with plastic insert and three-piece latch bolt are unacceptable on this project.

D. Locksets and Latch-sets shall be 2-3/4 inch backset and shall be furnished with ANSI 4-7/8 Strikes.

E. Furnish strikes with extended lips where required to protect trim from being marred by latch bolt.

F. Furnish key removable core cylinders for all locking devices under this contract.

G. Mortise Locks and Latches to Meet ANSI / BMHA A156.13, Series 1000, Grade 1, Operational, Grade 2, Security. All lockset shall be listed by Underwriters Laboratories For use on 3 hour "A" label doors.

E. Both deadbolt and latch bolt to extend into lock case a minimum of 3/8" (9.5 MM) when Fully extended.

F. Locksets and Latch sets to have self-aligning thru-bolted trim.

J. Lever handles must be of forged or cast brass, bronze or stainless steel construction and conform to ANSI A117.1. Levers, which contain a hollow cavity, are not acceptable.

12.12 KEYING

This project shall be provided with a Schlage Key system.

A. All cylinder locks shall be master keyed as directed. The local Schlage service center shall furnish new master keys directly to owner; all related costs and cylinder installation are to be a part of this bid package. Furnish all other keys as directed in this section. All cylinders shall be "Schlage" cylinders as indicated. All cylinders to be Master Keyed & grand master Keyed to the
Existing Key System or as directed by the owner. This Facility is to have a 6/7 PIN Key System (as directed). Visual Key Control as listed in section 2.03- D is required. All costs to set up the system provide training from the manufacturer and install permanent cores in the locks after the completion of construction are to be part of this bid package.

B. If required by owner provide brass construction cores for all exterior doors and additional brass cores for various other doors during construction (doors to receive these cores to be selected by the owner or contractor) and construction keys during the construction period. The balance of the doors shall be provided with plastic Construction cores and keys. These construction control and operating keys and cores shall not be part of the owner's permanent keying system or furnished on the same keyway as the Owner's permanent keying system.

C. If removable core system is required all cylinders shall be Schlage 6/7 – pin, interchangeable core and keyed to a (existing) factory registered Grand Masterkey System with restricted keyway.

D. Permanent keys and cores shall be stamped with the applicable key mark for identification. These visual key control marks or codes will not include the actual key cuts. Permanent keys will not include the actual key cuts. Permanent keys will also be stamped "Do Not Duplicate".

E. Grand Masterkeys, Masterkeys and other Security keys shall be transmitted to the owner U.P.S. delivery confirmation request.

F. Furnish keys in the following quantities:

6 each Great Grand Master-Key
6 each Grand Master-Key
4 each Master Keys per set
3 each Change Key per each
4 each Construction Master-Keys
4 each Control Keys For Construction Cores
4 each Control Keys For Permanent Cores

G. All cylinders will be Schlage cylinders. All cylinders to be standard/interchangeable core type (as required by owner) 6/7 - PIN cylinders.

H. Lock supplier will be required to meet with the Owner or his representative to establish the detailed keying requirements and type of cores required.

12.6 EXIT DEVICES

Exit Devices for this project must meet the following criteria:

13 Panic exit device must be listed with the Underwriters Laboratories, Inc. for Accident Hazard. Fire exit devices must be available with UL label for a three- (3) hour fire rating for the specified door opening size.

14 All exit devices must be reversible. All exit devices must have ¾" throw latch bolts. All exit devices must have components fastened with screws for ease of maintenance. Rivets are not acceptable as fasteners. All exit devices must be BHMA Architectural Finishes. Aluminum or plastic exposed surfaces are not acceptable. All exit device lever trim must be cast bronze with vandal resistant feature.

15 Mechanism Case: Cast Material

16 Center Case: Shall be interchangeable with all functions.

E. Center Case Cover: Forged.

F. Push bar Trim: Shall be of base material specified. No plastic.

G. Security Latch bolts: Latch bolts are stainless steel.

C. Springs: Uses only compression springs.

D. No Shims. Device shall have a ¼" gap between the door and the tube, preventing the need for shim kits to be used over lite kits.

J. Surface of the device shall have only BMHA Architectural finishes.

K. Trim: Trim to be heavy-duty, cast lever & escutcheon-thru bolted to the device. Optional "Vandal-RESISTANT" levers to be supplied where indicated. L. End caps shall have mechanical interlock.

M. Specials/Finishes: Shall accommodate special product applications. Special door widths, thickness, heights, and trim. Special finishes upon request.

N. Latches for vertical rod latches shall not contain springs.

O. Warranty: 3 years.

12.7 CLOSERS

A. Door closers shall be heavy-duty types, 10-year warranty.

B. Cylinder shall be aluminum. High strength - durable - long life. Aluminum cylinder and steel piston compatible. Resistant to scoring and abrasion.

C. Piston shall be forged steel 1-1/2" diameter - large rack teeth.)

D. Main arm shall be forged. Also, rigid forged forearm on parallel arm closer. Shaft/Pinion shall be 11/16" diameter shaft. Double heat-treated. Large teeth. Double slab drives for maximum contact between arm and shaft while maintaining strength of shaft.

F. Bearings - Full complement bearings.

C. Regulating screws - V slot valve, Superior since valve passage is larger and less susceptible to clogging due to floating particles. Permits non-critical adjustments for Fine-tuning of closing speeds.

H. All closers to have "all-weather" hydraulic fluid that allows hydraulics to operate in temperatures from -30' to 120' F. without seasonal adjustment.

I. Springs - Chrome silicon, Wire. Length to diameter ratio optimum.

J. Closers for both exterior and interior doors to be ADA compliant.

K. Closers with hold-open, delay, cush-n-stop, to be adjustable between 85' and 110' per template; friction hold-open up to 180'.

L. Heavy duty arms to have bronze bushings and shoulder bolts.

M. All Cush & Spring Cush closers to have bronze bushings and shoulder bolts.

N. All closers to have powder coated finish-powder coating to surpass 100 salt spray tests.

O. Floor Closers as written in 605 finish shall be provided as and where specified in the hardware sets.

12.8 PUSH PLATES

A. Push plates shall be minimum .050 Ga. Material as scheduled with all Edges beveled.

B. Push plates shall be Size as Listed unless otherwise specified.

16.9 KICK AND ARMOR PLATES

A. Kickplates for doors where scheduled shall be on the push side of door unless otherwise specified. Kickplates shall be 8" x 1" ldw on prs. Drs., 2" ldw on sgl. Dr. widths unless otherwise specified. All kickplates mop plates and armor plates to be beveled 4 edges (B4E). All kickplates mop plates and armor plates to have screw holes drilled and countersunk. Screws to be Phillips head, oval head, undercut sheet metal screws to match plate material, unless otherwise specified. On other than metallic kickplates, screws to match or complement other door hardware.

12.10 DOOR STOPS

A. Door stops and bumpers shall be provided for every door that will strike walls or any part of the building. Wherever possible furnish wall type bumpers, with correct attachments and fasteners. Furnish doorstops wherever required unless otherwise specified.

B. Where wall stops and bumpers cannot be applied; overhead stops will be required for 90' swing doors.

12.11 SLIENCERS

A. All interior doors shall be furnished with rubber silencers. Furnish 3 for Single doors and 2 for pairs of doors.

12.12 THRESHOLDS

A. Furnish non-ferrous thresholds as detailed for all doors where listed in the Door Schedules or called for in the hardware sets.

B. All Thresholds to be aluminum extruded. The alloy is 6063, and the hardware is T5 or T6. Extruded Aluminum to be .200 thick.

12.13 WEATHER-STRIPPING

A. All exterior openings shall be provided with weather-stripping.

B. All Neoprene to be closed-cell sponge and solid, both in an extruded form. All neoprene is black in color and, by virtue of its chlorine content, is flame resistant, self-extinguishing and nonstaining.

C. Neoprene is to have Tensile Strength over 3000 (PSI)

12.14 MAGNETIC LOCKS

D. Refer to electrical drawings, hardware sets and specifications for exact description and coordinate purchase and installation.

2.15 AUTOMATIC OPERATORS (If Required)

A. Quality Assurance: ANSI A156.10 Standard, Provide automatic entrance doors complying with applicable requirements of Power Operated Pedestrian Door Standards. UL 325, Provide powered door operators complying with UL 325, Electrical Door, Drapery, Gate, Louver and Window Operators and Systems.

B. Manufacturer's Qualifications: Provide units produced by a firm with not less than five years successful experience in the fabrication of automatic entrance doors of the type required for this project.

C. Installer's Qualifications: Engage an installer who is an authorized representative of the automatic entrance door manufacturer for both the installation and maintenance of the types of units required for this project.

D. Product Data: Submit manufacturer's product data and standard details for automatic entrance doors including – fabrication, finishing, hardware, operators, accessories, and other components of the work. Include rough – in diagrams, parts list, and maintenance instructions, as well as certified test data, where required.

12.16 FINISHES

A. The exposed surfaces of all hardware shall be plated BHMA as specified.

B. Types of finish required include the following:

Continuous Hinges		689,CTS, 630
Hinges		651, 652, 630
Lock Cylinders	626	
Lock Trim		626
Closers		689
Exit Devices		626,630
Over Head Stops		630
Door Trim and Thresholds		BLK, 313, 600,626,628,630

Finishes supplied are to be as specified in the hardware sets.

E. All Fasteners shall be of the same base material and finish as the product that they Are being used with.

08700-13 INSTALLATION, INSPECTION AND FINAL ADJUSTMENT

13.1 GENERAL

A. At final completion, all hardware shall be left clean and free from Disfigurement. Hardware supplier shall at completion of the project, have a competent Hardware Consultant check the job to determine that the proper application of hardware has been made according to the approved Hardware Section, and the proper keying and functioning and/or adjustment of all hardware items have been achieved.

B. After final check makes all required adjustments, replacements and repairs. Leave hardware in perfect condition.

C. Blemished or defective hardware will be rejected even though set in place before defects are discovered. Remove and replace with new hardware and repair any resultant damage to other work

13.2 INSTALLATION

A. Apply required hardware in prepared openings in doors and frames, and hang doors. Unless otherwise established, mount hardware units according to NBHA "Recommended Locations for Builder's Hardware".

B. Install each hardware item in compliance with the manufacturer's instructions, using fasteners provided. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, install each item completely and then remove and store in a safe place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the surface.

C. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Cut and fit thresholds and floor covers to profile of doorframes, with mitered corners and hairline joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

F. Screw thresholds to substrate with no. 10 or larger screws, of the proper type for permanent anchorage and of the same metal as the threshold.

G. At exterior doors, and elsewhere as indicated, set each edge of threshold in a seal strip of butyl rubber sealant or polyisobutylene mastic sealant, and removes excess.

H. It is the responsibility of the Electrical Contractor to provide all necessary wiring and connections between the electrified hardware products specified herein, and the operational systems for which they were intended.

I. Coordination of the various parties involved including, but not limited to, the Mechanical Contractor for Pneumatic Hardware, Electrical Sub-Contractor,
Security Contractor, and Hardware Supplier, is the sole responsibility of the Electrical Contractor. The General Contractor shall provide coordination Regardless of whether or not the plans, electrical drawings, or specifications indicate such coordination is necessary. This includes the integration of such items as electric exit devices, electric strikes, electric door openers, and electromagnet. Floor and wall holders, magnetic switches, etc., into either the new or existing fire alarm or security alarm systems, as is necessary. Power to and from specified power supplies shall also be the responsibility of the Electrical Contractor.

08700-14 GUARANTEE

A. Furnish guarantees for all material supplied. Manufacturer shall guarantee to replace all faulty hardware, at his own expense, for a period as indicated by manufacturer from date of final acceptance.

08700-15 EXECUTION

15.1 ADJUST AND CLEAN

A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with type lubrication recommended by manufacturer (graphite dust if no other recommended). Replace units, which cannot be adjusted and lubricated to operate freely and smoothly as intended for the application made.

B. After final check makes all required adjustments, replacements and repairs. Leave hardware in perfect operating condition. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

C. Blemished or defective hardware will be rejected even though set in place before defects are discovered. Remove and replace with new hardware and repair resultant damage to other work.

D. Instruct owner's personnel on proper adjustment and maintenance of hardware and hardware finish, during final adjusting of hardware.

15.2 MAINTENANCE

A. Tools for maintenance: After hardware is installed the installer shall turn over a complete set of specialized tools used to install and adjust the hardware for owner's continued adjustment, maintenance and removal and replacement of finish hardware.

15.3 HARDWARE REQUIREMENTS

Materials listed are building standard which are used through the facility and shall be as specified.

LIST OF MANUFACTURERS AND APPROVED EQUALS:

MFGR/SPEC*	APPROVED EQUALS
HINGES	
STANLEY*	
CONTINUOUS HINGES	
MARKAR *	
CYLINDERS	
Schlage*	
LOCKS & LATCHES	
Schlage, TACO*	
SPECIAL PANIC TRIM	
BEST*	

O/H SURFACE STOP
ABH*

EXIT DEVICES
PRECISION*

DOOR CLOSERS
RYOBI *

SLIDING DOOR HARDWARE
JOHNSON*

PUSH & PULLS
ROCKWOOD*

KICK PLATES
ROCKWOOD*

WALL BUMPERS
ROCKWOOD*

SILENCERS
ROCKWOOD*

ELECTRIC HARDWARE
RCI*

WEATHERSTRIPPING
ZERO*

RAINDRIP & THRESHOLDS
ZERO*

SOUND SEALS
ZERO*

GLASSWALL
HUFCOR*

Note: All products to be as specified in the hardware set

END OF SECTION

GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Description of Work: Work of this section includes, but is not limited to, the following:

1. Gypsum board and accessories
2. Metal studs and furring
3. Metal suspension systems
4. Sound-rated construction and accessories
5. Gypsum board finishing
6. Trim and accessories

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. CERAMIC TILE for tile facing on cement backer board. Section 09300

B. ACOUSTICAL CEILINGS for suspended acoustical ceilings. Section 09510

C. PAINTING AND FINISHING for gypsum board prime and finish coats. Section 09900

1.4 QUALITY ASSURANCE

A. Reference Standards:

1. Applicable requirements of ASTM C754 for installation of steel framing.
2. Install gypsum board in accordance with applicable requirements and recommendations of Gypsum Association GA 216, "Recommended Specifications for the Application and Finishing of Gypsum Board" except for more stringent requirements of manufacturer.

3. Apply acoustical sealant in accordance with applicable requirements of ASTM C919.

1.5 SYSTEM REQUIREMENTS

A. Performance Requirements: Fabricate and install systems as indicated but not less than that required to comply with ASTM C754 under the following conditions:

1. Gypsum board partitions:
   a. Standard systems: Maximum deflection of l/240 of partition height.
   b. Systems to receive water resistant gypsum board or backer board: Maximum deflection of l/360 of partition height.

2. Cavity shaftwall systems: Withstand minimum positive and negative pressure of 5 psf.

4. Interior suspended ceilings and soffits: Maximum deflection of l/360 of distance between supports.

4. Exterior soffits: Withstand minimum positive and negative pressure of 20 psf with maximum deflection of l/360 of distance between supports.

5. Nonstructural components that are permanently attached to structures and their support attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance to local jurisdiction

B. Fire Resistance Ratings: Where fire resistance classifications are indicated, provide materials and application procedures identical to those listed by UL or tested according to ASTM E119 for type of construction shown.

C. Acoustical Ratings: Where sound ratings are indicated, provide materials and application procedures identical to those tested by manufacturer to achieve Sound Transmission Class (STC) scheduled or indicated in accordance with ASTM E90.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions with project conditions and materials clearly identified or detailed for each required system.

1.7 PRODUCT HANDLING

A. Delivery:

1. Deliver material to site promptly without undue exposure to weather.

2. Deliver in manufacturer's unopened containers or bundles, fully identified with name, brand, type and grade.

B. Storage:

1. Store above ground in dry, ventilated space.

2. Protect materials from soiling, rusting and damage.

3. Store board to be directly applied to masonry walls at 70°F for 24 hours prior to installation.

1.8 JOB CONDITIONS

A. Environmental Requirements:

1. Do not install gypsum board when ambient temperature is below 40°F.
2. For adhesive attachment of gypsum board, and for finishing of gypsum board, maintain ambient temperature above 55°F from one week prior to attachment or joint treatment, and until joint treatment is complete and dry.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Gypsum Board:

1. ASTM C1396 (Section 5), regular type, except where Type X fire-resistant type is indicated or required to meet UL assembly types.

2. Edges: Tapered.

3. Thickness: 5/8 inch, unless otherwise indicated.
   a. Where curved gypsum board construction is indicated, use 1/4 inch thick flexible facing board.
   b. Gypsum board shall have a minimum of 5% Post-consumer and 20% Postindustrial as defined by FTC (Federal Trade Commission).

B. Ceiling Board:

1. ASTM C1396 (Section 12), non-sag type.

2. Thickness: ½ inch.

C. Cement Backer Board:

1. Aggregated Portland cement board with woven glass fiber mesh facing; complying with ANSI A118.9.

2. Thickness: 5/8 inch.

2.2 METAL FRAMING AND FURRING MATERIALS

A. Metal Studs and Runners:

1. ASTM C645, "C" shaped, gauge:
   a. Provide 25 gauge studs, except as otherwise indicated or specified. Provide heavier gauge if required.
   b. At door [and borrowed light] frames, provide (2) 25 gage minimum studs at each jamb. Where wall is indicated or specified to be typically framed with 20 gauge studs, provide (2) 20 gauge studs at each jamb.
   c. Provide 20 gauge studs at walls to receive cement backer board [,] [and] water resistant gypsum board with ceramic tile facing.
   d. Provide runner gauge as recommended by stud manufacturer.

2. Depth of sections: As indicated.

3. Corrosion protection: G40 hot-dipped galvanized coating per ASTM A525.

C. Metal Furring Channels:

1. Hat-shaped:
   a. ASTM C645, 7/8 inch high, 25 gauge, with G40 hot-dipped galvanized coating per ASTM A525.
   b. Provide 20 gauge at furring to receive tile backer board.

2. Z-shaped: ASTM C645, depths as indicated, 24 gauge minimum, with G40 hot-

3. Resilient: Manufacturer's standard type designed to reduce sound transmission; ½ inch deep, 25 gauge steel with G40 hot-dipped galvanized coating per ASTM A525.

2.3 CEILING AND SOFFIT SUPPORT MATERIALS

A. Hanger Anchorage Devices: Screws, clips, bolts or other devices compatible with indicated structural anchorage for ceiling hangers and whose suitability has been proven through standard construction practices or by certified test data.

B. Powder-Actuated Fasteners in Concrete: Fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers [and with capability to sustain, without failure, a load equal to 10x calculated loads].

C. Hangers:

1. Steel wire or rods, sizes to comply with requirements of ASTM C754 for ceiling or soffit area and loads to be supported.

2. Wire: ASTM A 641, soft, Class 1 galvanized.

3. Rods and flats:
   a. Mild steel components.
   b. Finish: Galvanized or painted with rust-inhibitive paint for interior work; galvanized for exterior work.

D. Framing System:

1. Main runners:
   a. Cold-rolled, "C" shaped steel channels, 16 gauge minimum.
   b. Finish: Galvanized with G40 hot-dip galvanized coating per ASTM A525 [for exterior work]; galvanized or painted with rust-inhibitive paint for other interior work.
   c. Form to required radius at curved ceilings.

2. Cross furring: Hat-shaped steel furring channels, ASTM C645, 7/8 inch high, 25 gauge, galvanized.

3. Furring anchorages: 16 gauge galvanized wire ties, manufacturer's standard wire-type clips, bolts, nails or screws recommended by furring manufacturer and complying with ASTM C754.

4. Provide compression posts and other accessories as required to comply with seismic requirements.

2.4 ACCESSORIES

A. Metal Trim for Gypsum Board:

1. Conform to profile and dimensions indicated.

2. Material for interior work: Galvanized steel, 26 gauge minimum.

3. Control joints:
   a. Roll-formed zinc with perforated flanges.
   b. Size: 1-3/4 inch wide, with ¼ inch wide center channel.
   c. Provide with removable tape strip over channel.

B. Special Trim and Reveals: Extruded aluminum alloy 6063-T5, profiles as indicated.

C. Hanger Wire Sound Isolators: Provide where indicated for sound-rated suspended ceilings.

D. Adhesives and Joint Treatment Materials:

1. Conform to requirements of ASTM C475.

2. Joint compounds:

a. Drying-type (ready-mixed)
b. Laminating adhesive for multiple layers: Special adhesive or joint compound specifically recommended for laminating gypsum boards.
c. Laminating adhesive for direct application: Special adhesive or joint compound specifically recommended for laminating gypsum boards and for adhering gypsum boards to solid substrates.

3. Reinforcing joint tape:
a. ASTM C475, 2 inch nominal width.
b. For backer board, provide fiberglass tape as recommended by board manufacturer [and acceptable to manufacturer of ceramic tile setting materials].

E. Gypsum Board Screws: Self-drilling, self-tapping steel screws.

1. For steel framing less than 0.03 inch thick: Comply with ASTM C1002.

2. For steel framing from 0.033 inch thick to 0.112 inch thick: Comply with ASTM C954.

3. Provide Type S or Type S-12 screws.

F. Backer Board Accessories: Provide accessories and corrosion-resistant-coated steel screws as recommended by backer board manufacturer and required for complete installation.

G. Acoustical Sealant: Equivalent to SHEETROCK® acoustical sealant by USG.

H. Miscellaneous Accessories: Provide as required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and adjoining construction and conditions under which work is to be installed. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install in accordance with reference standards and manufacturer's instructions and as required to comply with seismic requirements.

B. Tolerances:

1. Do not exceed 1/8 inch in 8'-0" variation from plumb or level in exposed lines of surface, except at joints between gypsum board units.

2. Do not exceed 1/16 inch variation between planes of abutting edges or ends.

3. Shim as required to comply with specified tolerances.

C. Install framing to comply with ASTM C754 and with ASTM C840 requirements that apply to framing installation.

D. Install supplementary framing, blocking and bracing at terminations in gypsum board assemblies to support fixtures, equipment, heavy trim, grab bars, toilet accessories, furnishings or similar construction.

3.3 METAL SUPPORT INSTALLATION

A. Metal Runners:

1. Align and secure runner tracks accurately to partition layout at both floor and ceiling.

2. Provide fasteners appropriate to substrate construction as recommended by manufacturer.

B. Metal Studs:

1. Position metal studs vertically in the runners, spaced as indicated.

2. Place studs so that flanges face in same direction.

3. Cut studs ½ inch short of full height to provide perimeter relief.

4. Align and plumb partition framing accurately.

5. Where partitions abut ceiling or deck construction or vertical structural elements, provide slip or cushion type joint between partition and structure as recommended by stud manufacturer to prevent transfer of structural loads or movements to partitions, and to provide lateral support.

6. Provide horizontal bracing where necessary for lateral support.

7. Curved partitions:
   a. Cut top and bottom runners through leg and web at 2-inch intervals for arc length.
   b. Bend runners to uniform curve of radius indicated and locate straight lengths tangent to arcs.
   c. Support outside (cut) leg of runners by clinching a 1-inch high x 25 gauge thick sheet steel strip to inside of cut legs using metal lock fasteners.
   d. Attach studs to runners with 3/8 inch long pan head framing screws.
   e. On straight lengths at ends of arcs, place studs 6 inches on center with last stud left free standing.

C. Hat Channel Furring:

1. Attach hat-shaped furring channels either vertically or horizontally with fasteners through alternate wing flanges (staggered).

2. Space furring channels at 24 inches on center, unless otherwise indicated. Where furring is indicated to receive backer board, water resistant gypsum board with ceramic tile, or veneer plaster, space at 16 inches on center.

3. Install furring channels within 4 inches of floor line and ceiling line.

D. Z-Furring:

1. Securely attach narrow flanges of members to wall with concrete stub nails or power-driven fasteners, except as otherwise indicated.

2. Sequence furring installation with installation of insulation.

E. Ceiling and Soffit Support Systems:

1. Secure hangers or rods to structural support by connecting directly to structure where possible; otherwise connect to inserts, clips or other anchorage devices or fasteners indicated.

2. Space main runners, hangers and furring according to requirements of ASTM C754, except as otherwise indicated.

3. Where spacing of structural members, or width of ducts or other equipment, prevents regular spacing of hangers, provide supplemental hangers and suspension members and reinforce nearest affected hangers to span extra distance.

4. Install compression posts, splay wires and other accessories as required to comply with seismic requirements.

5. Extend runners to within 6 inches of walls.

6. Wire-tie or clip furring members to main runners and to other structural supports indicated. In fire resistance rated assemblies, wire-tie furring members; do not clip.

7. Do not permit furring or runners to contact masonry or concrete walls.

8. Provide 1 inch clearance between furring or runners and abutting walls and partitions.

9. Curved (vaulted) applications:
   a. Install furring channels to provide indicated radius for finished ceiling.
   b. Space furring channels maximum 16 inches on center. Provide closer spacing if recommended by manufacturer for veneer base thickness and application method.

3.4 BOARD INSTALLATION

A. Single Layer Gypsum Board on Metal Studs:

1. Loosely butt gypsum board joints together and neatly fit.

2. Do not place butt ends against tapered edges.

3. Maximum allowable gap at end joints: 1/8 inch.

4. Stagger joints on opposite sides of partitions.

5. Apply ceiling boards first where gypsum board ceilings and wall occur.

6. Cut openings in gypsum board to fit electrical outlets, plumbing, light fixtures and piping snugly and small enough to be covered by plates and escutcheons. Cut both face and back paper.

7. Screw board in place securely with screws spaced according to manufacturer's recommendations.

B. Single Layer Gypsum Board on Furring:

1. Apply gypsum board with long dimension at right angles to furring channel.

2. Center end joints over channel web; stagger end joints from those in adjacent rows of board.

3. Fasten boards to furring channels with screws spaced according to manufacturer's recommendations.

C. Double Layer Gypsum Board:

1. Fasten base layer to studs or furring with screws, and attach face layer using laminating adhesive and screws, applied according to manufacturer's instructions.

2. Offset face-layer joints at least 10 inches from parallel base-layer joints.

3. Screw both layers to metal supports at double layer ceiling applications and where required for fire-rated construction.

D. Direct Gypsum Board Adhesive Application:

1. Apply adhesive with manufacturer's recommended spreader to backs of gypsum boards in band of four beads each to center of each board and along edges.

2. Position boards vertically and press firmly in place to insure good bond.

3. Fasten top and bottom of board if required.

F. Cementitious Backer Board Installation:

1. Install as indicated to comply with ANSI A108.11 and in accordance with manufacturer's instructions.

2. Complete plumbing rough-in before boards are erected.

3. Separate board from rough-in and fixtures and fill space as recommended by manufacturer.

4. Securely fasten boards to substrate as required.

5. Follow manufacturer's instructions for treatment of edge terminations.

6. At joints and corners, embed fiberglass tape in skim coat of mortar.]

3.5 ACCESSORY INSTALLATION

A. Trim:

1. Use same fasteners to anchor trim accessory flanges as required to fasten gypsum board to supports, unless otherwise recommended by trim manufacturer.

2. Install metal corner beads at external corners.

3. Install metal casing bead trim whenever edge of gypsum board would otherwise be exposed or semi-exposed.

B. Control Joints:

1. Install control joints at junction of gypsum board partitions with walls or partitions of other finish material.

2. Install control joints within long runs of partitions, ceilings or soffits at approximately 30'-0" on center or as indicated.

3. Where gypsum board is vertically continuous, as at stairwells, provide horizontal control joints at each floor level.

C. Special Trim: Install as indicated on drawings and in accordance with manufacturer's instructions.

3.6 FINISHING

A. Provide levels of gypsum board finish for locations as follows, in accordance with Gypsum Association GA 214, "Recommended Specification: Levels of Gypsum Board Finish".

1. Level 1: Ceiling plenum areas and concealed areas, except provide higher level of finish as required to comply with fire resistance ratings and acoustical ratings.

2. Level 2: Gypsum board substrate at tile except remove tool marks and ridges.

3. Level 3: Gypsum board surfaces, where textured finishes or heavy vinyl wall papering will be used

4. Level 4: Gypsum board surfaces, except where another finish level is indicated

5. Level 5: Gypsum board surfaces requiring extra smooth surface for critical light, where indicated using spray-applied Primer-Surfacer.
   a. Surface Preparation: Complete gypsum board surface to Level 4 before applying primer-surfacer.
   b. Primer-surfacer Application: Machine apply with airless sprayer to a wet film thickness of 15 to 20 mils [9-12 mils dry film thickness]. Surface may be painted after overnight drying.

B. Interior Gypsum Board:

1. Taping (Level 1):
   a. Use taping or all purpose [conventional weight, lightweight or midweight] compound.
   b. Butter taping compound into inside corners and joints.
   c. Center tape over joints and press down into fresh compound.
   d. Remove excess compound.
   e. Tape joints of gypsum board above suspended ceilings.

2. First coat (Level 2):
   a. Use taping or all-purpose [conventional weight, lightweight or midweight] dryingtype compound, or setting-type joint compound.
   b. Immediately after bedding tape, apply skim coat of compound over body of tape and allow to dry completely in accordance with manufacturer's instructions.
   c. Apply first coat of compound over flanges of trim and accessories, and over exposed fastener heads and finish level with board surface.

3. Second coat (Level 3): Use all purpose or topping (conventional weight, lightweight or midweight) drying type joint compound. After first coat treatment is dried, apply second coat of compound over tape and trim, feathering compound 2 inches beyond edge of first coat.

4. Third coat (Level 4):
   a. Use all purpose or topping [conventional weight, lightweight or midweight] drying type joint compound.
   b. After second coat has dried, sand surface lightly and apply thin finish coat to joints, fasteners and trim, feathering compound 2 inches beyond edge of second coat.
   c. Allow third coat to dry. Apply additional compound, and touch-up and sand, to provide surface free of visual defects, tool marks, and ridges, and ready for application of finish.

5. Skim coat (Level 5):
   a. Apply skim coat of all-purpose (conventional weight) drying-type compound or spray-applied Primer-Surfacer, TUFF-HIDE over exposed surfaces of gypsum board.
   b. After skim coat has dried, touch-up and sand to provide surface free of visual defects, tool marks, and ridges, and ready for application of finish.

C. Cementitious Backer Board: Prepare and finish joints in accordance with manufacturer's instructions.

D. Joint Compound:

1. After skim coat sets, apply finish coat of compound feathering 3 to 4 inches beyond tape edges.

2. Feather coats onto adjoining surfaces so that camber is maximum 1/32 inch.

3. Allow joint compound to completely set before applying veneer plaster finish.

E. Trim:
1. Use same fasteners to anchor trim accessory flanges as required to fasten gypsum board to supports, unless otherwise recommended by trim manufacturer.
2. Install metal corner beads at external corners.
3. Install metal casing bead trim whenever edge of gypsum base would otherwise be exposed or semi-exposed, and where gypsum base terminates against dissimilar material.

F. Control Joints: Install where indicated and specified.

G. Special Trim and Reveal Joints: Install as indicated on drawings and in accordance with manufacturer's instructions.

3.10 ADJUSTING

A. Correct damage and defects which may telegraph through finish work.

B. Leave work smooth and uniform.

END OF SECTION

09300

CERAMIC TILE

Part 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cleavage membrane and Portland cement mortar bed.

2. Ceramic tile floor and base, and wall surfacing, installed using the dry-set and thick-set bed method, with cementitious and epoxy grouted joints.

1.3 REFERENCES

A. American National Standards Institute (ANSI):

1. A108.1 - Installation of Ceramic Tile in a Mortar Bed.
2. A108.5 - Installation of Ceramic tile with Dry-Set Portland Cement or Latex Portland Cement.
3. A108.10 - Installation of Grout in Tilework.
4. A108.13 - Installation of Membranes for Thin-Set Ceramic Tile.
5. A118.3 - Chemical Resistant, Water-Cleanable, Tile-Setting and-Grouting Epoxy and Water-Cleanable Tile-Setting Epoxy Adhesive.
6. A118.4 - Latex-Portland Cement Mortar.
7. A 118.5 - Chemical-Resistant Furan Mortar and Grout.
8. A118.6 - Ceramic Tile Grouts.
9. A118.7 - Polymer Mortified Cement Grouts.
10. A118.10 – Load-Bearing, Bonded Waterproofing Membranes for Thin-Set Ceramic Tile and Dimension Stone Installations.
11. A136.1 - Organic Adhesives for Installation of Ceramic Tile.
12. A137.1 - Ceramic Tile.

B. American Society for Testing and Materials (ASTM):

1. C 136 - Sieve Analysis of Fine and Coarse Aggregates.
2. C 144 - Aggregate for Masonry Mortar.
3. C 150 - Portland Cement.
4. C 207 - Hydrated Lime for Masonry Purposes.

5. C 373 - Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products.
6. C 503 - Marble Dimensional Stone (Exterior).
7. C 623 – Young's Modulus, Shear Modulus, and Poisson's Ratio for Glass and GlassCeramics by Resonance.
8. C 627 – Robinson Floor Test for Tile Service Level.
9. C 847-95 Metal Lath.
10. C 933-96a Welded Wire Lath.
11. C 1028 - Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
12. D 87 - Melting Point of Petroleum Wax (Cooling Curve).
13. D 226 - Asphalt Saturated Organic Felt Used in Roofing and Waterproofing.
14. D 4397 - Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
15. E-90 and E-413 for STC (Sound Transmission Class), E-492 and E-989 for IIC (Impact Insulation Class) – Sound Deadening Underlayments.

C. TCA Handbook for Ceramic Tile Installation by Tile Council of America, latest edition.

1.4 SUBMITTALS

A. Submit shop drawings, product data, and samples under provisions of Section [01300.] B.

Submit product data, specifications, and instructions for using mortars, adhesives and grouts.

C. Samples:

1. Submit color samples illustrating full color range of each type tile.

2. Upon final selection, submit tile mock-up mounted on a plywood backer board, illustrating tile patterns and colors, grout joint width and colors, and maximum color variations anticipated. Size of mock-up minimum of 24 by 24 inch).

3. Grout: Submit manufacturer's full range of standard and designated color samples for each type for Architect's selection.

D. Submit following Informational Submittals:

1. Certifications specified in Quality Assurance article.

2. Qualification Data: Manufacturer's and installer's qualification data.

3. Manufacturer's instructions.

E. Closeout Submittals:

1. Submit under provisions of Section 01700.

2. Maintenance Data: Include stain removal methods.

1.5 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Obtain each type and color tile material required from single source.

2. Obtain setting and grouting materials from one manufacturer to ensure compatibility.

3. Furnish a 10-year guarantee from installation material manufacturer. The guarantee is inclusive of installation materials, finish product, and labor.

4. Obtain prefabricated edge protection and transition and movement profiles from one manufacturer to ensure compatibility.

5. Obtain membrane from same manufacturer as setting material or from manufacturer approved by setting material manufacturer to ensure compatibility.

B. Manufacturer Qualifications:

1. Tile: Minimum 5 years experience in manufacture of tile products.

2. Setting Materials: Minimum 10 years experience in manufacture of setting and grout materials specified.

3. Membrane: Minimum 5 years experience in manufacture of membrane materials specified.

C. Installer Qualifications: Specializing in tile work having minimum of 5 years successful documented experience with work comparable to that required for this Project.

D. Certifications:

1. Submit “Master Grade Certificate” for each type of ceramic, quarry, and paver tile in accordance with requirements of ANSI A137.1.

2. Submit manufacturer’s certifications that mortars, adhesives, and grouts are suitable for intended use.

E. Conform to ANSI- Recommended Standard Specifications for Ceramic Tile - A137.1.

F. Conform to TCA Ceramic Tile: The Installation Handbook.

1.6 FIELD SAMPLES

A. General: Comply with provisions of Section 01400.

B. Sample Installation:

1. For final review of each type tile, construct sample panel of approximately 100 square feet.

2. Install in location as directed by Architect.

3. Show workmanship of finished work and construction techniques. C. Approved field samples may remain as a part of the Work.

1.7 PRE-INSTALLATION CONFERENCE

A. Conduct pre-installation conference in accordance with Section 01300.
B. Convene one week prior to commencing work of this section.

C. Require attendance of installation material manufacturer, tile supplier, tile installer and installers of related work. Review installation procedures and coordination required with related work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 01600.

B. Labeling: Comply with ANSI A137.1.

C. Deliver materials in manufacturer's unopened containers, fully identified with name, brand, type, and grade.

D. Protect materials from contamination, dampness, freezing, or overheating in accordance with manufacturer's instructions.

E. Broken, cracked, chipped, stained, or damaged tile will be rejected, whether built-in or not.

F. Protect mortar and grout materials against moisture, soiling, or staining.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Comply with requirements of referenced standards and recommendations of material manufacturers for environmental conditions before, during, and after installation.

B. Do not begin installation until building is completely enclosed and HVAC system is operating and maintaining temperature and humidity conditions consistent with "after occupancy" conditions for a minimum of 2 weeks.

C. Maintain continuous and uniform building temperatures of not less than 50 degrees F during installation nor more than 100 degrees F.

D. Ventilate spaces receiving tile in accordance with material manufacturers' instructions.

1.10 WARRANTY

A. Special Project Warranty: Submit a written warranty, executed by the Contractor, Installer, and Manufacturer, agreeing to repair or replace tile that fails in materials or workmanship within the specified warranty period.

1. Warranty Period: 2 years after date of Substantial Completion.

1.11 EXTRA MATERIALS

A. At completion of project, deliver to Owner extra stock of materials used on project as follows:
   1. (10) square feet of each color of floor tile for each unit.
   2. (10) square feet of each color of wall tile for each unit
   3. Six linear feet of each color and type of base for each unit B. Store in location

as directed by Owner.

C. Ensure materials are boxed and identified by manufacturer, type, and color.

1.12 MAINTENANCE DATA

A. Submit maintenance data under provisions of Section 01700.

B. Include cleaning methods, cleaning solutions recommended, stain removal methods, and polishes and waxes recommended.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Standard for Ceramic Tile: Comply with ANSI A137.1 “American National Standard Specifications for Ceramic Tile” for types, compositions, and grades of tile indicated.

1. Furnish tile complying with “Standard Grade” requirements unless otherwise indicated.

B. ANSI Standard for Tile Installation Materials: Comply with ANSI standard referenced with products and materials indicated for setting and grouting.

C. Colors, Textures, and Patterns: Where manufacturer’s standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:

1. Match color, texture, and pattern indicated by reference to manufacturer’s standard designations for these characteristics.

D. Factory Blending: For tile exhibiting color variations within the ranges selected during sample submittals, blend tile in factory and package accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples.

E. Mounting: Where factory-mounted tile is required, provide back-face or edge-mounted tile assemblies as standard with manufacturer unless another mounting method is indicated.

1. Where tile is indicated for installation in swimming pools, on exteriors or in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies that this type of mounting is suitable for these kinds of uses and has been successfully used on other projects.

F. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with a continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 CERAMIC TILE

A. Submit samples as indicated on drawings from range of acceptable manufacturers

2.3 TRIMMERS

A. Provide necessary caps, stops, returns, trimmers and other shapes to complete installation.

B. Color and finish to match wall tile.

2.4 MORTAR, GROUT, AND ADHESIVE MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements herein, provide products from one of the following manufacturers.

1. Custom Building Products, Seal Beach, CA.

2. Laticrete International, Inc., Bethany, CT

3. Mapei Corporation, Deerfield, FL.

2.5 MORTAR MATERIALS - THICK SET BEDS

A. Portland Cement With Latex Additive; Thick-Set:

1. Portland Cement: ASTM C 150, Type I, from one source only, non-staining and non-airentraining.

2. Mortar Sand: ASTM C 144, free of deleterious materials, well graded.

3. Setting Bed Sand: ASTM C 136, 100 percent passing No. 4 sieve.

4. Latex Additive:
   a. Description: Latex additive serving as replacement for gauging water, for use with site mixed portland cement mortar.
   b. Quantity: As recommended by latex additive manufacturer to produce workable consistency.
   c. Acceptable Products:
      1) CustomFloat Bedding Mortar mixed with Acrylic Mortar Admix 1:1 water by Custom Building Products or equal

2) 3701 Mortar Admix by Laticrete or equak. 3) Planicrete 50 by Mapei or equal..

2.6 MORTAR MAT.ERIALS - THIN SET BEDS

A. Portland Cement With Latex Additive; Thin-Set

1. Description: Latex additive and site mixed portland cement mortar. Complying with ANSI A118.4.

2. Quantity: As recommended by latex additive manufacturer.

3. Acceptable Products:
   a. CustomCrete Latex Mortar Admix with site mixed Mortar or CreteMix Mortar by Custom Building Products or equal.
   b. 4237 Latex Thin set Mortar Additive by Laticrete or equal.
   c. Keracrete System consisting of KER 303 Latex mixed with 1:1 sand/cement blend.by Mapei orequal.

2.7 ORGANIC ADHESIVE

A. Thin-set bond type, complying with ANSI A136.1, Type [1.] [2.]

B. Acceptable Products:

1. ReliaBond Ceramic Tile Mastic by Custom Building Products or equal.

2. AcrylPro Ceramic Tile Mastic by Custom Building Products or equal.

3. 15 Premium Multi-Mastic Adhesive by Laticrete or equal.

4. KER 903 Type 1 Organic Adhesive by Mapei or equal

2.8 EPOXY ADHESIVE

A. Multi-component, factory prepared, 100 percent epoxy resin and hardener with sand or mineral filler material.

B. Comply with ANSI A118.3 for thin-set applications for chemical resistant, water cleanable quarry tile installations.

C. Acceptable Products:

1. 100% Solids Epoxy Mortar by Custom Building Products or equal

2. Latapoxy 300 Epoxy Adhesive by Laticrete or equal

3. Kerapoxy 410 Chemical Resistant Epoxy Mortar by Mapei or equal.

2.9 GROUT

A. Latex-Modified Grout:

1. Description: Latex-modified, factory blended, mildew resistant, sanded, grout consisting of portland cement, graded quartz and additives; comply with ANSI A118.7.

2. Latex Additive: Type as recommended by latex mortar manufacturer.

3. Acceptable Products:
   a. Polyblend Sanded Tile Grout by Custom Building Products or equal.
   b. Satillo Grout Mix with Acrylic Mortar Admix 1:1 with water by Custom Building Products or equal.
   c. 500 Series Sanded Grout Mixed with 1776 Grout Admix Plus by Laticrete or equal.
   d. KER 200 polymer-modified sanded grout by Mapei or equal.

2.10 SOUND ISOLATION:

A. Sound deadening underlayment exceeding IIC (Impact Insulation Class) standard of 50 and STC (Sound Transmission Class) standard of 56.

1. Acceptable Products:
   a. #18 Sound Control Underlayment by Laticrete or equal.
   b. Mapei Kerafonic two component sound deadening mortar underlayment or equal.
   c. Mapei Mapelastic SM sheet membrane sound deadening underlayment or equal.
   d. Nobleseal SIS by The Noble Company, Grand Haven, MI. or equal.

2.11 CEMENTITIOUS BACKER UNITS

A. Description:

1. Cementitious composition with glass fiber reinforcement.

2. Product specifically manufactured as substrate material for application of ceramic tile in wet areas.

3. Comply with ANSI A118.9.

4. Thickness: ½ inch minimum.

B. Accessories:

1. Fasteners: Corrosion resistant type required by board manufacturer for securing units.

2. Joint Reinforcement Tape:
   a. 2 inch nominal width.
   b. Polymer coated fiberglass mesh of type recommended by board manufacturer.
   c. Acceptable Products

1) ½" Wonderboard Backerboard by Custom Building Products or equal.

3. Vapor Retarder:
   a. Comply with ASTM D 4397.
   b. Thickness and Maximum Permeance Rating: [4.0 mils, 0.19 perms] [6.0 mils, 0.13 perms].
   c. Vapor Retarder Tape: Pressure-sensitive tape of type required by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.12 MISCELLANEOUS MATERIALS

A. Temporary Protective Coating: Provide product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout, is compatible with tile and mortar/grout products, and is easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined, tasteless, odorless, containing at least 0.5 percent oil with a melting point of 120 degree F to 140 degree F per ASTM D 87.

2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as a temporary protective coating for tile.

2.13 MIXING MORTAR AND GROUT

A. Mix mortars and grouts in accordance with manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that areas to receive tile installed by thin bed method have wood float finish, are true within [1/4 inch in 10'-0" and are pitched to drains where required.

B. Condition of Surfaces to Receive Tile:
   1. Firm, dry, clean and free of oily or waxy films, mortar and soil.
   2. Grounds, anchors, plugs, hangers, bucks, electrical and mechanical work in or behind tile installed.

C. Air Temperature and Surfaces in Rooms to Receive Flooring: Between 60 degrees to 90 degrees F unless otherwise recommended by manufacturers of materials being installed.

3.2 PREPARATION

A. Clean substrates.

B. Wet down or wash dry, dusty surfaces and remove excess water immediately prior to application of tiles.

C. Prepare surfaces in strict accordance with instructions of manufacturer whose setting materials or additives are being used.

D. Acid Based Cleaners: Use not permitted.

E. Scarify concrete substrates with blast track equipment if necessary to completely remove curing compounds or other substances that would interfere with proper bond of setting materials. Clean and maintain substrate in condition required by setting material manufacturer. F. Do not seal substrate unless required by manufacturer.

G. Prime substrate when required by manufacturer.

H. Membrane:

1. Install membrane in accordance with Section 01600.

2. Flash membrane up adjacent walls and restraining surfaces.

3. Use preformed cove, corners, and expansion joint flashing.

4. Allow membrane to cure as prior to setting tile.

5. Do not allow construction traffic on membrane.

I. Apply primer-sealer to wood and plywood subfloors when recommended by setting materials manufacturer.

J. Blending: For tile exhibiting color variations within the ranges selected during sample submittals, verify that tile has been blended in factory and packaged accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

K. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent adhesion or staining of exposed tile surfaces by grout, protect exposed surfaces of tile against adherence of mortar and grout by precoating them with a continuous film of temporary protective coating indicated below, taking care not to coat unexposed tile surfaces:

1. Petroleum paraffin wax, applied hot.

2. Grout release.

3. Petroleum paraffin wax or grout release.

3.3 INSTALLATION

A. Cement Board Substrate

1. Place rough side out and fasten with galvanized or resin coated gypsum board screws at 8 inches on center in field of panel and at 6 inches on center at edges.

2. Provide ¼ inch gap above floor or fixture lip for flexible calking.

3. Maintain manufacturer's required space between board edges.

4. Fill joints by applying tile setting material and joint reinforcement.

B. Vapor Retarder:

1. Extend vapor retarder to extremities of areas indicated to be protected from vapor transmission.

2. Secure in place with mechanical fasteners or adhesives.

3. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose mineral-fiber insulation.

4. Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs.

5. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; space fasteners no greater than 16 inches apart.

6. Seal joints in vapor retarders caused by pipes, conduits, electrical boxes and similar items penetrating vapor retarders with vapor retarder tape.

7. Repair tears and punctures in vapor retarder immediately before concealing it with the installation of cementitious backer units.

C. Membrane:

1. Install membrane in accordance with Section 01600.
2. Install membrane with products or methods approved in writing by membrane manufacturer when joining, sealing, fastening, or adhering sheet membranes.

3. Flash membrane to cure prior to setting tile.

4. Do not allow construction traffic on membrane.

D. Crack Isolation Membrane

1. Install crack isolation membrane over cracks of up to 1/8 inch or greater in substrates. Apply a 12 inch wide strip centered on crack. Install in accordance with manufacturer's recommendations.

2. Install membrane with products or methods approved in writing by membrane manufacturer when joining, sealing, fastening, or adhering sheet membranes.

E. Waterproofing

1. Install waterproofing in strict compliance with manufacturer's instructions.

2. Flash waterproofing up adjacent walls in accordance to manufacturer's details, to a height of [4] inches.]

3. Flood test waterproof membranes after fully cured.

4. Field Quality Control water test when required.

F. Tile Installation, General

1. Install tile materials in accordance with ANSI A137.1, other referenced ANSI and TCA specifications, and TCA "Handbook for Ceramic Tile Installation", except for more stringent requirements of manufacturer or these Specifications.

2. Cut and fit tile tight to protrusions and vertical interruptions and treat with a compatible sealant as specified in Section 07900 Form corners and bases neatly.

3. Work tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joint watertight, without voids, cracks, excess mortar, or grout.

4. Prepare surface, fit, set, bond, grout and clean in accordance with applicable requirements of ANSI standards and Tile Council of America.

G. Layout

1. Lay out work [to pattern indicated] so that full tile or joint is centered on each wall and no tile of less than half width need be used. Do not interrupt pattern through openings. Lay out tile to minimize cutting and to avoid tile less than half size.

2. For heights stated in feet and inches, use courses of full tile to produce nearest attainable heights without cutting tile.

3. No staggered joints will be permitted.
4. Align joints in tile in both directions.

5. Align joints between floor and base tile.

6. Make joints between sheets of tile exactly same width as joints within sheet.

7. File edges of cut tile smooth and even.

8. Cut and fit tile at penetrations through tile. Do not damage visible surfaces. Carefully grind edges of tile abutting built-in items. Fit tile at outlets, piping and other penetrations so that plates, collars, or covers overlap tile.

9. Extend tile work into recesses and under or behind equipment and fixtures, to form complete covering without interruptions, except as otherwise indicated. Terminate work neatly at obstructions, edges and corners without disrupting pattern or joint alignments.

10. Accurately form intersections and returns.

11. Form internal angles [square] [coved] and external angles [bullnosed] [square].

H. Thick Bed Method, Horizontal Surfaces

1. Apply slurry bond coat approximately 1/16 inch thick to substrate surface using flat trowel.

2. Place thick bed mortar, [1-1/4 inch thick nominally] onto slurry bond coat while coat is still wet and tacky.

3. Spread prepared mortar approximately one-half desired bed thickness and then lay reinforcing mesh.

4. Lap wire 3 inches and place additional mortar on top of wire to bring bed to required thickness.

5. Rod and compact mortar with steel trowel.

6. Before placing tiles on green or wet screed bed, apply slurry bond coat approximately 1/16 inch thick to mortar using flat trowel.

7. Apply mortar skim coat to back of each tile or sheet of tile immediately prior to placing on bed.

8. Place tiles in wet slurry coat before surface dries maintaining uniform joints.

9. After each tile or sheet of tiles is laid, beat tile with wooden block or rubber mallet to level surface and embed tiles.

10. Perform beating before mortar takes initial set.

11. Pitch surface to drain where required.

12. On hardened screed or mortar bed, install tiles by thin bed method.
13. Sound tiles after setting. Replace hollow sounding tiles.

14. Clean excess mortar or adhesive from surface of tile with wet cheese cloth (not a sponge) while mortar is fresh.

I. Thin Set Method, Floors and Walls

1. Apply mortar or adhesive with notched trowel using scraping motion to work material into good contact with surface to be covered. Maintain 90 percent coverage on back of tile and fully bed all corners.

2. Apply only as much mortar or adhesive as can be covered within allowable windows as recommended by mortar or adhesive manufacturer or while surface is still tacky.

3. When installing large tiles, ceramics or mosaics, trowel small quantity of mortar or adhesive onto back of each tile or sheet of tiles.

4. Set tiles in place and rub or beat with small beating block.

5. Beat or rap tile to ensure proper bond and also to level surface of tile.

6. Align tile to show uniform joints and allow to set until firm.

7. Clean excess mortar or adhesive from surface of tile with wet cheese cloth (not a sponge) while mortar is fresh.

8. Allow face mounted tile to set until firm before removing paper and before grouting.

9. Sound tile after setting. Replace hollow sounding tiles.

L. Grouting

1. Allow tiles to set a minimum of 48 hours before grouting.

2. If bonding materials are rapid setting, follow manufacturer's recommendations.

3. Install in accordance with grout manufacturer's recommendations and ANSI A108.10.

4. Pack joints full and free before mortar takes initial set.

5. Clean excess grout from surface with wet cheesecloth as work progresses. Do not use hydrosponges.

6. Cure after grouting by covering with kraft or construction paper for 72 hours.

7. Install sealant in vertical wall joints at interior corners.

M. Marble Threshold

1. Provide thresholds at wall or framed openings to other building areas not receiving tile.

2. Set one piece threshold in adhesive without voids, full width of door opening.

3. Point threshold base flush with adjoining tile floors.

4. Cope ends to fit door frame profile.

N. Control Joints and Other Sealant Usage

1. Install control joints where tile abuts retaining surfaces such as perimeter walls, curbs, columns, wall corners and directly over cold joints and control joints in structural surfaces conforming to architectural details.

2. Install control joint in floors at spacings as indicated in TCA Installation Handbook, unless noted otherwise.

3. Rake or cut control joints through setting bed to supporting slab or structure. Keep joints free of mortar.

4. Install in accordance with TCA Installation Handbook.

5. Fill joints with self-leveling polyurethane sealant and backing material specified in Section [07900]

6. Fill joints around toilet fixtures with white silicone sanitary sealant. Refer to Section [07900]

O. Expansion Joints:

1. Keep expansion joints free of mortar and grout.

2. Use manufacturer's expansion joint flashing when covering expansion joints with waterproof or crack isolation membranes.

3. Provide expansion joints directly over changes in material, over control and expansion joints in substrate, at juncture of floors and walls, at other restraining surfaces such as curbs, columns, bases, and wall corners, and where recommended by TCA EJ171 Expansion Joint requirements.

4. Install sealant in expansion joints.

5. Provide sealant material at items penetrating tile work, unless otherwise indicated.

6. Provide sealants and related materials in accordance with cited ANSI and TCA requirements.

3.4 ADJUSTING

A. Sound tile after setting. Replace hollow sounding units.

3.5 CLEANING

A. Clean excess mortar from surface with water as work progresses. Perform cleaning while mortar is fresh and before it hardens on surfaces.

B. Sponge and wash tile diagonally across joints. Polish with clean dry cloth

C. Remove grout haze following recommendation of mortar additive manufacturer. Do not use acids for cleaning.

D. [Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to brick and grout manufacturer. Trap and remove coating to prevent it from clogging drains.]

3.6 PROTECTION

A. Prohibit traffic from floor finish for 72 hours after installation.

B. Where temporary use of new floors is unavoidable, supply large, flat boards or plywood panels for walkways over kraft paper.

C. Protect work so that it will be without any evidence of damage or use at time of acceptance.

END OF SECTION

09510

ACOUSTIC CEILING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Section Includes:

1. Acoustical ceiling panels.

2. Exposed grid suspension system.

3. Wire hangers, fasteners, main runners, cross tees, and wall angle moldings.

B. Related Sections

1. Section 09250 - Gypsum Board

2. Section 09120 - Suspension System Framing and Furring for Plaster and Gypsum Board Assemblies

3. Division 15 Sections - Mechanical Work

4. Division 16 Sections - Electrical Work

C. Alternates

1. Prior Approval: Unless otherwise provided for in the Contract documents, proposed product substitutions may be submitted no later than TEN (10) working days prior to the date established for receipt of bids. Acceptability of a proposed substitution is contingent upon the Architect's review of the proposal for acceptability and approved products will be set forth by the Addenda. If included in a Bid are substitute products which have not been approved by Addenda, the specified products shall be provided without additional compensation.

2. Submittals which do not provide adequate data for the product evaluation will not be considered. The proposed substitution must meet all requirements of this section, including but not necessarily limited to, the following: Single source materials suppliers

(if specified in Section 1.5); Underwriters' Laboratories Classified Acoustical performance; Panel design, size, composition, color, and finish; Suspension system component profiles and sizes; Compliance with the referenced standards.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

A. Manufacturer's Product and Maintenance Data: Include detailed instructions for repair and for modification due to changes in penetrating items

1. ASTM A 1008 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
2. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
3. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
4. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
5. ASTM C 635 Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
6. ASTM C 636 Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
7. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
8. ASTM E 1414 Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
9. ASTM E 1111 Standard Test Method for Measuring the Interzone Attenuation of Ceilings Systems.
10. ASTM E 1264 Classification for Acoustical Ceiling Products.
11. ASTM E 1477 Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.
12. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
13. ASTM E 119 Standard Test Methods for Fire Tests of Building Construction and Material.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each type of acoustical ceiling unit and suspension system required.

B. Samples: Minimum 6 inch x 6 inch samples of specified acoustical panel; 8 inch long samples of exposed wall molding and suspension system, including main runner and 4 foot cross tees.

C. Shop Drawings: Layout and details of acoustical ceilings. Show locations of items which are to be coordinated with, or supported by the ceilings.

D. Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, each carton of material must carry an approved independent laboratory classification of NRC, CAC, and AC.

E. If the material supplied by the acoustical subcontractor does not have an Underwriter's Laboratory classification of acoustical performance on every carton, subcontractor shall be required to send material from every production run appearing on the job to an independent or NVLAP approved laboratory for testing, at the architect's or owner's discretion. All products not conforming to manufacturer's current published values must be removed, disposed of and replaced with complying product at the expense of the Contractor performing the work.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.

B. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.

C. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 for Class A products.

D. Flame Spread: 25 or less

E. Smoke Developed: 50 or less

F. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical ceiling units, permit them to reach room temperature and stabilized moisture content.

C. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

1.7 PROJECT CONDITIONS

A. Space Enclosure:

1. Standard Ceilings: Do not install interior ceilings until space is enclosed and weatherproof; wet work in place is completed and nominally dry; work above ceilings is complete; and ambient conditions of temperature and humidity are continuously maintained at values near those intended for final occupancy. Building areas to receive ceilings shall be free of construction dust and debris.

2. HumiGuard Plus Ceilings: Building areas to receive ceilings shall be free of construction dust and debris. Products with HumiGuard Plus performance and hot dipped galvanized steel, aluminum or stainless steel suspension systems can be installed up to 120°F (49°C) and in spaces before the building is enclosed, where HVAC systems are cycled or not operating. Cannot be used in exterior applications where standing water is present or where moisture will come in direct contact with the ceiling.

3. HumiGuard Max Ceilings: Building areas to receive ceilings shall be free of construction dust and debris. Ceilings with HumiGuard Max performance can be installed in conditions up to 120°F (49°C) and maximum humidity exposure including outdoor applications, and other standing water applications, so long as they are installed with either SS Prelude Plus, AL Prelude Plus, or Prelude Plus XL Fire Guard suspension systems. Products with HumiGuard Max performance can be installed in exterior applications, where standing water is present, or where moisture will come in direct contact with the ceiling. Only Ceramaguard with AL Prelude Plus suspension system can be installed over swimming pools.

1.8 WARRANTY

A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace acoustical panels that fail within the warranty period. Failures include, but are not limited to:

1. Acoustical Panels: Sagging and warping

2. Grid System: Rusting and manufacturer's defects

B. Warranty Period Standard:

1. Acoustical panels: One (1) year from date of substantial completion.

2. Cirrus Acoustical panels: Ten (10) year from date of substantial completion. Note Space Enclosure requirements

3. Grid: Ten years from date of substantial completion.

C. Warranty Period HumiGuard:

1. Acoustical panels: Ten (10) years from date of substantial completion.

2. Grid: Ten (10) years from date of substantial completion.

D. Acoustical panels and grid systems with HumiGuard Plus or HumiGuard Max performance supplied by one source manufacturer is fifteen (15) years from date of substantial completion.

E. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.9 MAINTENANCE

A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.

1. Acoustical Ceiling Units: Furnish quality of full-size units equal to 5.0 percent of amount installed.

2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 2.0 percent of amount installed.

Part 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ceiling Panels:

1. Armstrong World Industries, Inc.

2. USG Industries

2.2 SUSPENSION SYSTEMS

A. General Areas (Non-Humid): Armstrong World Industrie; CLEAN ROOM 15/16”

1. System includes main tees, cross tees, angles, wall molding and hold down clips

C. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

D. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least time three design load, but not less than 12 gauge.

2.3 CEILING TILE

A. Type 1: Armstrong World Industries; CLEAN ROOM VL 24x48 (Back of House areas and Starbucks prep room)
B. Type 2: Armstong World industries: Cortega Second Look II 2758 - 24x48 (Conference Center and Corridors)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations. (Exception: HumiGuard Max Ceilings)

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.

3.3 INSTALLATION

A. Install suspension system and panels in accordance with the manufacturer's instructions, and in compliance with ASTM C 636 and with the authorities having jurisdiction.

B. Suspend main beam from overhead construction with hanger wires spaced 4-0 on center along the length of the main runner. Install hanger wires plumb and straight.

C. Install wall moldings at intersection of suspended ceiling and vertical surfaces. Miter corners where wall moldings intersect or install corner caps.

D. For reveal edge panels: Cut and reveal or rabbet edges of ceiling panels at border areas and vertical surfaces.

E. Install acoustical panels in coordination with suspended system, with edges resting on flanges of main runner and cross tees. Cut and fit panels neatly against abutting surfaces. Support edges by wall moldings.

3.4 ADJUSTING AND CLEANING

A. Replace damaged and broken panels.

B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Provide painting/finishing work as indicated on the drawings and schedules, and as herein specified.

B. The work includes painting and finishing of new and rehabilitated existing interior and exterior exposed items and surfaces throughout the project, except as herein specified in paragraph 'Painting Not Included".

1. Surface preparation, priming and coats of paint specified are in addition to shop-priming and surface treatment specified under other sections except as otherwise specified.

C. Such work includes field painting as follows:

1. Painting all new and existing hollow metal, including doors, frames, louvers, grilles, closures, trim and the like, including factory-primed components, on the exterior and interior, furnished under other divisions of the specifications and by the various trades.

2. All new exposed structural steel and ferrous metal surfaces, such as the steel structure, miscellaneous angles, lintels, channels, clips, bolts, etc. railings, and all exposed miscellaneous steel items.

3. All new and existing gypsum wallboard and plaster surfaces surfaces.

4. Painting safety surface markings at new and existing fire extinguisher locations.

5. Painting of the mechanical and electrical items:

a. Within the finished areas of ceiling, walls, floors paint all mechanical and electrical work items exposed to view, such as wall grilles, registers, and access panels that are not factory finished; valves, bare, and covered pipes and ducts; hangers, conduits, and all fastenings; exposed steel and iron work and primed metal surfaces of equipment installed under the mechanical and electrical trades; and sprinkler piping system.

b. Paint all unprotected ferrous metal surfaces in concealed spaces above the finished ceilings, on the roof, and in the mechanical and electrical equipment room.

7. Mechanical and Electrical Identifications. For mechanical and electrical identifying of equipment, piping, conduit lettering, signs and directional flows see Divisions 15 and 16.

8. Paint all exposed masonry, new and existing.

D. "Paint" as used herein means all coating systems materials, including surface preparation, primers, emulsions, enamels, sealers and fillers, and other applied materials whether used as primer components, intermediate or finish coats.

E. Paint all exposed surfaces whether or not they are shown in "schedules". Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas. If color or finish is not designated, the Architect will select these from standard colors available for the materials systems as specified.

F. Paint all areas of the existing rehabilitated facilities and all areas disturbed under this contract by removals and relocations.

1.3 PAINTING NOT INCLUDED

A. The following categories of work are not included as part of the painter-applied finish work, or are included in other sections of these specifications, unless otherwise shown or specified.

B. Shop Priming

1. Unless otherwise specified, shop priming of ferrous metal items is included under the various sections for structural steel, miscellaneous metal, hollow metal work, and similar items; also, for fabricated components such as metal door assemblies and shopfabricated factory-built mechanical and electrical equipment or accessories.

C. Pre-Finished Items

1. Unless otherwise indicated, do not include painting when factory finishing or installer finishing is specified for such items as (but not limited to) acoustic materials, finished mechanical and electrical equipment including plumbing and light fixtures and switchgear and distribution cabinets.

2. For mechanical and electrical damaged factory finished surfaces requiring protective paint coatings, see Divisions 15 and 16.

3. All factory-finished items such as ceiling diffusers, cabinet type unit heaters, finned tube radiation, and propeller type unit heaters shall not be painted.

D. Unfinished Wall, Ceiling, and Floor Surfaces

1. Unless otherwise indicated, painting is not required on the exposed to view concrete floors of spaces, and exposed exterior concrete surfaces of foundation walls, walks and paving, except for painting required by parking lanes and traffic directional markings.

E. Operating Parts and Labels

1. Do not paint any moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motor and fan shafts, unless otherwise indicated.

2. Do not paint over any code required labels, such as Underwriter's Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

1.4 SUBMITTALS

A. Prepare and submit catalogue data in accordance with section "Special Provisions", Division 1.

B. Samples. Painting

1. Submit samples for review of color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Provide a listing of the material and application for each coat of each finish sample.

2. On a 12" x 12" hardboard, provide 2 samples of each color or material, with texture to simulate actual conditions. Resubmit each sample as requested until required sheen, color, and texture are achieved.

3. On Exterior E.I.W.S., provide two 12" x 12" samples of each type of finish and color, defining filler, prime and finish coats. Coordinate with E.I.W.S., where required.

4. Provide mock-up of painted area in each color/finish for review and approval on site prior to start of work.

C. Catalogue data shall include manufacturer's specifications, including paint label analysis and application instructions for each material supplied.

D. Provide complete MSDS data for all paints and coatings used, including clearly stated VOC content in grams per liter (g/L)

1.5 DELIVERY AND STORAGE

A. Deliver all materials to the job site in original, new, and unopened packages bearing manufacturer's name and label.

B. Provide labels on each container with the following information:

1. Name or title of material.

2. Fed. Spec. number, if applicable.

3. Manufacturer's stock number.

4. Manufacturer's name.

5. Contents by volume, for major pigment and vehicle constituents.

6. Thinning instructions.

7. Application instructions.

C. Keep the space for storage of equipment and materials in a clean and orderly condition. Keep all waste and paint rags in metal containers, tightly covered, and safely dispose of them at the end of each working day. Take precaution to avoid fire. Provide an approved type of fire extinguisher immediately outside each paint storage area.

1.6 JOB CONDITIONS

A. Do not apply water base paints when the temperature of surfaces to be painted and the surrounding air temperatures are below 50 degrees Fahrenheit, unless otherwise permitted by the paint manufacturer's printed instructions.

B. Do not apply solvent-thinned paints when the temperature of surfaces to be painted and the surrounding air temperatures are below 45 degrees Fahrenheit, unless otherwise permitted by the paint manufacturer's printed instructions.

C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or to damp or wet surfaces, unless otherwise permitted by the paint manufacturer's printed instructions. Painting may be continued during inclement weather only if the areas and surfaces to be painted are enclosed and heated within the temperature limits specified by the paint manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 COLORS AND FINISHES

A. Paint surface treatments, finishes, and areas are shown on the drawings and indicated in the schedules of the contract documents.

B. Final acceptance of colors will be from samples applied on the job.

C. Proprietary names used to designate colors or materials are not intended to imply that products of the manufacturers are required to the exclusion of equivalent products of other manufacturers.

D. Paint Coordination. Provide finish coats which are compatible with prime paints use. Review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coating systems for various substrates. Upon requests from other trades, furnish information on characteristics of specified finish materials, to ensure compatible prime coats are used. Provide barrier cots over incompatible primers or remove and reprime as required.

2.2 MATERIAL QUALITY

A. Provide the quality grade of the various types of coatings as regularly manufactured by approved paint materials manufacturers. Materials not displaying the manufacturer's identification as a standard will not be acceptable

B. Provide undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by the paint manufacturer, and use only within recommended limits.

2.3 VOC LIMITS

A. VOC content for paints and coatings shall not exceed the following limits:

1. Flat paints and coatings VOC content not more than 50 g/L

2. Non-flat paints and coatings VOC conyents not more than 150 g/L

3. Anti-corrosive coatings VOC content not more than 250 g/L

2.4 MATERIALS

A. See "schedule" following this section for material requirements.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which painting work is to be applied. Starting of painting work will be construed as the Contractor's acceptance of the surfaces and conditions within any particular area. – Contractor to perform walkthru Gypsum drywall contractor to identify remedial work and sign-off on surface prior to start of work.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable paint film.

3.2 SURFACE PREPARATION

A. General. Perform preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions as herein specified, for each particular substrate condition.

1. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surfaceapplied protection prior to surface preparation and painting operations. Remove, if necessary, for the complete painting of the items and adjacent surfaces. Following completion of each space or area, reinstall the removed items by workmen skilled in the trades involved.

2. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Program the cleaning and painting so that contaminants from the cleaning process will not fall onto newly painted, wet surfaces.

B. Cementitious Materials

1. Prepare cementitious surfaces of concrete, concrete block (CMU) to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, and roughening as required to remove glaze.

2. Determine the alkalinity and moisture content of the surfaces to be painted by performing appropriate tests. If the surfaces are found to be sufficiently alkaline to cause blistering and burning of the finish paint, correct this condition before application of paint. Do not paint over surfaces where the moisture content exceeds that permitted in the manufacturer's printed directions.

C. Wood

1. Clean wood surfaces to be painted of all dirt, oil, or other foreign substances with scrapers, mineral spirits and sandpaper as required. Sandpaper smooth those finished surfaces exposed to view, and dust off. Scrape and clean small, dry seasoned knots and apply a thin coat of white shellac or other approved sealer, before application of the priming coat. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sandpaper smooth when dried.

2. Prime wood required to be job-painted immediately upon delivery to job. Prime edges, ends, face, undersides, and backsides of such wood, trim, and overhead doors.

D. Ferrous Metals

1. Clean ferrous surfaces, which are not galvanized or shop-coated, of oil, grease, dirt, loose mill scale, and other foreign substances by solvent or mechanical cleaning.

2. Touch-up shop-applied prime coats wherever damaged or bare, where required by other sections of these specifications. Clean and touch-up with the same type shop primer.

3.3 MATERIALS PREPARATION

A. Mix and prepare painting materials in accordance with manufacturer's directions.

B. Store materials not in actual use in tightly covered containers. maintain containers used in storage, mixing and application of paint in a clean condition, free of foreign materials and residue.

C. Stir materials before application to produce a mixture of uniform density, and stir as required during the application of the materials. Do not stir surface film into the material. Remove the film and, if necessary, strain the materials before using.

3.4 APPLICATION

A. General

1. Apply paint in accordance with the manufacturer's directions. Use applicators and techniques best suited for.

2. Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint, until the paint film is of uniform finish, color, and appearance.

3. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces.

4. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, nonspecular black paint.

5. Paint the back sides of access panels and removable or hinged covers to match the exposed surfaces.

6. Finish exterior doors on tops, bottoms, and side edges the same as the exterior faces, unless otherwise indicated.

7. Omit the first coat (primer) on metal surfaces which have been shop-primed and touchup painted, unless otherwise specified.

B. Minimum Coating Thickness

1. Apply each material at not less than the manufacturer's recommended spreading rate, to provide a total dry film thickness of not less than 5.0 mils for the entire coating system of prime and finish coats for 3 coat work.

2. Prime Coats. Apply a prime coat to material which is required to be painted or finished, and which has not been prime coated by others.

3. Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.

4. Pigmented (Opaque) Finishes. Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

5. Completed work. Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

3.6 FIRE EXTINGUISHER SAFETY MARKINGS

A. Wall-Hung Extinguishers and Hose Racks

1. Wall-hung extinguishers will have a painted solid rectangle extending 6" beyond each side of the extinguisher, using safety red meeting color number 11105 in Fed. Spec. 595. Where the location is partially obscured by columns or other obstructions, and additional red stripe will be painted not less than 12" high and the same width as the extinguisher rectangle, at least 12' from the floor or at ceiling height.

B. Column-Hung Extinguishers

1. Extinguishers hung on columns will have a painted red band encircling the column and extending 6" above and below the extinguisher. Where the location is partially hidden by another column, an additional red band at least 12" high will be painted 12' above the extinguisher, or at ceiling level.

C. Hose rack locations shall be similar to wall Items above, 6" beyond surfaces.

3.7 COLOR CODES

A. Color will be used for marking physical hazards, location of safety equipment, and identification of fire and other protective equipment in accordance with American Standard Requirements, "Safety Color Code for Marking and Identification of Certain Equipment". Color coding for all piping will be in accordance with ANSI A13.1 and OSHA Standard 1410.144.

3.8 CLEAN-UP AND PROTECTION

A. Clean-Up. During the progress of the work, remove from the project daily all discarded paint materials, rubbish, cans, and rags.

1. Upon completion of painting work, clean all window glass and other paint splattered surfaces. Remove splattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

B. Protection. Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damages by cleaning, repairing or replacing and repainting, as directed by the Contracting Officer.

1. Remove "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings after completion of painting operations.

3.9 PAINTING SCHEDULE

A. Exterior Ferrous Metal. Silicone Alkyd, Eggshell Finish on all non-primed metal surfaces. Prepare, treat, and provide metal primer followed by 2 coats as specified.

1st coat - Zinc Chromate DTM primer
2nd coat - Latex High Gloss
3rd coat - Latex High Gloss

B. Exterior Concrete (Exposed) and stucco -. 1st coat - alkyd undercoat
2nd coat - alkyd enamel (semi-gloss)
3rd coat - alkyd enamel (semi-gloss)

C. Exterior and Interior Wood Surfaces (opaque finish). Alkyd Semi-Gloss Finish.
1st coat - alkyd undercoat
2nd coat - alkyd enamel (semi-gloss)
3rd coat - alkyd enamel (semi-gloss)

E. Interior Ferrous Metals. Alkyd, Semi-Gloss Finish.
Spot coat - Zinc chromate primer on abraded surfaces of shop primed surfaces. On exposed galvanized metal, treatment and primer per paint manufacturer. On all nonprimed metal surfaces, prepare, treat, and provide metal primer followed by 2 coats as specified.

1st coat - Polyurethane alkyd blend enamel (semi-gloss)
2nd coat - Polyurethane alkyd blend enamel (semi-gloss)

G. Interior Drywall, Interior ceilings and exsiting plaster surfaces - Latex, Flat Finish.
1st coat - latex primer-sealer
2nd coat - latex flat
3rd coat - latex flat

H Repainting of all existing exposed rehabilitated interior surfaces shall include the required prep and touch-up primer, plus a 1 coat of finish paint for material as specified for new work surfaces. Repainting of the existing exterior CMU wall along column Z line with the new windows.

I. Parking Stripes and Traffic Markings. Semi-gloss 4" wide stripes, modified V.T. alkyd (quick dry), yellow only.

J Stained Wood Doors and Baseboard and Trim. Sand smooth.
1st coat - paste wood filler
2nd coat - stain and wipe clean.
3rd coat - polyurethane - low lustre
4th coat - polyurethane - low lustre

END OF SECTION

SECTION 09705
EPOXY URETHANE FLOORING

PART 1.00 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.02 WORK INCLUDED

A. Work of this Section includes all labor, materials, equipment and services necessary to complete the urethane cement composition flooring and integral base as scheduled on the drawings and/or specified herein.

1.03 RELATED WORK

A. Concrete - Section 03300.

B. Floor drains - Division 15.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product Data: Submit manufacturer's technical data, application instructions and general recommendations for the urethane cement composition flooring specified herein.

C. LEED Submittals:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, submit documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    a. Include statement indicating costs for each product having recycled content.
    b. Include LEED Product Information Form for LEED Credits MR 4.1 and 4.2.
2. Product Data for Credit EQ 4.2: For field applied, interior, paints coatings and primers, include printed statement of VOC content indicating compliance with Credit requirements.
    a. Include LEED Product Information Form for LEED Credit EQ 4.2.
3. Provide additional documentation for products as required to achieve each Credit(s).

D. Samples for initial selection purposes in form of sample of red, gray or natural pigmented Tek-Crete

1. Submit 2-1/2" x 4" samples in color (red or gray) the selection shall be designated by the Architect.

E. Samples for Verification: For each resinous flooring system or color specified, provide 2 each, 6 inches (150mm) square samples in the selected color and texture, applied to a ridged backing by the installing contractor for this project.

F. Material certificates signed by manufacturer certifying that the urethane cement composition flooring supplied for the project complies with requirements specified herein.

G. Maintenance Instructions: Submit manufacturer's written instructions for recommended maintenance practices.

H. Contractor Certification: Submit a letter from the primary materials manufacturer certifying that the installing contractor has been properly trained in the application of the materials being installed, is acceptable to the materials manufacturer, with a record of successful in-service performance.

1. Engage an installer who employs only persons trained and approved by the resinous flooring manufacturer for applying resinous flooring systems specified.
2. Engage an installer who is certified in writing by the resinous flooring manufacturer as a factory trained applicator qualified to apply the specified resinous flooring system.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer or applicator that has specialized in installing resinous flooring types similar to that required for this Project and who is acceptable to manufacturer of primary materials.

B. Single-Source Responsibility: Obtain urethane cement composition flooring materials, including primers, resins, hardening agents, and finish or sealing coats, from a single manufacturer. Provide secondary materials, including patching and fill materials, joint sealant, accessory items, and repair materials. Of a type and from a source recommended by the manufacturer of the primary materials

C. Qualified Materials: Request for material approvals for any products other than the specified products must be submitted to the architect two weeks prior to the bid, including complete application specification, physical characteristics, and chemical resistance data. Any request after this date will not be accepted. Failure of performance requires immediate removal and replacement of unapproved substituted material with those originally specified at no cost to the owner, architect, construction manager, or general contractor.

D. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set the standard of quality for materials and installation.

1. Apply all components of the specified resinous flooring system at the specified thickness and finished in the texture and color as selected. Apply a minimum 100 square feet area to simulate the actual installation characteristics. Include areas that demonstrate the finished cove base, joint detailing, terminations or any other special conditions.
2. Simulate finished lighting conditions for Architects review of mockups.
3. Approved mockups may become part of the completed work if undisturbed at the time of substantial completion.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels containing brand name and directions for storage and mixing with other components.

B. Store materials to comply with manufacturer's directions to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

1.07 PROJECT CONDITIONS

A. Environmental Conditions: Comply with urethane cement composition flooring manufacturer's directions for maintenance of ambient and substrate temperature, moisture, humidity, ventilation, and other conditions required to execute and protect Work.

B. Lighting: Permanent lighting will be in place and working before installing resinous flooring.

C. Moisture Vapor Transmission: Perform Calcium Chloride test in conformance to ASTM F1869 or In Situ relative humidity test conforming to ASTM F2170 to determine moisture vapor emission levels prior to application of any component of the flooring system. Do not install flooring over substrate with MVT emission levels in excess of 14 lbs. per 24 hour period over a 1000 square foot area or with a relative humidity in excess of 88%. Notify the architect immediately if MVT or rh levels exceed these levels.

PART 2.00 - PRODUCTS

2.01 MATERIALS

A. Troweled urethane cement composition flooring shall be Dex-O-Tex Tek-Crete SL as manufactured by Crossfield Products Corp. in Rancho Dominguez, California and Roselle Park, New Jersey.

2.02 PROPERTIES

A. Colors: As indicated, or if not otherwise indicated, as selected by Architect from manufacturer's standard colors.

B. Physical Properties:
Provide flooring system that meet or exceed the listed minimum physical property requirements when tested according to the referenced standard test method in parentheses.

Compressive Strength (ASTM C579) .....……..…….8,100 psi.

Density (ASTM C905) .....……..……130 lbs/ft^3

Water Absorption (MIL PRF-3134) .....…….……0.64%

Surface Hardness (ASTM D2240) .....……....85- 90 Durometer "D"

Abrasion Resistance (ASTM D1044) .....…….0.0 gr.

Adhesion (ASTM D4541)……>400 psi (100% failure in concrete)

Flammability-Critical Radiant Flux (ASTM E648).....Greater than 1.07 watts/cm^2

Resistance to Fungal Growth (ASTM G21) .....…….Passes Rating 1

PART 3.00 - EXECUTION

3.01 INSPECTION

A. Examine the areas and conditions where the urethane cement composition flooring is to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected by the Contractor in a manner acceptable to the Architect.

B. Moisture Test: Perform moisture test in conformance with ASTM F 1869 and ASTM F 2170

3.02 PREPARATION

A. Substrate: Perform preparation and cleaning procedures according to flooring manufacturer's instructions for particular substrate conditions involved, and as specified. Provide clean, dry, and neutral substrate for flooring application.

B. Concrete Surfaces: Shot-blast, or power scarify as required to obtain optimum bond of flooring to concrete. Remove sufficient material to provide a sound surface free of laitance, glaze, efflorescence, and any bond-inhibiting curing compounds or form release agents. Remove grease, oil, and other penetrating contaminate. Prepare substrate in

accordance with SSPC SP 13. Repair damaged and deteriorated concrete to acceptable condition. Leave surface free of dust, dirt, laitance, and efflorescence.

C. Materials: Mix resin hardener and aggregate as required, and prepare materials according to flooring system manufacturer's instructions.

3.03 APPLICATION

A. General: Apply each component of urethane cement composition flooring system according to manufacturer's directions to produce a uniform monolithic flooring surface of thickness indicated.

B. Body Coat: Over prepared surface, Screed mortar mix at nominal 3/16" – ¼"-inch thickness as specified. Allow material flow out and begin to settle. Back roll with a spike roller or looped roller as appropriate to distribute material to a smooth even finish.

C. Cove Base: Apply cove base mix to wall surfaces at locations shown to form cove base height of 4 inches unless otherwise indicated. Follow manufacturer's printed instructions and details including taping, mixing, troweling, and sanding, of cove base.

3.04 CURING, PROTECTION AND CLEANING

A. Cure urethane cement composition flooring materials according to manufacturer's directions, taking care to prevent contamination during application stages and before completing curing process. Close application area for a minimum of 24 hours.

END OF SECTION

1. GENERAL PROVISIONS

1.1 The applicable requirements and conditions of specifications section "General Provisions" of specifications division 16100, General Electrical, are hereby made an integral part of this section.

1.2 The work governed by these specifications includes but is not limited to that as defined in specifications section "Scope of Work" of specifications division 16100, General Electrical.

2. INSTALLATION

2.1 Provide all equipment and materials in accordance with the recommendations and instructions of the respective manufacturers. This includes recommendations and instructions for equipment furnished by other trades or the owner and installed or connected by the electrical contractor.

2.2 Perform all work in an approved first class and workmanlike manner and conform to the best practices of the trade and to all requirements of the NEC.

2.3 Protect and preserve all existing, new and proposed raceways, wiring, materials, devices, luminaires, and equipment from corrosion, dirt, paint, building materials, acid, solvents, chemicals, water, ice, tools, overload, freezing, heat, combustion, theft, damage, abrasion, inadvertent removal, improper installation (including where installation has not been completely or properly coordinated), conflicts, interference, vandalism, etc. at all times. Repair or replace all equipment and materials lost or damaged as the result of inadequate protection. Cap and plug open ends of raceways and equipment during construction until wiring is ready to be installed.

2.4 Coordinate with and obtain approval of the owner and architect for all exact locations of all outlets, raceways, materials, and equipment. Prior to purchasing conduit or prior to any installation, submit sketches/drawings of proposed raceway routing, equipment locations, and any other details of installation. Any conduits routed in a location not formerly approved shall be removed and reinstalled by the Contractor at the Contractor’s own expense.

2.5 Completely coordinate installation and routing of all wiring, materials, and equipment in the field and with shop drawing information of all trades prior to rough in of wiring or releasing equipment. Completely inspect equipment and materials upon receiving in the field (including equipment received by other trades where installed or connected to by the electrical contractor) and verify exact installation requirements and details (compare to installation and routing as coordinated above) prior to installing, preparing installation, modifying, or handling in any manner which would restrict the ability to return material or equipment in the event of potential installation complications.

2.6 Cooperate and fully coordinate all work with the work of all other trades, contractors, subcontractors, and the owner, including work as part of other contracts and projects related to and/or in the vicinity of the specified work. Coordinate the locations of pipes, ducts, structure, reinforcement, foundation components, floor/wall/ceiling construction, raceways, branch and distribution panels, luminaires, devices, electrical outlets, air outlets, motor controls, and all other equipment in order to avoid conflicts, interference, or placing services at the wrong locations. Coordinate with shop drawings of all trades. Install all wiring and equipment in such a way to maintain clearance and clear access to all equipment requiring access by code or for operating, servicing, maintaining, replacing, examining, etc.. This includes access to electrical equipment and devices as well as mechanical, architectural, and other equipment including, but not limited to, valves, dampers, sensors, meters, gauges, clean-outs, access doors and panels, operating mechanisms, motors, pumps, fans, air handling and other mechanical equipment, etc.. This specifically includes coordinating wall mounted electrical devices and outlets with wall mounted HVAC equipment (including baseboard, radiation, cabinets, etc.).

2.7 Provide all work indicated on the electrical drawings and electrical specifications but involving disciplines of other trades performed by the electrical contractor (or applicable sub-contractors to the electrical contractor), unless specifically indicated otherwise. Perform work in complete accordance with all general construction specifications applicable to the work. This applies to all work including, but not limited to, cutting and patching, excavation, backfill, surface restoration (including paving), concrete, metal fabrication, fire stopping and sealing, painting, etc..

2.8 Properly isolate all materials and equipment against the transmission of vibration or noise to, from, or between any parts of the building.

2.9 The electrical contractor is fully responsible for determining and verifying all exact details of installation. Where installation details or similar information is shown on the drawings or is otherwise forwarded to the contractor (including during construction), the information represents the minimum criteria required and serves as a guide to the contractor but does not relieve the contractor of the responsibility for determining and verifying installation details.

3. GROUNDING

3.1 Completely ground and bond all equipment (specifically including all metallic raceways, cable armor, cladding, and shielding, supports, transformers, cabinets, cable trays, service equipment, and the neutral conductor) in strict and complete accordance with all applicable requirements of the NEC.

3.2 Provide insulated grounding conductors run with all wiring (not applicable to "BX" armored cable [type "AC"] where permitted elsewhere in this specification).

3.3 Install all metallic raceways in such a way to provide a continuous grounding path without the use of the insulated grounding conductor required above. Include all bonding jumpers and conductors (in addition to the insulated conductor required above) as required for flexible conduit, loosely jointed raceways, etc.. Provide suitable raceway/conduit fittings for a completely grounded raceway system as required, including the use of fittings approved and/or listed for grounding, grounding bushings, grounding lock nuts, etc..

3.4 Provide all grounding and bonding materials and connections as per specifications section "Grounding Materials" of specifications division 16300, Electrical Materials.

3.5 Wherever connections to grounding electrodes or electrode systems are required by code, provide, interconnect, and connect and bond to the following.

A. Provide new driven (made) grounding rod electrodes, for all services and where equipment is located on or below the second floor of a building.

B. Connect to the domestic cold water piping system and any other metal piping system where required by the NEC (excluding piping prohibited from bonding/grounding by the NEC).

C. Connect to the structural steel and/or metal building frame, where applicable.

3.6 Wherever the following is installed as part of this project (including where installed by other contractors), connect and bond to the grounding electrode system.

A. Ground new metal piping systems where required by the NEC.

B. Ground new structural steel and/or metal building framing.

C. Wherever any new foundation and/or footing is installed with continuous length of 3.0 m (10'0") or more or covering area of 3.3 m^2 (36 sq. ft.) or more, provide concrete-encased electrode(s) as per NEC Article 250.52(A)(3). Provide consisting of not less than 6.0 m (20'0") of #4 AWG bare copper conductor encased in not less than 50 mm (2") of the foundation/footing concrete, except that concrete reinforcement may be substituted for the copper conductor where the size, length, type, and installation of reinforcement complies with NEC Article 250.52(A)(3) for use as a grounding electrode.

3.7 Where driven (made) grounding rod electrodes are installed, provide grounding resistance not exceeding 1.0 ohm (maximum). Verify proper ground resistance by testing as per the section "Testing" of this specifications division 16100. Where the measured resistance exceeds the maximum value, install additional ground rod(s) at the location and/or set ground rods in suitable listed and NEC approved chemical ground
enhancement material as required to obtain proper values, include all costs in bid.

3.8 Detail all grounding on as-built record documents.

3.9 Do not install any wiring or electrical equipment of any type (specifically including disconnecting means and receptacles) within 4.5 m (15'0") of any edge of any roof, to avoid tripping hazards. Equipment and wiring is only permitted within 4.5 m (15'0") of any edge of any roof where necessary to serve utilization equipment within the space and only where specifically approved in writing by the engineer and architect (where approved suitable protective means are included to prevent fall hazards). Wherever new wiring or equipment is installed at or near roofs of buildings with lightning protection system(s), bond wiring/equipment to the lightning protection system(s) as required by lightning protection codes and standards.

4. WIRING METHODS

4.1 The wiring methods in this section apply to all systems (including power, lighting, emergency, control, telecommunications, data, fire alarm, sound, security, CCTV, and any other system), unless specifically indicated otherwise.

4.2 In finished areas, run all wiring hidden or concealed in/behind ceilings, walls, and floors, include all cutting and patching as required. In unfinished areas, wiring may run exposed. Run exposed wiring following building lines.

4.3 Utilize steel rigid metal conduit (RMC) for all wiring unless indicated otherwise. Utilize only steel RMC for all exposed visible exterior raceways, for raceways in wet locations above ground, for exposed visible raceways in damp locations.

4.4 Steel intermediate metal conduit (IMC) may be utilized for all wiring except conditions indicated above as requiring only steel RMC. Steel IMC may be utilized in any condition where PVC RNC is permitted by these specifications.

4.5 Where permitted by code, schedule 40 or schedule 80 polyvinyl chloride rigid nonmetallic conduit (PVC RNC) may be used underground. Changing PVC RNC thickness (i.e. from schedule 40 to schedule 80 or vice versa) in the middle of any run of PVC RNC is not permitted.

4.6 Where runs of PVC RNC protrude exposed and visible above grade or floors, in indoor or outdoor locations, utilize steel RMC for the portions above grade/floor to a minimum depth of 155 mm (6") below finished grade/floor. This requirement does not apply where protruding PVC RNC is completely concealed/hidden within equipment enclosures, walls, or ceilings. Where exposed visible runs of PVC RNC are installed by the contractor (without prior written approval) the contractor shall remove the PVC RNC and install new steel RMC (including cutting and patching to a minimum 155 mm (6") depth and including replacing or reinstalling conductors) at no cost to the owner.

4.7 Where permitted by code, electrical metallic tubing (EMT) may be used for interior feeder and branch wiring in locations not subject to abuse or injury. Utilize steel RMC for conditions indicated above as requiring only steel RMC.

4.8 Utilize flexible conduit for flexible connections to motors, equipment requiring flexibility, equipment subject to vibration (including transformers), and where required for adjustment, in lengths not to exceed 1.8 m (6'0"). Flexible conduit may be utilized for flexible connections to luminaires only where wiring is concealed or located above accessible ceilings (in lengths not to exceed 1.8 m (6'0")). Exposed visible flexible conduit is not permitted for luminaires, except adjustable luminaires. Flexible conduit may be used where existing walls are fished in lengths not to exceed the portion in the wall plus 0.9 m (3'0"). Utilize liquidtight flexible metal conduit (LFMC, "Sealtite"), unless indicated otherwise. Utilize only LFMC in damp, wet, and outdoor locations, mechanical rooms. Utilize flexible metal conduit (FMC, "Greenfield") in dry locations only (except conditions indicated above as requiring only LFMC). Flexible conduit/fittings of any type are not permitted as a substitute for conduit bends or offsets under any circumstance.

4.9 Where permitted by Code and approved by local authorities and the owner, metal clad cable (type "MC") may be used for interior branch wiring concealed in walls/ceilings and hidden above accessible ceilings in dry locations only. Where applicable, comply with NEC Article 518 "Assembly Occupancies". Utilize raceway for all feeder wiring (#4 AWG and larger). Type "MC" cable is not permitted in wet,

damp, or exterior locations. Type "MC" cable is not permitted in exposed visible locations. Hide cables at panels in electrical rooms and electrical closets as per the section "Branch Panels" of specifications division 16300, Electrical Material.

4.10 Surface raceway without integral wiring devices is permitted only where all of the following conditions are met or where specifically indicated on the drawings. Surface raceway without integral wiring devices is permitted where physically impossible to run wiring hidden or concealed, where impossible to hide or conceal wiring by cutting, patching, and painting, where approved by code, in dry locations only, and where specifically approved by the owner and architect in writing. Permission to use surface raceway without integral wiring devices is conditional upon there being no cost change to the contract, unless specifically indicated on the written approval.

4.11 Nonmetallic-sheathed cable (types "NM", "NMC", and "NMS", i.e. "Romex") is not permitted under any circumstance. Electrical nonmetallic tubing (ENT), liquidtight flexible nonmetallic conduit (types LFNC-A and LFNC-B), high-density polyethylene (HDPE) conduit, type "A" nonmetallic conduit, and type "EB" nonmetallic conduit are not permitted under any circumstance.

4.12 Provide all wiring within air handling plenum spaces in complete accordance with the NEC. Provide wiring methods utilizing metal conduit raceways (as permitted by the specifications) only. Type "MC" cable, where otherwise permitted, may be utilized in plenum ceilings (but not other plenum spaces).

4.13 Provide all systems wiring (fire alarm, clock, intercom, sound, security, etc.) in raceway. Where otherwise permitted by the specifications and where permitted by code, type "MC" cable may be utilized.

4.14 Except as indicated otherwise on the drawings, 21 mm (3/4") raceways are the minimum permitted. No raceway smaller than 21 mm (3/4") is permitted under any circumstance (except where specifically approved in writing by the owner and engineer for the individual condition encountered). Where luminaires, devices, or equipment have factory knockouts or hubs smaller than 21 mm (3/4") size (or smaller than conduit sizes specified on the drawings), provide suitable reducing conduit fittings or provide field knockouts at equipment to match conduit size.

4.15 Except as indicated otherwise on the drawings, #12 AWG conductors are the minimum permitted for power and lighting and #14 AWG conductors are the minimum permitted for control and signal systems. #10 AWG conductors are the minimum permitted for outdoor wiring, night lighting circuit wiring, and emergency power and lighting wiring. #10 AWG conductors are the minimum permitted where

circuits exceed 23 m (75'0") for 120/208/240 V circuits or exceed 46 m (150'0") for 277/480 V circuits, measured to the center of the load.

4.16 Provide a separate neutral conductor with each branch circuit where a neutral is required or indicated on the drawings. Multi-wire branch circuits with a shared common neutral are not permitted, unless specifically indicated otherwise on the drawings. Utilize multi-wire branch circuits with a shared common neutral conductor for lighting controlled by "dual switching" where the lighting is connected to two (2) circuits.

4.17 Multiple branch circuits may be installed in the same raceway (including surface raceways) where permitted by code and provided all of the following conditions (A through D below) are met.

A. Apply appropriate NEC de-rating factors and adjust conductor sizes accordingly. Wiring sizes indicated on the drawings are based on each circuit run in an individual raceway (and are not adjusted for de-rating factors), except where multiple branch circuits in a common raceway are specifically indicated on the drawings (wiring is adjusted for applicable de-rating factors in this case, but only for the specific wiring combination shown on the drawings).

B. Provide no conductor (after de-rating adjustment) exceeding #10 AWG, except grounding conductors as provided below (or as otherwise specifically approved in writing by the engineer).

C. Common equipment grounding conductors are permitted in lieu of individual equipment grounding conductors for each individual circuit. Provide minimum single equipment grounding conductor size two (2) standard wire sizes larger than the size as determined in accordance with the NEC. Provide isolated grounding conductors (where required) individually for each circuit and in addition to common equipment grounding conductors.

D. Provide raceway fill (after derating adjustment) not exceeding 30% (provide maximum number of conductors permitted not exceeding 75% of the maximum number allowed by Code [i.e. refer to NEC Chapter 9 and Annex C] to allow for future wiring). Adjust minimum raceway size to maintain 30% maximum fill.

4.18 Minimum raceway sizes indicated in the specifications and on the drawings are applicable to all conduit types specified, except schedule 80 PVC RNC (unless the drawings specifically indicate schedule 80 PVC RNC). Where schedule 80 PVC RNC is utilized and the specified conduit size is 63 mm (2.5") and smaller, increase conduit to the next higher trade size. Where schedule 80 PVC RNC is proposed and the specified conduit size is 78 mm (3") and larger, submit raceway fill calculations;

where raceway fill with the specified conduit size exceeds 40%, increase conduit to the next higher trade size.

5. WIRING INSTALLATION

5.1 Securely support and fasten all raceways, cables, outlets, boxes, equipment, etc. in place as required by the NEC. Support at intervals as required by the NEC, but in no case exceeding 3.0 m (10'0"). Refer to the section of this specification "Fastenings, Supports, and Hangers" for information.

5.2 Where any run of wiring passes vertically through more than one (1) floor level (including where installed in open vertical chases), support at every floor level. For conduits 63 mm (2.5") and larger, utilize only suitable pipe riser clamps (B-Line #B3373 series), suitable wall bracket offset pipe clamps (National Pipe Hanger Corp. (NPHC) figure #430 series), or engineer approved heavy duty steel brackets (fabricated of not less than 6.5 mm (1/4") thick steel and of type, design, and arrangement suitable for the specific application and weights involved) for these floor level supports. Conduit clamps and strut type supports are not acceptable for this application. Equal equipment as manufactured by B-Line, Erico, and NPHC shall be considered.

5.3 Make all changes in direction of 27 mm (1") and larger conduits with standard elbows or case metal fittings. Fabricate field-made bends and offsets in conduit with suitable hickey/conduit-bending machine. Make conduit bends of the long radius type without kinks, flattening or crushing. Do not install crushed or deformed raceways. Avoid trapped raceways in damp and wet locations. Exercise care to prevent the accumulation of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Entirely free clogged or obstructed raceways or replace raceways.

5.4 Provide raceway ends cut squarely and reamed. Provide raceway installation (including pull boxes as required) so there is no more than a total of 360 degrees of bends in any run of raceway. Provide pull boxes at intervals not greater than every 30 m (100'0"), unless otherwise indicated on drawings.

5.5 Maintain a separation of not less than 155 mm (6") between all raceways and hot water
lines, steam lines, and any other surface with temperature exceeding 104 degrees F (40 degrees C), whenever possible. When not possible to maintain the 155 mm (6") separation, provide insulation pipe covering on the electrical raceways.

5.6 Provide a suitable insulating or grounding type (as required) bushing on each conduit

terminating in a pressed steel box and for each conduit stub. Bushing is not required where conduit terminates in a suitable conduit connector/termination fitting which includes an integral bushing or which provides smoothly rounded surface suitable and approved for use without a bushing.

5.7 Wherever raceways pass across structure expansion joints, provide suitable conduit expansion fittings. Where expansion fittings are not listed for grounding, provide external flexible copper grounding strap. Wherever expansion fittings are installed, provide a suitable junction box located not farther than 7.6 m (25'0") from the expansion fitting location. Coil suitable slack conductors in this junction box to allow functioning of expansion fittings. For continuous runs of PVC RNC exceeding 27 m (90'0"), provide expansion fittings at intervals not exceeding 15 m (50'0") as required to compensate for linear thermal expansion and contraction.

5.8 Where metal raceway is installed in contact with or entering earth or concrete in outdoor, wet, or damp locations, coat raceway with engineer approved coal tar or epoxy based corrosion resistant coating (3M, Benjamin Moore, Carboline, or approved equal).

5.9 Running threads are not permitted.

5.10 Do not run wiring horizontally across floors or the ground, to avoid tripping hazards and facilitate cleaning floors.

5.11 Horizontal runs of raceway at rooftops are not permitted (to facilitate future roofing repairs/replacement) except where specifically approved in writing by the architect and owner. Horizontal runs may not exceed 2.4 m (8'0") length. Horizontal runs of any length (and electrical equipment of any type) are not permitted within 4.5 m (15'0") of any edge of any roof under any circumstance, to avoid tripping hazards. Support raceways at roofs in a manner to avoid harming, impacting, or compromising the roofing weatherproof integrity (fully coordinate requirement with roofing contractor/supplier [where present], architect, and owner). Where wiring is installed atop roofing material, utilize only pre-cast concrete paving units measuring not less than 12" x 12" x 2" (300 mm x 300 mm x 51 mm) laid on the roof and bonded to the roof using suitable roofing adhesive. Running rooftop wiring on wood blocks or bricks is not permitted under any circumstance.

5.12 In all kitchens, food preparation, and similar areas, run wiring concealed as much as possible. Where necessary to run wiring exposed, maintain space between raceways and building surfaces and run raceways *vertically only* in such a way to facilitate cleaning walls, ceilings, and floors and to avoid accumulation of foreign materials.

5.13 Install wiring in such a manner to avoid infiltrating water into the wiring system (during or after construction). Install wiring in such a manner so any water which does infiltrate cannot become trapped or accumulate and cannot drain into electrical or other equipment.

5.14 Install exposed wiring (including visible wiring and wiring in accessible ceiling spaces or other accessible locations) parallel or perpendicular to walls, structural members, or intersections of vertical planes and floors or ceilings.

5.15 Install concealed wiring (except as provided above for wiring in accessible spaces) as straight and direct as possible. Detail routing of all concealed wiring on record (asbuilt) documents.

5.16 Space raceways embedded in concrete slabs, walls, beams, etc. or run underground not closer than 76 mm (3") between outsides of raceways and install as to avoid changing the locations of reinforcement.

5.17 Except when plans of raceways are approved by the engineer, provide embedded raceways, other than those merely passing through, not larger in outside diameter than one-third the thickness of the slab, wall, beam, etc. in which they are embedded.

5.18 Embedded raceways are not permitted to cross, except where the 76 mm (3") spacing and one-third thickness provisions above are maintained or exceeded.

5.19 Provide all splices only in suitable code-sized junction or outlet boxes. Splices are not permitted in any type of conduit body under any circumstance.

5.20 Do not install any conductors in raceways until all raceway work is completed and closed in such a manner as to prevent the possibility of water or other foreign matter entering raceways.

5.21 Wherever empty or spare raceways are installed, provide suitable pull wires with identification tags securely attached to each end. Where empty or spare raceways do not terminate in boxes or enclosures, provide suitable conduit caps. Utilize only conduit fitting type caps appropriate for the conduit involved. Rubber and plastic conduit plugs, duct sealing compounds, and tape are not acceptable.

6. FASTENERS, SUPPORTS, AND HANGERS

6.1 Provide all fastenings, supports, hangers, clamps, and anchors of the type made for the specific purpose for which they are used.

A. Utilize wood screws for fastening to wood.
B. Utilize toggle bolts or bolt fastenings for fastening to hollow tile, terra cotta, hollow masonry units, lath, and similar construction.
C. Utilize machine screws/bolts with nuts for fastening to structural steel.

D. Utilize metallic expansion shield anchors and machine screws/bolts for fastening to concrete, brick, and solid masonry. Wooden plugs with screws and plastic expansion shield anchors are not acceptable.
E. Threaded studs driven in by a powder charge and provided with washers and nuts may be used in lieu of expansion anchors, machine screws, and wood screws under the applications indicated above.
F. Utilize engineer approved adhesive fastening on roofing areas (mechanical fasteners are not be permitted to be driven into roofing surfaces). G. Threaded C-clamps are not permitted.
H. Additional acceptable supports for a single 21 mm (3/4") EMT only include common nails for wood, spring-tension clamps for steel and nail-type nylon anchors for masonry.
I. Additional acceptable supports for not more than two (2) cables (where cable wiring methods are permitted elsewhere in this specification) only include nails for wood, spring-tension clamps for steel, and nail-type nylon anchors for masonry. A single cable only may be secured directly to wood with N.E.C approved cable staples.

6.2 To prevent swaying, vibrating and/or sagging, rigidly and firmly install raceway and cable (where cable wiring methods are permitted elsewhere in this specification).

A. Support with malleable or wrought steel clamps, hangers, or with fabricated strut type supports. Provide strut type supports as B-Line, Kindorf, Power-Strut, Unistrut, or approved equal (steel only, aluminum is not acceptable unless specifically indicated on the drawings).
B. Stamped metal one-hole and two-hole straps are permitted to secure EMT and cable wiring methods permitted by the specifications in exposed and concealed dry indoor locations not subject to abuse or injury only.
C. Stamped metal wrap around "Mineralax" type hangers are permitted to secure EMT and cable wiring methods permitted by the specifications in hidden and concealed dry indoor locations not subject to abuse or injury only. Stamped metal wrap around type hangers are not permitted for visible exposed wiring.
D. Additional manufactured fastening systems specifically designed for the purpose shall be considered to secure cable wiring methods permitted by the specifications, but only where submitted for review and approval before commencing work.
E. Do not weld raceways, clamps, hangers, or straps to steel structure.
F. Wire (including ceiling support wires), perforated pipe straps, plastic ties, "J" hooks, and bridle rings are not acceptable.

6.3 Provide all supports and fasteners of the following materials, unless indicated otherwise.

A. Utilize stainless steel for all applications, unless indicated otherwise. Utilize stainless steel only when underground or in contact with earth or floors in outdoor areas, mechanical rooms, kitchens, and other areas subject to the possible presence of water on the floor/ground.
B. Steel protected by hot-dip or mechanical galvanizing after fabrication may be utilized for all conditions except conditions indicated above as requiring only stainless steel. Clean areas where galvanizing is cut or damaged and touch-up with suitable zinc dust/zinc oxide paint.
C. Steel protected by pre-galvanizing before fabrication, epoxy coating, zinc electrolytic plating, or other engineer approved corrosion resistant coating may be utilized for interior locations not subject to abuse or injury.
D. Other materials providing equivalent strength and corrosion resistance to the above shall be considered.
E. Supports and fasteners without corrosion protection, protected only by painting, or protected only by oil coating are not acceptable under any circumstances.
F. For electrical fasteners (at conductors and all current-carrying parts), utilize only materials and types approved by the NEC and listed for the application.

6.4 Provide all fastening, supports, wall brackets, ceiling trapeze, and hangers as required for the installation of all equipment and wiring. Install all fastenings, supports and hangers in such a way and at such intervals as required by Code or otherwise required to support the equipment. The electrical contractor is responsible for verifying that supports are adequate for the load supported, based upon weight, stresses which may be applied to the support (including when installing equipment, pulling wiring, physical impacts to equipment, and seismic/earthquake loads as per IBC Section 1613), vibration, etc. Submit calculations for any supports where requested by the engineer.

6.5 For all telephone and equipment backboards indicated on the drawings and wherever plywood backboards are installed to support and/or mount electrical equipment, utilize only fire resistant plywood.

6.6 Where the contractor installs fasteners or supports not meeting specified requirements (without prior written approval) the contractor shall remove the fasteners and supports and install new fasteners and supports as specified at no cost to the owner.

7. CHASES, RECESSES, AND OPENINGS

7.1 Provide, including all excavation, cutting, patching, fire stopping, sealing, backfill, surface restoration, and painting, all required openings, chases, and recesses in the construction for all work.

7.2 Where openings are required in new or modified structure, furnish the exact location, size, and other necessary information to the contractor installing or modifying the structure in ample time to have them incorporated during construction as approved by the architect and engineer. If the electrical contractor fails to comply with these information requirements, then the electrical contractor shall perform the necessary cutting and patching at his own expense under the direct supervision of the general contractor.

7.3 Where openings in masonry are required, make by coring only.

7.4 Locate and provide all openings (including openings for junction and outlet boxes and luminaires) in such a manner to maintain any required fire/smoke rating, waterproof, and sound transmission integrity in accordance with all applicable codes and standards (including, but not limited to IBC/BOCA, NFPA, and UL). Where boxes are located in opposite sides of fire/smoke/sound rated walls, maintain minimum spacing between boxes as required. The general contractor shall provide fire/smoke rated enclosures around luminaires and boxes where required to comply with fire/smoke ratings.

8. CUTTING, PATCHING, FIRE STOPPING, AND PAINTING

8.1 Perform all required excavation, cutting, patching, fire stopping, sealing, backfill, surface restoration, and painting associated with the electrical installation. Perform in accordance with general construction specifications and as indicated elsewhere in this specification. Coordinate all requirements with the general contractor. This includes cutting and patching associated with suspended ceiling tiles and grid.

8.2 Completely restore (including painting where applicable) all surfaces to match existing condition as directed and approved by the owner, architect, and engineer.

8.3 Completely seal and fire stop all penetrations of all fire and/or smoke rated walls, floors, ceilings and any other construction (including all construction required to be rated by any code) to a rating matching or exceeding the fire rating of the construction. Refer to architectural drawings and specifications for information on fire ratings of building construction and include all costs in bid. Provide the complete installation (including fire stopping methods and materials) complying with all applicable fire rating codes and standards (including the NEC, NFPA, IBC/BOCA, and UL (including the UL "Fire Resistance Directory").

8.4 Completely seal and weatherproof all penetrations of exterior, at or below grade, and wet location walls and floors and roof penetrations.

8.5 Paint all exposed raceways, boxes, enclosures, etc. as directed by the owner and architect.

8.6 Provide baked enamel painted finish for all equipment and materials as directed by the owner and architect. Wherever finish colors are indicated on the drawings (including symbol list and luminaire schedule) as being selected by the architect ("as per architect", etc.), include costs in bid to utilize any of the available standard and/or optional colors listed in manufacturers' catalogs (excluding any colors identified in manufacturers' catalogs as "custom" or "premium").

8.7 Touch up damages to prime and/or finished paint coats on equipment. This includes touching-up stainless steel surfaces to avoid superficial surface rust (i.e. at cut surfaces and welds).

9. SLEEVES

9.1 Provide sleeves in all construction. Provide sleeves of minimum 0.85 mm (22 ga.) galvanized steel, sized for passing raceway/cable, and of the proper design for sealing and flashing around the sleeves where required. Locate and set sleeves extending approximately 51 mm (2") above floor in concealed locations, unfinished rooms, and mechanical spaces. Locate and set all sleeves flush with finished surfaces in finished areas unless otherwise directed by the owner and architect.

9.2 Seal the space between the raceway/cable and sleeve and between the sleeve and structure in an engineer and code approved manner. Seal and fire-stop all penetrations to a fire rating not less than the wall, ceiling, floor, or member penetrated. Completely seal and waterproof all penetrations of exterior walls, roofs, mechanical room floors, or any other area subject to weather or water.

10. FLASHING AND ACCESS PANELS

10.1 Where a general contractor is present, base flashing is by the general contractor, otherwise base flashing is by the electrical contractor. Counter flashing (provide of 0.47 mm (28 ga.) copper) is by the electrical contractor under all circumstances.

10.2 Provide access panels for all items requiring accessibility for operation and maintenance or where required by code. Provide access panels of not less than 1.6 mm (16 ga.) steel frame and not less than 1.9 mm (14 ga.) steel panel, with tamper-proof fasteners, and compatible with the type of construction in which they are installed.

10.3 Where a general contractor is present, the electrical contractor shall furnish all access panels and the general contractor shall install access panels under the direction of the electrical contractor.

11. LOCATIONS AND MOUNTING HEIGHTS

11.1 The approximate locations of luminaires, pipes, switches, radiation, receptacles, outlets and other equipment and materials are indicated on the drawings. Provide actual locations and mounting heights as determined by, confirmed with, and approved by the owner and architect during field construction (prior to rough-in). Where equipment or devices are installed without prior approval/confirmation or without prior written notification (see below) and the location or mounting height is not acceptable to the owner and architect, relocate the equipment and all associated wiring as directed by the owner and architect at no cost to the owner.

11.2 Provide mounting heights complying with all applicable federal, state, and local disabled ("handicapped") access codes, standards, and requirements, including the Americans with Disabilities Act (ADA).

11.3 Provide mounting heights for all equipment as follows. Utilize standard mounting heights indicated below for all equipment, unless indicated otherwise on the drawings or otherwise directed by the owner and architect. Where installation conditions and/or obstructions make it impossible to install equipment at the standard height, the mounting height may be adjusted as required by conditions, provided the mounting height falls within the listed maximum and minimum heights. Notify the architect and engineer in writing of all conditions where deviating from standard mounting heights. Provide mounting heights not greater than the maximum mounting height and not less than the minimum mounting height under any circumstance, unless specifically approved in writing by the owner, architect, and engineer.

11.4 All mounting heights listed below are above finished floor (AFF), unless indicated otherwise. Mounting heights listed as "to bottom" are measured to the lowest operable part of the equipment or the lowest visual indicating device on the equipment. Mounting heights listed as "to top" are measured to the highest operable part of the equipment or the highest visual indicating device on the equipment.

	Mounting Heights		
	Standard	Minimum	Maximum
Control Devices			
Wall Switches & lighting controls	46" (1.17m) to ctr.	15" (0.38m) to bot.	48" (1.22m) to top
Thermostats & other controls	46" (1.17m) to ctr.	15" (0.38m) to bot.	48" (1.22m) to top
Receptacles and Outlets			
Receptacles, tele/data, & similar *	18" (0.46m) to ctr.	15" (0.38m) to bot.	48" (1.22m) to top
Wall mounted telephones	46" (1.17m) to top	27" (0.69m) to bot.	48" (1.22m) to top

Electrical Equipment			
Safety switches **	See max./min.	15" (0.38m) to bot.	48" (1.22m) to top
Enclosed circuit breakers **	See max./min.	15" (0.38m) to bot.	48" (1.22m) to top
Devices with fuses/breakers **	See max./min.	15" (0.38m) to bot.	48" (1.22m) to top
Contactors **	See max./min.	15" (0.38m) to bot.	48" (1.22m) to top
Transfer Switches **	See max./min.	15" (0.38m) to bot.	48" (1.22m) to top
Time clocks, individual **	See max./min.	15" (0.38m) to bot.	48" (1.22m) to top
Annunciators and displays 46" (1.17m) to ctr. 15" (0.38m) to bot. 48" (1.22m) to top Equip. indicated with (**) where 15" (0.38m) to 48" (1.22m) None 78" (1.98m) to top group mounted			
Equip. indicated with (**) where large to mount at above heights	15" (0.38m) to 48" (1.22m)	None	78" (1.98m) to top too
Branch panels	15" (0.38m) to 48" (1.22m)	None	78" (1.98m) to top
Wall mounted distribution panels	15" (0.38m) to 48" (1.22m)	None	78" (1.98m) to top
Controllers & grouped controls	15" (0.38m) to 48" (1.22m)	None	78" (1.98m) to top
Fire Alarm Equipment			
Fire alarm controls 15" (0.38m) to 48" (1.22m) None 78" (1.98m) to top Pull stations 48" (1.22m) to top 42" (1.07m) to bot. 48" (1.22m) to top			
Horns/speakers/strobes/bells ****	80" (2.03m) to bot.	80" (2.03m) to bot.	96" (2.43m) to bot.
All equipment mounted above counters	*****	15" (0.38m) to bot.	46" (1.17m) to top
Other Equipment			
Other equipment mounted on standard electrical outlet boxes	46" (1.17m) to ctr.	15" (0.38m) to bot.	48" (1.22m) to top

Contact the engineer for any equipment not listed or similar to equipment above.

* Specifically coordinate with any wall-mounted radiation, if present

** Applies where equipment is mounted individually, see below for group mounted equipment.

*** Provide metering equipment mounting heights conforming to utility company requirements, where applicable, regardless of mounting heights indicated above.

**** For ceilings lower than 90" (2.29m), mount fire alarm signaling devices 6" (0.15m) below the ceiling. Fire alarm signaling devices may be ceiling mounted if mounted on the lowest portion of the ceiling, if mounted not higher than 9.14 m (30'0") above the lowest floor level in the room and if located and spaced in accordance with NFPA requirements.

***** Standard mounting height for above counter equipment is 6" (0.16m) above back splash or 8" (0.20m) above counter where no back splash is present.

11.5 Where any equipment or device protrudes more than 100 mm (4") from the finished wall surface, mount at height conforming with the ADA and in accordance with the following. Contact the engineer where maximum and minimum heights listed above conflict with mounting requirements summarized below.

A. Mount so the bottom of equipment/device is 0.68 m (2'3") AFF or less.

B. Mount so the bottom of equipment/device is 2.0 m (6'8") AFF or greater.

C. Projecting equipment/devices are permitted mounted with the bottom between 0.68 m (2'3") and 2.0 m (6'8") AFF where protected with a suitable warning barrier in accordance with ADA requirements.

D. Projecting equipment/devices are permitted mounted with the bottom between 0.68 m (2'3") and 2.0 m (6'8") AFF without warning barrier protection only where specifically approved in writing by the engineer.

12. ELECTRIC SERVICE

12.1 Perform all electrical service work complying with applicable electric utility company standards and requirements, including metering equipment locations, equipment specifications, service/meter applications, inspections, notification, scheduling, and service pole/manhole.

12.2 Reference single line diagram for description of the proposed electrical system.

13. UTILIZATION EQUIPMENT CONNECTIONS

13.1 Provide complete power wiring and final connections for utilization equipment as indicated on the drawings. This includes, but is not limited to, all mechanical, kitchen, elevator, manufacturing, computer, medical, office, copier, fixed, and portable equipment and apparatus. Coordinate all requirements with the contractor supplying
the equipment (the supplying contractor).

13.2 Provide connections complete and including power wiring from the electrical contractor provided local disconnecting means to each piece of equipment. If required, pass power wiring through supplying contractor furnished control equipment (including thermostats, relays, timers, integrated controllers, starters, contactors, VFD's, etc.). Provide a single point connection or multiple-point connections (by separating one larger circuit into smaller circuits at controller and/or equipment) as required (include all costs in bid). The electrical contractor is responsible for taking deliveries of all control equipment (which power wiring passes through) from the supplying contractor and for mounting and passing power wiring through this control equipment. Locate control equipment as indicated on mechanical or other trades documents or as otherwise coordinated with and approved by the owner, architect, mechanical engineer, and the supplying contractor.

13.3 All control wiring and associated raceway is by the supplying contractor, unless specifically indicated on the drawings. All central/common control panels are by the

supplying contractor (power wiring is by the electrical contractor), unless specifically indicated on the drawings.

13.4 Provide safety switches as local disconnecting means at all equipment. Provide switches regardless of whether shown on the drawings or not. Provide switches regardless of whether or not the equipment includes integral unit switches or circuit breakers. Provide outdoor switches as NEMA-3R and indoor switches as NEMA-1.

13.5 For all equipment rated 120 V or 277 V and 20 A or less, provide either direct connection, including thermal overload switch where disconnecting means is required, or suitable receptacle where equipment is supplied with cord and plug (combination of plug and receptacle serves as disconnecting means), include all costs in bid.

13.6 Prior to rough in of raceway or purchasing any associated electrical equipment, obtain shop drawings from the supplying contractor and verify all requirements. The electrical contractor is fully responsible for contacting and obtaining copies of approved shop drawings from the supplying contractor. This includes fully coordinating the locations of all equipment and wiring in/serving elevator shafts, pits, and machine rooms.

13.7 Where equipment is served by variable frequency drives (VFD's), other solid-state controllers, or other special starters or controllers, wiring indicated on the drawings is as a guide to pricing only. Prior to rough in of raceway or purchasing associated electrical equipment, verify all requirements in writing with the supplying contractor. Provide exact circuit breaker trip amperes (or fuse amperes, where applicable) for circuits feeding this equipment as coordinated with and directed and approved by the manufacturer, include all costs in bid. Where the required circuit breaker/fuse amperes exceed the ampacity of the specified wiring, notify the engineer in writing. Provide all safety switches connected on the load side of VFD's with auxiliary contacts and interconnect (including providing all required wiring in separate 21 mm (3/4") raceway from power wiring) with VFD controls (to prevent and stop operating VFD with load
disconnected). Provide all power wiring on the load side of any VFD as a dedicated circuit (from individual VFD to motor served) with no other circuit or wiring (of any kind) in the same raceway.

13.8 Where heat trace, control power transformers and control power supplies (rated 500 VA and less), electric alarm bells, plug-in condensate pumps, ultraviolet germicidal lamps in HVAC equipment, electrically operated security devices, door hardware, dampers (including smoke and fire dampers), and valves (including sinks/toilets/urinals), switchgear/switchboard strip/space heaters, etc. are specified on mechanical, plumbing, fire protection, electrical, or architectural drawings or specifications, provide appropriate wiring and power connections (whether shown on

electrical drawings or not). Verify and coordinate voltage and wattage/amperes in field and provide wiring accordingly. Obtain power from a suitable nearby branch circuit. Include all disconnecting means switches, junction boxes, receptacles, and other equipment as required by code or manufacturer recommendations. Provide ground fault protection (utilizing protective devices complying with the NEC) for all heat tracing.

15. EXCAVATION, BACK-FILLING, AND RESTORATION

15.1 Perform all required excavation, cutting, patching, backfill, surface restoration, and painting associated with the electrical installation, perform in accordance with general construction specifications. Coordinate all requirements with the general contractor. Refer to the section of this specification "Cutting, Patching, Fire-Stopping, and Painting" for additional information.

15.2 Install all underground wiring to maintain a minimum cover of 0.8 m (2'7") to top of raceways. Where field obstructions do not facilitate the above minimum cover, minimum cover as indicated in NEC Article 300.5 is permitted.

15.3 Perform all excavation and work in and associated with excavation in accordance with all applicable safety codes, standards, regulations, and requirements (refer to specifications section "Safety" of specifications division 16100, General Electrical).

15.4 Completely restore all surfaces to a condition matching or exceeding the original condition to the satisfaction of the owner, architect, and engineer. Back-filling and restoration below does not supersede or serve as a substitute for concrete encasement of raceways specified elsewhere.

A. Earth (and other unpaved surfaces) excavation: Backfill with suitable on-site material, preferably utilizing excavated material, and compact during backfill. Provide additional material as required to provide a flush surface after compacting or settlement. Provide seeding (as directed by the owner and architect) to restore grass surfaces.

B. Sidewalk (and other paved surfaces not subject to vehicular traffic) excavation: Where pavement construction joints are spaced not greater than 1.8m (6'0") apart, remove complete blocks of paving to the construction joints to facilitate excavation. Where construction joint spacing exceeds 1.8 m (6'0"), either saw cut pavement at a convenient location or remove to construction joints to facilitate excavation. Backfill with suitable on-site material, preferably utilizing excavated material and compact during backfill. Replace pavement sub-base with new

materials to match existing sub-base materials. Replace pavement with new materials to match existing pavement.

C. Roadway and parking lot (and other surfaces subject to vehicular traffic) excavation: Saw cut pavement 76 mm (3") deep prior to excavation. Remove pavement 300 mm (1'0") beyond the edges of below grade excavation ("cut-back" pavement 300 mm (1'0") on both sides of trench). Backfill with suitable on-site material, preferably utilizing excavated material and compact during backfill. Replace pavement sub-base with new materials to match existing sub-base materials. Replace pavement with new materials to match existing pavement, filling the entire width of the excavation with "cut-backs".

D. Optional roadway and parking lot (and other surfaces subject to vehicular traffic) excavation: The following may be substituted for the methods indicated in item "C" above at the contractor's option. Saw cut pavement 76 mm (3") deep prior to excavation. Remove pavement to the same width as the edges of below grade excavation (without any "cut-back"). Back fill with concrete only to the bottom of the sub-base. Replace pavement sub-base with new materials to match existing sub-base materials. Replace pavement with new materials to match existing pavement.

15.5 Completely remove and properly dispose of any material excavated and not utilized for backfill, include all costs in bid.

END OF SECTION

1. GENERAL PROVISIONS

1.1 The applicable requirements and conditions of specifications section "General Provisions" of specifications division 16100, General Electrical, are hereby made an integral part of this section.

1.2 The work governed by these specifications includes but is not limited to that as defined in specifications section "Scope of Work" of specifications division 16100, General Electrical.

1.3 Provide all materials and equipment (products) as new, the best in grade and quality, and manufactured in the United States of America with standards and ratings as specified herein. No substitution or deviation from the materials and equipment specified is permitted except by written permission from the engineer. Provide all materials and equipment listed and/or labeled where applicable.

1.4 Replace or repair, to the satisfaction of the owner, any materials and equipment damaged before or after installation.

1.5 Materials and equipment manufacturers and catalog numbers specified constitute the type and quality of design, material, workmanship, ruggedness of construction, resistance to vandalism, exact operating and performance characteristics, features, configuration, dimensions, etc.. Where multiple manufacturers are shown in the drawings and/or specifications, not all manufacturers shown may be capable of providing materials and equipment meeting the specifications, field conditions, etc.. Manufacturers not specifically shown on the drawings or specifications shall be considered, provided the products equal or exceed the requirements of the drawings and specifications (including equaling or exceeding products and/or manufacturers specifically shown on drawings and specifications). Manufacturers, whether shown on the drawings or specifications or not, are acceptable only if they can meet the specifications, conditions, and requirements specific to this project. Provide materials and equipment as required (include all costs in bid).

2. RACEWAYS

2.1 Steel Rigid Metal Conduit (RMC) and Steel Intermediate Metal Conduit (IMC)

A. Provide steel RMC as full weight, heavy wall, mild steel pipe, galvanized inside and outside.

B. Provide steel IMC as standard wall steel pipe; otherwise the same as steel RMC.

C. Provide fittings for steel RMC and steel IMC of high grade steel, having rust resistant finish, providing ample wiring space, having smooth round edges, and having full threaded hubs.

D. Utilize only fully threaded screw-on fittings with steel RMC and steel IMC (coat field-cut threads as per NEC Article 300.6(A)). Compression, set screw, bolt on, or other thread-less fittings are not permitted.

2.2 Electrical Metallic Tubing (EMT)

A. Provide EMT of high grade steel and galvanized inside and outside. Enamel coating only is not acceptable.

B. Provide fittings for EMT of high-grade steel, having rust-resistant finish, providing ample wiring space, having smooth round edges, and of the thread-less compression type without set screws. Die cast, set screw, and indenter fittings are not permitted.

2.3 Flexible Metal Conduit (FMC) and Liquidtight Flexible Metal Conduit (LFMC)

A. Provide FMC ("Greenfield") of high-grade steel, galvanized inside and outside, having a smooth interior, and providing a continuously effective ground. Provide fittings for FMC of high grade steel, having rust resistant finish, providing ample wiring space, having smooth round edges, of the two (2) screw type, listed and NEC approved for grounding.

B. Provide LFMC ("Sealtite") with an overall PVC sheath; otherwise the same as FMC. Provide fittings for LFMC of high grade steel, having rust resistant finish, providing ample wiring space, having smooth round edges, listed and NEC approved for grounding, and of the sealing compression gland type.

C. Where applicable, provide FMC and LFMC manufactured to comply with NEC Article "Places of Public Assembly".

2.4 Polyvinyl Chloride Rigid Nonmetallic Conduit (PVC RNC)

A. Provide PVC RNC of virgin PVC (or material reground from the manufacturer's own products), heavy wall, schedule 40 or schedule 80.

B. Provide fittings for PVC RNC of schedule 40 virgin PVC, providing ample wiring space, and having smooth round edges. Make all interfaces between PVC RNC and raceways, enclosures, boxes, other conduit types, etc., utilizing adapter fittings designed for the purpose.

C. Make all joints utilizing solvent welding method, installed to be completely watertight and pressure-tight to 172 kPa (25 p.s.i.).

D. High density polyethylene (HDPE) conduit and type "EB" encased burial and type "A" PVC conduits are not permitted under any circumstance.

2.5 Surface Raceway

A. Surface raceway without integral wiring devices: Provide steel type. Utilize Wiremold types #V700, #V2000, #V2100, or #V2400 (or approved equals) as required by the number of conductors to be run in the raceway. Utilize the smallest size raceway facilitating conductors. Raceway smaller than #V700 type is not acceptable.

B. Provide all steel surface raceways in factory ivory finish. Provide final painting (over the ivory factory finish) as directed by the owner and architect in the field. Provide all aluminum surface raceways in natural brushed aluminum finish.

C. Nonmetallic surface raceways are not permitted, unless specifically indicated otherwise on the drawings.

D. Provide all installations of surface raceways complete including all required fittings, accessories, details of installation, etc.. Include costs in bid for installing surface raceways around all obstructions encountered.

E. Provide fittings for surface raceways manufactured by the surface raceway manufacturer and specifically designed to be used with and compatible with the surface raceway and the actual installation conditions encountered. Provide fittings for surface raceways having rust resistant finish, providing ample wiring space, and having smooth round edges. Provide device box type fittings as per the section of this specification "Outlet, Switch, and Junction Boxes".

F. Perform all cutting, bending, and offsetting of surface raceways and components utilizing tools specifically designed and manufactured for the purpose by the surface raceway manufacturer. Cutting with hacksaws and bending/offsetting with standard conduit benders is not acceptable. Where the manufacturer does not manufacture or supply tools to perform work required (as indicated in manufacturer's standard catalogs), use only tools specifically recommended and approved for the purpose by the manufacturer.

G. Fasten and secure all surface raceways utilizing hardware concealed by the surface raceway. Visible securing and fastening hardware is not acceptable except that Wiremold #V5703 (or approved equal) supporting "back clip" type fasteners are permitted with #V700 style surface raceway without integral wiring devices only. One (1) or two (2) hole straps over the raceway are not acceptable.

H. Specifications are based on equipment as manufactured by Wiremold. Equipment as manufactured by Hubbell, Mono-Systems, or approved equal shall be considered.

3. OUTLET, SWITCH, PULL, AND JUNCTION BOXES

3.1 Provide boxes of proper types and sizes as required at all outlets and junctions indicated on the drawings and as otherwise required.

3.2 In unfinished areas, mount boxes flush or exposed. In finished areas, mount boxes flush in ceilings, walls, and floors, include all cutting and patching as required. Where impossible to mount flush in finished areas or where surface wiring is required to serve equipment in finished areas, finished style (Wiremold #V5730 to #V5760 series or approved equal by Hubbell or Thomas & Betts) surface boxes are permitted. Standard style pressed steel boxes are not permitted in finished areas. Where the contractor installs improper boxes in finished locations (without prior written approval), the contractor shall remove the boxes and install new boxes flush mounted (including cutting and patching to flush mount boxes and wiring and including replacing or reinstalling wiring) at no cost to the owner.

3.3 Utilize boxes of either unit or ganged construction and sized as required for devices and wiring installed and not smaller than the minimum sizes as per the drawings and specifications (and in no case smaller than the minimum size permitted by the NEC). Provide boxes as galvanized pressed steel (unless indicated otherwise), not less than 4" square, and with the proper size knockouts to facilitate wiring.

3.4 For flush mounted boxes, provide box shape permitting surfacing materials to be on straight lines and to fit closely around the box. Provide boxes in plastered, drywall (GWB), and similar walls, partitions, and ceilings with suitable plastering rings.

3.5 Utilize cast and/or malleable rust-resisting steel boxes for wiring in exterior, wet, or damp locations and for exposed visible steel RMC and IMC runs. Utilize aluminum or alloy boxes only where aluminum conduit is permitted by the specifications and used.

3.6 For all boxes in floors, utilize only boxes specifically designed, NEC approved, and listed for floor installation. Provide as required to maintain fire rating of the floor.

3.7 Provide all boxes for lighting outlets with studs of a size suitable for the weight of the luminaire supported (in no case less than 10 mm (3/8")). Provide the stud of integral construction with the box or of the type inserted from the back of the box. Studs held to the box with bolts to support luminaire weight are not permitted.

3.8 100 mm (4") diameter "octagon" boxes are not acceptable, except under the following conditions. Octagon boxes are permitted in conjunction with luminaire mounting studs where studs are required above. Octagon boxes are permitted where required to mount equipment where equipment is not compatible with square or ganged type boxes (including the use of adapter rings on square boxes).

3.9 Secure boxes firmly in place and set true, square, and flat or flush (as applicable) with finished surfaces. Keep all unused knockouts closed or close with suitable threaded plugs (for threaded knockouts or hubs) or knockout seals (for unthreaded knockouts). Install flush mounted boxes so the covers are flush with the finished surface.

3.10 Provide all boxes with cover plates as specified below.

4. COVER PLATES

4.1 Provide cover plates for switches, receptacles, outlet and junction boxes, and other devices of 1.0 mm (0.04") thick metal with paint finish or of stainless steel (as directed by the owner and architect, include costs in bid for painted or non-magnetic stainless steel), unless indicated otherwise.

4.2 Utilize suitable pressed galvanized steel code gauge raised covers for exposed wiring methods in unfinished areas and accessible hidden locations. Flat pressed galvanized steel code gauge covers may be utilized on junction boxes (where devices are not installed) or for ganged devices (three (3) gang or greater only). Tile and/or plastering rings style covers are not permitted for exposed wiring methods under any circumstance.

4.3 Utilize cast rust-resisting steel or #302 stainless steel covers with gaskets for boxes in wet, damp, or exterior locations or other locations where cast steel boxes are utilized.

4.4 Provide suitable blank covers on all unused boxes and boxes for future use (including boxes where devices are not installed at the time that electrical work is completed; specifically including telephone/data outlets where jacks and covers are not installed).

5. CONDUCTORS AND CABLE (600 V)

5.1 Provide all wiring (for all systems) utilizing multiple single conductors in raceway, unless indicated otherwise. Conductor sizes indicated in the specifications and on the

drawings are the minimum that will be accepted (conductor sizes are identified based on the NEC, as either American Wire Gauge [AWG] or thousands of circular mils [MCM equivalent to kcmil]). Where the contractor installs conductors smaller than the minimum size, the contractor shall remove conductors and install new conductors of the specified size at no cost to the owner.

5.2 Provide all conductors (including conductors in cables, where permitted) as 600 V, having flame retardant, heat resistant, and moisture resistant insulation, and listed and marked in accordance with industry standards and the NEC. Unless indicated otherwise, provide all conductors identified both as type "THHN" and as type "THWN"
("THHN/THWN"), rated 90 degrees C for dry and damp locations and rated 75 degrees C for wet locations. Conductors identified as type "XHHW" (in lieu of type "THHN/THWN") are permitted only where conductors are of the compact stranded type (type "XHHW" is not permitted for solid conductors or for standard concentric or compressed stranded conductors). Provide all conductors for all systems of a type suitable for installing in dry, damp and wet locations. Conductors suitable for dry locations only and conductors suitable for dry and damp locations only are not acceptable (except as specifically otherwise provided for plenum rated systems cables).

5.3 Provide all conductors of soft drawn copper (Cu, CU) wire of 98% conductivity. Aluminum (Al, AL) conductors are not acceptable, unless specifically indicated otherwise on the drawings.

5.4 Where permitted elsewhere in this specification, provide metal clad cable (type "MC") having interlocked steel or aluminum cladding and having conductors as specified above, including an insulated grounding conductor. Provide conductors #10 AWG and smaller as solid and conductors #6 A.W.G and larger as stranded. Conductors #8 AWG may be solid or stranded. Provide type "MC" cable listed and NEC approved to provide an acceptable grounding path. Provide fittings for type "MC" cable of suitable pressure pad/clamp type, high grade steel, having rust resistant finish, providing ample wiring space, having smooth round edges, and having full threaded hubs. Fittings utilizing set screws are not acceptable. "Snap-in" fittings of any kind (including, but not limited to, fittings designed to fasten in knockouts or hold cable with spring tension, fittings without treaded hubs, and fittings designed to be installed without the use of tools) are not acceptable. Provide type "MC" cable as listed and install in complete accordance with NEC Article 330. Where permitted by the NEC (including Article 604), listed manufactured wiring systems consisting of cables identified as type "MC" may be utilized wherever specifications allow the use of type "MC" cables. Where permitted by the NEC (including Articles 725 and 770), listed type "MC" cables containing Class 2 and Class 3 cable and/or optical fiber members in addition to power conductors may be utilized wherever specifications allow the use of type "MC" cables.

6. SPLICES, TAPS, AND CONNECTIONS

6.1 Make all splices, taps, and connections at locations indoor and above ground only. Splices, taps, and connections are not permitted below grade (including below any floor level where the floor is in direct contact with earth, i.e. basement slabs, slabs on grade, etc.), or where subject to being submerged (except as specifically provided as follows). Route raceways and wiring as required and include all costs in bid. Where physically impossible to install wiring to make splices/taps above grade, splices/taps below grade shall be considered where specifically requested in writing in advance (prior to installing conductors) by the contractor and where approved in writing by the engineer. Specifically and individually identify each and every case involved for below grade splices/taps in the request(s) and submit shop drawings for splices/taps (as indicated below). Where below grade splices/taps are installed by the contractor (without prior written approval) the contractor shall remove the raceways, wiring, splices, and taps and install new raceways and wiring in such a manner to completely avoid below grade splices/taps at no cost to the owner.

6.2 Perform all splices/taps in suitable code sized outlet and junction boxes only, not in raceways, conduit bodies, or equipment cabinets. Clean each strand of conductors carefully before connecting.

6.3 Insulation piercing type splices, taps, and connections of any kind are not permitted under any circumstance (including where applied after removing insulation).

6.4 Provide connections at equipment, apparatus, and devices as required for a complete installation and as follows. Coordinate all requirements with equipment to connect.

A. Where equipment includes factory "pig tails" for connections, make connections as specified above for splices and taps.

B. For stranded wiring #10 AWG and smaller, utilize suitable crimp-on "Stacon" type terminals. Where equipment terminals include pressure pads, wiring may terminate directly at equipment without crimp-on terminals. Connecting stranded wiring directly at wire binding screw terminals (i.e. wrapped around screw) is not permitted under any circumstance.

C. For solid wiring #8 AWG and smaller, provide wiring connecting directly at terminals.

D. For wiring #6 AWG and larger and #8 AWG stranded wiring, utilize suitable crimp-on compression lugs. Where equipment is provided with factory-installed lugs, wiring may connect directly at factory lugs.

6.5 Provide splices and taps at indoor locations and outdoor locations above ground (excluding exposed outdoor splices/taps) as follows.

A. For stranded wiring #10 AWG and smaller and solid wiring #8 AWG and smaller, make splices/taps by twisting conductors together and utilizing suitable pressure type "wire nut" connectors. Tightly over-wrap with vinyl insulating tape. Utilize listed wire nuts with internal coiled square metal binding spring ("all plastic" and porcelain wire nuts are not acceptable under any circumstance). For splices/taps in wet locations, utilize only "self-sealing" wire nuts with integral water repellent non-hardening sealant (Ideal #60 "DB Plus" or approved equal).

B. For wiring #6 AWG and larger and for #8 AWG stranded wiring, make splices/taps utilizing suitable crimp-on compression connectors. Bolted type connectors are not permitted, except where available crimp-on compression connector configurations do not correspond to combinations and arrangement of conductors to be connected. Wrap with rubber insulating tape or vinyl mastic of type, thickness, and insulation level equal to or exceeding the original insulation then tightly over wrap the entire assembly with vinyl insulating tape covering all rubber tape/mastic without gaps or voids.

6.6 Provide all splices and taps underground, below grade, and subject to being submerged (where specifically approved in writing by the engineer) as follows. Provide splices/taps of direct buried and open aerial wiring (where specified elsewhere) as follows. Submit shop drawings for all proposed splice/tap products and methods. Where any splice/tap is installed in any underground, below grade, submerged, or exposed wet or outdoor location for which shop drawings are not previously submitted, the contractor shall disconnect and remove the installed splices/taps and provide new acceptable splices/taps (as directed by the engineer) at no cost to the owner.

A. Utilize manufactured or pre-engineered splices/taps specifically designed and listed for the application, including being suitable for installation underground, direct buried, submerged, and in wet locations. Provide outdoor exposed splices/taps also as sunlight resistant. Pre-molded, heat-shrink, and cold-shrink manufactured kits and engineer approved pre-engineered hand-wrapped tape kits shall be considered.

B. For underground splices/taps of stranded wiring #10 AWG and smaller and solid wiring #8 AWG and smaller <u>only</u>, splices/taps may be made as follows. Permanently electrically connect conductors by either of the following options:

1) Twist conductors together then <u>solder</u> conductors. Utilize suitable pressure type wire nut connectors with integral water repellent non-hardening sealant

(Ideal #60 "DB Plus" or approved equal) to mechanically bind the soldered splice/tap and tightly over wrap with vinyl insulating tape.

2) Splice/tap conductors with suitable insulated crimp-on connectors and tightly over wrap with vinyl insulating tape.

Once electrically connected, embed splices/taps in sealant compound. Utilize only engineer approved hardening flexible sealant (i.e. "Bondo" traffic detector loop style sealant; contact the engineer for information and submit shop drawings for approval). Place sealant (uncured liquid) in a suitable container, immerse splices/taps in sealant in the container, and rigidly support splices, taps, and conductors in place until sealant has set.

C. Self-sealing wire nuts (used alone and/or when over wrapped with vinyl insulating tape) are not an acceptable substitute for splices/taps as specified in items "A" and "B" above.

6.7 Splices, taps, and connections (and associated materials) as manufactured by Burndy, Elastimold, G&W, Homac, Ideal, Ilsco, Mac Products, O-Z/Gedney, Plymouth, Raychem, Skotch/3M, Thomas and Betts/Blackburn, and approved equal shall be considered.

7. GROUNDING MATERIALS

7.1 Provide all material used for grounding of non-ferrous copper. Aluminum is not acceptable, unless specifically indicated on the drawings.

7.2 Provide all driven (made) grounding rod electrodes of copper or copper clad steel, minimum 19 mm (3/4") diameter by 3.0 m (10'0") long.

7.3 Provide all grounding conductors in accordance with the section of this specification "Conductors and Cable (600 V)", except as follows. Grounding conductors may be insulated or bare, except as follows. Wherever grounding conductors #6 AWG and smaller are insulated, provide insulation colored green. Provide "isolated" grounding conductors as insulated only (green with yellow tracer). Provide grounding conductors run in raceway/cable with wiring as insulated only (bare conductors are not permitted for grounding conductors run with wiring, except cable wiring methods permitted elsewhere in the specifications where insulated grounding conductors are not available).

7.4 Provide all grounding connections as per the section of this specification "Splices and Taps", except as modified below. Grounding connections do not require insulation.

7.5 For wiring #4 AWG and larger, provide all grounding connections utilizing exothermic weld process (Erico/Cadweld, Thermoweld, Thomas & Betts, or approved equal). Crimp-on compression type connectors may be used only where available exothermic weld process connection configurations do not correspond to combinations and arrangement of conductors to be connected. Bolted type connectors are not permitted, except where available exothermic weld process and crimp-on compression connector configurations do not correspond to combinations and arrangement of conductors to be connected. Where equipment is provided with factory installed lugs, #4 AWG and larger wiring may terminate directly at factory lugs.

7.6 Utilize only exothermic weld process connections for all concealed grounding connections; compression, mechanical, and other grounding connections are not permitted concealed. Where available exothermic weld process connection configurations do not correspond to combinations and arrangement of conductors to be connected in concealed locations, utilize combinations and arrangement of conductors as required to facilitate exothermic weld process connections and extend from the concealed connection location to an accessible location where crimp-on compression or bolted type connections may be utilized (as permitted above).

7.7 Accessible connections of wiring #6 AWG and smaller to piping and similar materials/equipment may utilize multiple-bolt type ground clamps. Accessible connections of wiring #6 AWG and smaller to driven (made) grounding rod electrodes may utilize one-piece, single bolt "acorn" type ground clamps.

7.8 Provide conduit grounding bushings of galvanized malleable iron with integral screw pressure connector or provisions to accept factory or field installed lug where required.

8. IDENTIFICATION, NAMEPLATES, AND TAGS

8.1 Provide all new electrical equipment with engraved three (3) layer laminated plastic nameplates describing the equipment, load/device served, ratings, circuit(s) feeding the equipment, etc. as indicated below. Provide engraved plastic nameplates for existing electrical equipment where modified or connected to as part of this project or where specifically indicated on the drawings. Provide these engraved plastic nameplates in addition to any code required or manufacturers' standard nameplates.

8.2 Provide engraved plastic nameplates for all electrical equipment, including, but not limited to, safety switches, enclosed circuit breakers, branch panels, distribution panels
(including branch circuit breakers and circuit breaker spaces), transformers, any

equipment containing fuses, power outlets, thermal overload switches, contactors, time clocks, photocells, meter sockets, modular meter centers, fire alarm equipment and devices, lighting controllers, dimming cabinets, capacitors, snow melting equipment, generators, motor control centers, motor controls (starters, variable frequency drive [VFD] units, etc.) where furnished by the electrical contractor, high voltage equipment, etc. (where applicable). Provide engraved plastic nameplates for all receptacles and switches where dedicated to serving specific equipment. Provide engraved plastic nameplates for convenience receptacles (only where indicated on the drawings).

8.3 Secure engraved plastic nameplates with suitable screws or rivets, self-adhesive nameplates are not acceptable. Provide engraved plastic nameplates with white letters on black background, unless indicated otherwise. Provide engraved plastic nameplates with 6.5 mm (1/4") minimum lettering, unless indicated otherwise. Provide engraved plastic nameplates on the front and/or cover of the equipment plainly visible when the cover (where applicable) is closed, unless indicated otherwise.

8.4 Submit shop drawings showing proposed sizes (overall and lettering sizes) and exact proposed wording (including exact arrangement of wording) of all engraved plastic nameplates for review and approval.

8.5 Provide all engraved plastic nameplates in accordance with the following example. Equipment names are the alphanumeric designation for equipment indicated on the drawings (i.e. "MDP", "PP1", "EF-1", etc.). Equipment descriptions identify the equipment in "plain English" (see example). Indicate the operating voltage of the equipment, including phase and wires (see example). Where equipment includes overcurrent devices (i.e. main breaker panels, fused switches, enclosed circuit breakers, etc.) show the appropriate amperes on the engraved plastic nameplate. Where equipment does not include overcurrent devices (i.e. main lug panels, unfused switches, contactors, transformers, etc.) show the amperes of the overcurrent device protecting the circuit serving the equipment. Remarks include information as described below.

EXAMPLE ENGRAVED PLASTIC NAMEPLATE WORDING

Equipment Name (use 10 mm (3/8") lettering):	PP1
Equipment Description:	POWER PANEL
Equipment Voltage, Phase, Amperes:	120/208V-3PH-4W, 100A
Remarks:	FED FROM MDP - CCT. 4

A. Branch Panel: Provide engraved plastic nameplate showing panel name and use (description) as indicated on the single line diagram and/or respective panel

schedule. Remarks indicate the panel and circuit number or transformer feeding the panel.

B. Distribution Panel: Provide "master" engraved plastic nameplate on the front cover showing information as indicated above for branch panels. For multiple section panels, locate master nameplate on the section containing the main breaker or incoming line main lugs. Remarks indicate the panel and circuit number or transformer feeding the panel (i.e. sub-distribution panel) or indicate "Service Disconnect" if a service entrance distribution panel. Provide additional nameplates for all branch circuit breakers and circuit breaker spaces (see below).

C. Branch Circuit Breaker in Distribution Panel: Provide engraved plastic nameplate for each new circuit breaker within a distribution panel (including breakers in existing panels connected to as part of this project). Show the name and description of equipment/load fed. Voltage and phase are not required on these nameplates. Amperes are not required on these nameplates if the rating is clearly and visibly indicated on the circuit breaker. Where adjustable trip circuit breakers are used, show the proper ampere setting on this nameplate. Remarks indicate the approximate location of the equipment/panel served. Where the distribution panel includes a hinged overall cover door, provide these nameplates mounted inside the hinged door.

D. Circuit Breaker Space in Distribution Panel: Provide engraved plastic nameplate for each circuit breaker space within a new distribution panel. Show the word "SPACE" and the maximum circuit breaker poles and frame size ampere rating. Equipment name, description, voltage, and remarks are not required on these nameplates. Where the distribution panel includes a hinged overall cover door, provide these nameplates mounted inside the hinged door.

E. Safety Switch/Enclosed Circuit Breaker: Provide engraved plastic nameplate with the name and description of equipment/load fed. Remarks indicate the panel and circuit number or transformer feeding the switch/breaker. Ampere rating may be omitted if the proper rating is clearly indicated on the switch/breaker and is visible with the cover closed. Where fusible switches are used, show the fuse ampere rating. Where adjustable trip circuit breakers are used, show the proper ampere setting.

F. Fusible Device: On the inside cover of each fused device, provide an engraved plastic sign indicating the proper fuse size (as indicated on the drawings or as required). Provide nameplate reading, "USE ___A FUSE ONLY" (fill in the proper fuse rating).

8.6 Provide engraved plastic nameplates for power outlets, thermal overload switches, and for receptacles and switches where dedicated to serving specific equipment. Show the equipment served, the voltage and ampere rating, and the circuit feeding

the equipment. Utilize 3.2 mm (1/8") high minimum lettering. Provide as per the following example:

Equipment Name and Description: MO-1 MICROWAVE OVEN Equipment
Voltage and Amperes: 120V, 20A - PP1-12

8.7 Where specifically indicated on the drawings only, provide engraved plastic nameplates for convenience receptacles showing the voltage and ampere rating and the circuit feeding the receptacle. Utilize 3.2 mm (1/8") high minimum lettering. Provide as per the following example:

Equipment Voltage and Amperes: 120V, 20A
Equipment Circuit: PP1-14

8.8 Provide engineer approved wrap-around adhesive or tube type wire tags or markers for all conductors, except conductors in feeders tagged as indicated below. Provide tags/markers indicating the panel or device where the wiring originates and the conductor circuit number (or other identifying number/letter/designation unique to the conductor). Tag/mark neutral and grounding conductors with the respective circuit number(s) of the corresponding phase conductor(s).

8.9 Provide engineer approved tags for all panel feeders (regardless of ampere rating) and other circuits (600 V and less) rated 100 A and larger, at both ends and at all intermediate junction and pull boxes. Provide tags indicating the circuit designation or equipment served, panel name and circuit number (or other source of feeder), and stating the voltage, phase, and amperes of the circuit. Provide tag wording and layout similar to engraved plastic nameplates as indicated above.

8.10 Where any conductor size differs from the conductor size normally expected for the respective overcurrent device (for any reason, whether specified or not, including voltage drop consideration, NEC "tap rule" application, ampacity de-rating considerations, etc.), provide engineer approved tags at the point where the wiring terminates at the overcurrent device reading, "WIRING IS ADJUSTED FOR VOLTAGE DROP/TAP RULE/DE-RATING, USE MAXIMUM ___A FUSE/CB" (indicate the proper reason for the adjustment and fill in the proper overcurrent device ampere rating). For feeders, this information may be included on the tags specified above.

8.12 Provide all new branch panels with accurate and descriptive typewritten circuit directories.

8.13 Provide all new electrical equipment with all caution, danger, and warning signs or indications required by any applicable regulation, code, standard, or manufacturer's

recommendation (refer to specifications section "Regulations and Codes" of specifications division 16100, General Electrical and provide signs as listed where applicable). This includes, but is not limited to NEC Articles 100, 110, 200, 230, 250, 450, 490, 504, 513, 516, 550-552, 585, 620, 647, 665, 669, 690, 692, 700, 705, etc., as applicable.

8.14 Identify conductors in complete accordance with the NEC and as indicated below (including identifying "high-leg", grounding, and grounded (i.e. neutral) conductors, where applicable). For conductors #6 and smaller, identify by natural insulation color. For conductors #4 and larger (and for cable wiring methods where applicable colors are not readily available from cable manufacturers), identify by natural insulation color or by a 155 mm (6") long (minimum) band of colored vinyl electrical tape on conductors at all terminations and in all boxes and enclosures. Where "tracers" are required, identify by natural insulation color including narrow stripes of the tracer color. Where conductors including tracer stripes are not readily available, provide a 25 mm (1") band of tape (apply over and in the center of the 55 mm (6") band of tape, where applicable)
of the tracer color at all terminations and in all boxes and enclosures.

8.15 Identify phases of all conductors where more than one phase conductor is present (in raceways, cables, boxes, enclosures, etc.) with methods as indicated above.

9. LOCKS AND KEYS

9.1 Provide all locks for lighting and power panels, fire alarm and signaling cabinets and all other electrical systems or locked apparatus with keys which are alike.

10. RECEPTACLES AND SWITCHES

10.1 Provide all receptacles and switches as industrial and specification grade, totally enclosed in non-flammable and heat resistant heavy-duty thermoset or thermoplastic case, with terminal screws on the side of the case. Pigtail conductor connections are not permitted (except for specialty devices where side terminal screws are not available options in the manufacturer's catalog). Provide color as selected and approved by the owner and architect.

10.2 Provide receptacles as duplex, parallel blade, side wired, three (3) wire, grounding type, 20 A, 120 V, and listed as "tamper-resistant", unless specifically indicated otherwise on the drawings. Listed combination receptacle and separable snap-in wiring terminal assemblies (Hubbell "SNAPConnect" style, Pass & Seymour "PlugTail" style, or approved equal) may be used and may utilize pigtail connections on the wiring terminal assemblies.

10.3 Provide weatherproof receptacles listed as weather-resistant type and mounted in a weatherproof box with gasket and single spring-hinged weatherproof-while-in-use cover over both receptacle positions.

10.4 Provide receptacles at bathrooms, janitor closets, kitchen/kitchenette counters, outdoors, wet locations, and as indicated on the drawings or required by the NEC with integral ground fault circuit interrupter (GFCI) protection for personnel with trip characteristics as per the NEC and UL standards.

10.5 Provide wall switches as single pole, three-way, or four-way as required, heavy duty flux tumbler type, UL "T" rated, specification grade, and rated 20 A, 277 V and 120 V.

10.6 Provide horsepower rated single-pole thermal overload switches (manual motor starters, O/L switches, etc.) with thermal overload heater element coordinated with equipment served. Where overload protection is not required (where the switch acts only as disconnecting means) provide overload heater element rated in excess of the branch circuit breaker amperes.

10.7 For all switches where locking provisions are required by Code or indicated on the drawings and for all thermal overload switches, provide a suitable handle locking guard capable of visibly padlocking in the open or closed position (with switch handle position visible when locked).

10.8 Provide dimmer switches of thin profile slide type ("off" when slider is in the lowest position), Lutron #NT series or approved equal by Hubbell or Leviton, unless indicated otherwise. Dimmer switches of the rotary type, with raised profile (with raised cooling fins), and/or with on/off toggle separate from slider are not acceptable. Provide with full wattage rating as indicated on the drawings, do not "de-rate" by removing cooling fins or heat sink sections (unless specifically indicated on the drawings). Where multiple dimmer switches or dimmer switch(es) along with standard type switches (single pole, three-way, and four-way) are shown grouped together on the drawings, gang switches together with a single overall cover plate (conform with NEC Article 404.8(B) "Voltage Between Adjacent Switches", where applicable). Utilize special cover plates as required by the combination of switches involved. Where ganged with dimmer switches, utilize single pole, three-way, and four-way switches of the slide type with appearance and manufacturer matching dimmer switches.

11. SAFETY SWITCHES

11.1 Provide all safety switches (disconnect switches) of the quick-make and quick-break type, with contacts not marked or shielded, designed to function if the operating

spring fails or is removed, with mechanical interlock so operation is impossible when the cover is open (provide means to manually bypass/defeat the interlock), with provisions for padlocking in both the open and closed positions, and of the heavy duty type. Provide switches with voltage ratings equal to or exceeding the operating voltage.

Provide indoor switches with NEMA-1 enclosures. Provide outdoor switches with NEMA-3R enclosures. Where NEMA-4X enclosures are specifically indicated on the drawings only, provide of the stainless steel type only.

11.2 Provide fuse clips in fusible switches to facilitate fuses as per the section of this specification "Fuses". Provide suitable "rejection" type clips to prevent replacing fuses with short circuit ratings lower than specified.

11.3 Provide safety switches with ground busses. Where neutral conductor is present, provide safety switches with separate neutral busses (with provisions for bonding; bond where required by the NEC).

11.4 For all safety switches on the load side of variable frequency drive (VFD) units, provide safety switches with integral "electrical interlock" auxiliary contacts (one (1) N.O. and one (1) N.C., minimum) which "break" before safety switch opens. Provide two (2) #14 AWG interlock conductors run (in raceway with line side power conductors) from auxiliary contact to VFD unit. The VFD supplying contractor shall connect interlock wiring at VFD unit to shut down VFD unit if safety switch is opened to prevent operating VFD without load connected.

11.5 Equipment as manufactured by Eaton, General Electric, Siemens, Square-D, and approved equal shall be considered.

12. FUSES

12.1 Provide an NEC cartridge fuse for each fuse-gap in the work. Furnish three (3) spare fuses of the rating installed to the owner for each fused device. Specifications are based on equipment as manufactured by Cooper/Bussman. Equipment as manufactured by Ferraz Shawmut, Littlefuse, and approved equal shall be considered.

12.2 Provide fuses of the dual element time delay, current limiting, and non-renewable type with voltage rating not less than the operating voltage and coordinated with the respective fuse clips and with short circuit rating of 200,000 A. Provide fuses as class "RK1" (600 A and less, Cooper/Bussman #LPN/S-RK series) or class "L" (over 600 A, Cooper/Bussman #KRP-C series). Class "CC" fast acting (Cooper/Bussman #LP-CC series) or time delay (Cooper/Bussman #KTK-R series) fuses, as recommended by manufacturer, are permitted for control applications.

13. CIRCUIT BREAKERS

13.1 This section applies to all circuit breakers installed within or in conjunction with branch and distribution panels, enclosed circuit breakers, contactors, starters, and any other electrical equipment, unless indicated otherwise.

13.2 Provide all circuit breakers of the molded case type unless specifically indicated otherwise. Provide readily removable from the front of panels and equipment without disturbing adjacent units, having quick-make and quick-break toggle mechanisms and non-fusible contacts, having inverse time and short circuit characteristics, which trip free on overload or short circuit so that they cannot be held closed on overload, clearly indicating whether they are in the open, tripped, or closed position. Provide automatic release obtained through the medium of a bimetallic thermal type element (ambient compensated) engaged in the releasing latch of the breaker or mechanism.

13.3 Provide circuit breakers in branch and distribution panels with short circuit ratings as indicated in the respective equipment specifications. Provide circuit breakers as part of enclosed circuit breakers, contactors, starters, and any other electrical equipment with short circuit ratings not less than the short circuit rating of the first overcurrent device on the line side of the breaker, unless indicated otherwise on the drawings.

13.4 Provide field-installed handle locking devices for all circuit breakers not requiring switch control, for all circuit breakers feeding emergency lighting equipment (including battery equipment) and fire alarm controls, and for all circuit breakers fed from an emergency generator system (where applicable).

13.5 Provide 15 A and 20 A circuit breakers "SWD" and "HID" rated. Provide branch panel (250 V and less) circuit breakers rated 70 A and less as "HACR" rated. Provide enclosed circuit breakers and circuit breakers in distribution panels rated 250 A and less as "HACR" rated.

13.6 Provide all circuit breakers over 250 A of a type with interchangeable trip units. Provide all circuit breakers rated 1,000 A or larger and operating at over 250 V with integral ground fault protection for equipment.

13.7 Where circuit breakers include or facilitate adjustable settings, adjust and set as follows. Set adjustable continuous current settings (where applicable) to ratings shown on drawings. For adjustable instantaneous, short time, and ground fault settings (where applicable), the electrical contractor is responsible for (include all costs) a basic short circuit and coordination study performed by the respective circuit breaker manufacturer. Set breakers as per this study. Provide study in accordance with applicable ANSI and IEEE standards. Gather all information required by the

manufacturer to perform this study. Submit a written report of the study to the engineer for review prior to releasing equipment for manufacture. The basic coordination study may be limited to a minimum of coordinating each adjustable setting circuit breaker with the nearest line side overcurrent device directly feeding the breaker and all nearest load side overcurrent device(s) fed directly by the breaker. The basic short circuit study may be limited to the minimum required to complete the coordination study and confirm proper settings. Setting adjustable circuit breaker settings to the minimum or factory "default" settings (i.e. as shipped from the factory) is not acceptable.

14. BRANCH PANELS

14.1 Provide branch panels (panel boards) of dead front completely enclosed safety type construction, listed (with all components bearing labels), of a type suitable for use as service entrance, and containing thermal-magnetic "bolt-on" type circuit breaker branches as per the respective schedules on the drawings.

14.2 Provide circuit breakers as specified elsewhere in this specification.

14.3 Provide cabinets consisting of code gauge galvanized sheet steel boxes of sufficient depth, width, and length to mount the panels as indicated on the drawings and to facilitate wiring, with suitable lugs for mounting panel interiors, and with wiring gutters at top, bottom, and sides of sufficient size to adequately accommodate the raceways, conductors, and cables entering and leaving (provide all gutters at least 100 mm (4")).

14.4 Provide panel faces with adjustable indicating type clamps and of single door construction, with door opening over the circuit breaker section (secured with locks and pulls as specified under paragraph heading "Locks and Keys"), hung with heavy hinges, and with faces and doors not less than 2.7 mm (12 ga.) thick.

14.5 Provide metal frame circuit directory holders welded to the inside of the cabinet doors with transparent covers. Place typewritten directories in these holders.

14.6 Provide bus bars with ampacity as indicated on the drawings (or corresponding to main breaker, where applicable) and with all current carrying parts sized per UL 67 heat rise
testing.

14.7 Provide panels with copper or aluminum bus bars.

14.8 Provide panels with separate ground and neutral busses. Provide neutral bus with provisions for bonding and bond where required by the NEC.

14.9 Provide panels with 10,000 A short circuit rating (A.I.C., I_{sc}), unless indicated otherwise on the drawings. Provide panels fully short circuit rated, series short circuit rating of panels are not acceptable (unless specifically indicated otherwise).

14.10 Equipment as manufactured by Eaton, General Electric, Siemens, Square-D, and approved equal shall be considered.

14.11 Where branch wiring fed from the panel utilizes cable wiring methods (i.e. types "AC" or "MC" cables, where permitted elsewhere by the specifications) avoid visible exposed cables in electrical closets and electrical rooms by either of the following options:

A. Provide suitable sheet metal panel "skirt" enclosure(s) above and/or below the panel as required to completely enclose cable wiring methods so not more than a 300 mm (12") total length of each cable is visible. Provide skirt enclosures fabricated of galvanized sheet steel not less than 0.55 mm (26 ga.) thick.

B. Provide a nearby junction box for branch wiring as indicated below.

14.12 Where panels are flush mounted, provide an adjacent junction box for branch wiring as indicated below.

15. JUNCTION BOXES FOR BRANCH PANELS

15.1 Provide suitable junction boxes (and/or wiring troughs) for branch wiring at branch panels as follows. The electrical contractor must provide junction boxes for all flush mounted panels. The electrical contractor may utilize junction boxes (as an option to metal panel skirts) to avoid exposed visible cables in electrical closets/rooms. The electrical contractor may utilize junction boxes at other locations and applications if desired, but the boxes and raceways (wherever used) must comply with the following.

15.2 Locate each junction box above an accessible drop ceiling (or an access panel if ceiling
is inaccessible) directly above or as close as practical to the panel. Where junction box is installed to satisfy requirements to hide cable wiring methods, locate outside of the electrical closet/room or inside the closet/room at a perimeter wall so there are no visible cables in the closet/room (except that not more than 300 mm (12") total visible length of each cable is permitted leaving the junction box).

15.3 Provide junction boxes and raceways between boxes and panel as indicated below.

Panel Size (Branch Cct. Poles)	Junction Box Min. Dimensions	Quantity and Size of Conduits
43-Poles & Over (All Double panels)	48"W x 8"H x 8"D (1.2m x 205mm x 205mm) *	(8) 53 mm (2")
31-to 42-Poles	24"W x 8"H x 8"D (0.6m x 205mm x 205mm)	(4) 53 mm (2")
19-to 30-Poles	24"W x 6"H x 6"D (0.6m x 155mm x 155mm)	(3) 53 mm (2")
18-Poles and less	18"W x 6"H x 6"D (460mm x 155mm x 155mm)	(2) 53 mm (2")

* Two (2) 24"W x 8"H x 8"D (0.6 m x 205 mm x 205 mm) junction boxes may be substituted. Provide (2) 78 mm (3") conduit nipples between the junction boxes.

15.4 Adjust wiring sizes between each junction box and panel in accordance with NEC derating factors. Utilize #8 AWG wiring for branch circuits rated 25 A or 30 A. Utilize #6 AWG wiring for branch circuits rated over 30 A but less than 60 A. Coordinate routing of wiring between junction box and panel with the engineer during construction for all circuits rated over 30 A. Where wiring sizes change due to de-rating considerations, splice wiring in the junction box as required.

15.5 Do not pass the incoming panel feeder and any branch circuits rated 60 A and larger through junction boxes, run this wiring directly into panels. Do not terminate any branch wiring conductors (including grounding conductors associated with each branch circuit) in junction boxes. Terminate conductors only at circuit breakers, ground bus, and neutral bus in panels. Do not splice conductors in junction boxes, except straightthrough splicing of two (2) conductors as provided above for de-rating.

15.6 Bond each junction box to the panel enclosure with a grounding conductor run in one of the raceways between the panel and junction box. Provide bonding conductor not smaller than the grounding conductor for the panel feeder.

16. DISTRIBUTION PANELS

17.1 Distribution panel (distribution panel boards and switchboards) specifications are based on Square-D "I-Line" type. Additional equipment including Square-D #QED type, Eaton "Pow-R-Line" type, General Electric "AV-Line" type and "Spectra" series, Siemens "P-series", and approved equal shall be considered.

16.2 Provide distribution panels of dead front completely enclosed safety type construction, listed (with all components bearing labels), and of a type suitable for use as service entrance.

16.3 Provide thermal-magnetic branch circuit breakers featuring "bolt-on" type modular mounting, facilitating mounting of breakers regardless of breaker frame sizes or poles.

16.4 Provide circuit breakers as specified elsewhere in this specification.

16.5 Where new "spaces" or "provisions" for circuit breakers are indicated on the drawings or specifications, include all circuit breaker mounting brackets, hardware, bus bar straps, screws, and any other material, equipment, and accessories required to install
circuit breakers in the future (install in panel spaces). Provide so the only necessary component not furnished as part of provisions is the circuit breaker(s) themselves.

16.6 The quantity of provisions (of each respective frame size) specifically indicated on the drawings is the minimum acceptable. If necessary, provide additional branch distribution sections to provide the specified minimum quantity. After satisfying specified minimums, provide additional provisions (of 100 AF, 225/250 AF, and/or 400 AF frame sizes; in any combinations at the manufacturer's/contractor's discretion) as required so all remaining available circuit branch breaker mounting space in the panel (for the full height of the panel enclosure) consists of provisions.

16.7 Provide all compartments (and all main and branch circuit breakers and other equipment therein) completely accessible from the front, unless otherwise indicated on the drawings (regardless if panels are shown against a wall or free-standing).

16.8 Provide enclosure consisting of code gauge steel box(es) of galvanized sheet steel of sufficient dimensions to mount panels and to facilitate wiring.

16.9 Provide bus bars with ampacity as indicated on the drawings (or corresponding to main breaker, where applicable) and with all current carrying parts sized per UL 67 heat rise testing.

16.10 Provide panels with copper or aluminum bus bars.

16.11 Provide panels with separate ground and neutral busses. Provide neutral bus with provisions for bonding and bond where required by the NEC.

16.12 Provide bus bars braced to withstand 100,000 A short circuit current. Provide panels with 100,000 A short circuit rating (A.I.C., I_{sc}), unless indicated otherwise on the drawings (rating on drawings does not apply to bus bracing, provide bracing as indicated above). Provide panels fully short circuit rated, series short circuit rating of panels is not acceptable.

16.13 Identify each branch circuit breaker individually with an engraved plastic nameplate as indicated in the section of this specification "Identification, Nameplates and Tags".

17. CONTACTORS

17.1 Provide lighting contactors with number of poles and ampere ratings as indicated on the drawings. Provide contactors mechanically held and electrically operated with integral solid-state control modules as required for two (2) wire control, unless indicated otherwise. Utilize electrically held and electrically operated contactors only where specifically indicated on the drawings (and provide with not less than one (1) N.C. and one (1) N.O. auxiliary contacts). Provide contactors with silver alloy double break contacts, with all contacts rated 600 V, and with coil clearing contacts.

17.2 Provide 120 VAC coil voltage, unless indicated otherwise. Provide contactors mounted in NEMA-1 enclosures, unless indicated otherwise. Provide all contacts normally open, unless indicated otherwise.

17.3 Provide contactors rated 20 A as ASCO #918 series, or approved equal. Provide contactors rated 30 A and larger of the non-fusible combination type, with integral disconnect switch, Square-D Class #8903 type "S", or approved equal.

17.4 Equipment as manufactured by ASCO, Eaton, General Electric, Square-D, Siemens, and approved equal shall be considered.

17.5 Provide an engraved laminated plastic nameplate on the front cover (refer to the section of this specification "Identification, Nameplates, and Tags") describing the contactor ("OUTDOOR LIGHTING CONTACTOR - 120V, 5A - CONTROLS FED FROM PP1 - CCT. 4 - SEE INSIDE FOR CONTROLLED LIGHTING CIRCUITS - *"). Describe the device(s) controlling the contactor and controlling device(s) location(s), where applicable. Provide a typewritten circuit directory affixed within the enclosure listing each respective contactor pole, panel, circuit number, and circuit description of each controlled circuit. Nameplate is not required for contactors integral to a lighting controller where the controller includes a similar nameplate.

18. TIME CLOCKS AND PHOTOCELLS

18.1 Provide one (1), two (2), or four (4) channel time clocks, as indicated on the drawings. Provide time clocks with one (1) single pole, double throw (SPDT) contact for each respective channel (to facilitate control of mechanically held, electrically operated contactors), with digital control (electromechanical type is not acceptable), of the seven (7) day type with 365 day single and block holiday scheduling, with astronomic feature, indicating "on" or "off" condition with an illuminated light emitting diode (LED) visible with the enclosure cover open, with integral manual override capability, with integral automatically recharging nickel cadmium (NiCd) battery providing minimum 72 hour reserve power. Provide coil and contact voltage rated 120 V, unless indicated otherwise. Provide time clock with

NEMA-1 metal or NEMA-3 "Noryl" enclosure, unless indicated otherwise. Provide contacts rated 20 A where directly switching branch circuit load or rated 10 A (resistive) minimum where controlling contactor(s). Utilize Tork #DZS100BP (one channel), #DZS200BP (two channel), or #K400Z (four channel) time clocks or approved equal.

18.2 Provide an engraved laminated plastic nameplate on the front cover of each time clock (refer to the section of this specification "Identification, Nameplates, and Tags") describing the time clock ("OUTDOOR LIGHTING - 120V, 5A - CONTROLS FED FROM PP1 - CCT. 4 - SEE INSIDE FOR CONTROLLED LIGHTING CIRCUITS - *"). Describe the device(s) controlled by the time clock and controlled device(s) location(s), where applicable. Where time clock switches branch circuits directly, provide a typewritten circuit directory affixed within the enclosure listing each respective contact pole, panel, circuit number, and circuit description of each controlled circuit. Nameplate is not required for time clocks integral to a lighting controller where the controller includes a similar nameplate.

18.3 Provide photocells of the utility-grade twist-lock type with integral time delay feature (nominal 3-5 s), with molded sealed infrared (IR) silicon electronic sensor and 360 J integral utility grade metal oxide varistor (M.O.V.) over-voltage surge protection, arranged to "fail-on", listed, and rated 120-305 V (suitable for 120 V, 208 V, 240 V, and 277 V operation), 1,000 W tungsten, 1,800 VA ballast, and 1,000 W LED, unless indicated otherwise. Provide a suitable twist-lock photocell receptacle and mount atop a suitable weatherproof box. Utilize Tork #5237M photocells and Tork #2223/4 photocell twist-lock receptacles or approved equal.

18.4 Provide an engraved laminated plastic nameplate at photocell twist-lock receptacles (refer to the section of this specification "Identification, Nameplates, and Tags") describing the device(s) controlled by the photocell and the circuit feeding the photocell ("SEE LIGHTING CONTROLLER IN ELECTRICAL ROOM - 120V, 5A - PP1, CCT. 4"). Nameplate may utilize 3.2 mm (1/8") letters.

18.5 Specifications are based on equipment as manufactured by Tork. Equipment as manufactured by Intermatic, Paragon, and approved equal shall be considered.

END OF SECTION

1. GENERAL PROVISIONS

1.1 The applicable requirements and conditions of specifications section "General Provisions" of specifications divisions 16100, General Electrical, and 16300, Electrical Materials, are hereby made an integral part of this section.

1.2 Provide lighting systems consisting of all components necessary for a complete installation. Refer to the Lighting Fixture Schedule on the drawings for additional information.

1.3 Lighting fixtures including, but not limited to, those manufactured by the following shall be considered: Abolite, Cooper, Columbia, Contech, Elliptipar, Emergilite, General Electric, Hubbell, Insight, Kenall, Kim, Kirlin, Kurt Versen, Light Guard, Lightolier, Lithonia, LSI, Prescolite, Sim-Kar, Sterner, Stonco, Tivoli, Williams, Winona, ZSLI, and approved equal.

2. BALLASTS, DRIVERS, AND WIRING

2.1 Completely coordinate exact lamp types (including configuration, dimensions, bases, pins, etc.), drivers, lighting fixture construction and arrangement (as related to facilitating lamps and related equipment), and all applicable ancillary equipment as required and provide a complete and compatible installation.

2.2 Submit shop drawings of all drivers proposed for use (multiple manufacturers and series are permitted, provided all drivers conform to the specifications). Where lighting fixtures are installed by the contractor which include drivers that do not meet the specifications (without prior written approval) the contractor shall remove drivers and provide new drivers meeting the specified criteria at no cost to the owner.

2.3 For lighting shown with 0-10 V dimming, provide with drivers to facilitate dimming. For all light emitting diode (LED) and fluorescent lighting fixtures shown or specified with 0-10 V dimmable drivers/ballasts (wherever 0-10 V dimming is indicated on the drawings [including lighting fixture schedule] or specifications), provide both power wiring and 0-10 V control wiring to all lighting fixtures. Run control wiring as required from all lights with 0-10 V dimmable drivers/ballasts to the respective dimmer or switch controlling the lighting. Where dimmers are shown on the drawings (including combination sensors/dimmers), interconnect control wiring

with dimmers as per manufacturer. Where dimmers are not shown on the drawings, install control wiring to the switch (non-dimmed) location and safely insulate and cap off control wiring as required (to facilitate future replacement of non-dimmed switch with dimmer).

3. LAMPS

3.1 Completely coordinate exact lamp types (including configuration, dimensions, bases, pins, etc.),driver, lighting fixture construction and arrangement (as related to facilitating lamps and related equipment), and all applicable ancillary equipment as required and provide a complete and compatible installation.

3.2 Provide lamps for lighting fixtures as indicated on the drawings. Provide all lighting fixtures with lamps (even if lamp types and/or quantities are not shown on drawings) as required for a complete installation.

3.3 Acceptable lamp manufacturers include Osram/Sylvania, General Electric, Philips, and approved equal.

3.4 Maintain compatibility and consistency of lamp types and manufacturers (as well as lamp colors, except where different lamp colors are indicated on the drawings) throughout the project as much as possible.

4. LIGHTING FIXTURES

4.1 Provide lighting fixture types and manufacturers as indicated on the drawings. Where a lighting fixture type designation (i.e. letter) is not shown at a lighting fixture symbol, include costs in bid to provide any applicable type of lighting fixture used for the same symbol anywhere else on the drawings.

4.2 Support all lighting fixtures (including outlet boxes and/or conduits used to support lighting fixtures, where permitted) in complete accordance with all applicable requirements of the NEC (including, but not limited to, code requirements for mounting and support of lighting fixtures, outlet and other boxes, conduits, raceways, and devices). Provide all required mounting hardware, including pendant kits, fasteners, hangers, wall mounted brackets, concrete bases, conduits, supplementary supports, grounding, etc., as required for a complete installation. Support all lighting fixtures completely independent of suspended ceilings and direct from the structure (suspended ceilings are permitted to provide supplemental lateral support to lighting fixtures which are vertically supported direct from the structure), except as follows. Lighting fixtures are permitted to be supported from/by suspended ceilings only where both the general contractor's suspended ceiling installation and the electrical

contractor's method of securing lighting fixtures to the suspended ceiling are in complete accordance with NEC requirements for supporting lighting fixtures. Supporting lighting fixtures with or from conduits or raceways is not permitted, except that lighting fixtures specifically designed for conduit support may be supported utilizing only rigid steel conduit (supporting with any other type conduit or raceway, including IMC, EMT, PVC, surface raceway, and flexible conduit, is not permitted under any circumstance). Supporting lighting fixtures from screw shells of lamp holders is not permitted under any circumstance. Supporting lighting fixtures or wiring from trees or vegetation is not permitted under any circumstance.

4.3 Refer to architectural drawings, reflected ceiling plans, and details for exact locations of all lighting fixtures. Verify final location of all lighting fixtures with the owner, architect, and lighting designer (where applicable) prior to rough-in.

4.4 Perform field measurements, verify proper clearances, and verify all exact mounting and installation conditions and requirements prior to ordering lighting fixtures.

4.5 Provide integral thermal protection for all recessed lighting fixture housings.

4.6 Perform aiming of all adjustable interior lighting fixtures. Include all costs as required to aim to the satisfaction of the owner, architect, and engineer. This aiming may be performed during normal working hours.

4.7 For surface mounted lighting fixtures wired utilizing surface mounted wiring methods, provide wiring entering the side of lighting fixtures. Where fixtures do not facilitate side entry of wiring, provide fixture with manufacturer's back mounting adapter as required (so wiring enters side of adapter and then enters rear of fixture by passing through adapter). Installing the fixture on surface outlet boxes (in such a way that there is a significant "gap" between the fixture and the wall/ceiling surface) is not acceptable.

4.8 Wherever finish colors are indicated on the drawings (including symbol list and lighting fixture schedule) as being selected by the architect ("as per architect", etc.), include costs in bid to utilize any of the available standard and/or optional colors listed in manufacturers' catalogs (excluding any colors identified in manufacturers' catalogs as "custom" or "premium").

4.9 Where lighting fixtures are specified or furnished by the contractor with tamper resistant hardware (including, but not limited to, torx, spanner, allen/torx with center reject pin, etc.) which must be removed in order to access lamps or drivers for replacing or servicing, furnish and turn over to the owner not less than two (2) tamper resistant screw drivers of each type required.

4.10 Where track lighting, continuous linear lighting, and similar lighting fixtures are indicated on the drawings, provide complete and coordinated installation. Install in continuous lengths with even appearance as shown on the drawings utilizing general sections as shown on the drawings (or if not shown as otherwise required and available from the manufacturer). Include all joining/extension fittings (corners, tees, crosses, straight extensions, etc., with lens and/or louver where applicable), end caps, aligning/attaching hardware, ceiling flanges, grid rails, yokes, etc. (where applicable). For lighting fixtures installed continuous between building members (walls, ceiling soffits, or other architectural structures and details), individually measure exact dimensions at each and every locations and order and install lighting fixtures accordingly. Fully coordinate the installation with the architect and general contractor.

5. EXTERIOR LIGHTING

5.1 All provisions of the section of this specification "General Lighting" apply to exterior lighting as modified herein.

5.2 Perform night aiming of all adjustable exterior lighting fixtures. Include all costs in bid (including overtime costs for work at night) as required to aim to the satisfaction of the owner, architect, and engineer.

6. EMERGENCY AND EXIT LIGHTING

6.1 Provide all emergency and exit lighting as indicated on the drawings.

6.2 Verify exact mounting, quantity of faces, and directional arrows of all exit signs prior to ordering.

6.3 Install all exit signs at general locations as shown on the drawings. Coordinate and obtain approval for exact locations with the architect and local code enforcement officials before installation. Install exit signs as required to ensure they are completely and clearly visible from the entire covered areas and egress paths.

6.4 Perform aiming of all adjustable emergency lighting fixtures. Include all costs as required to aim to the satisfaction of the owner, architect, engineer, and local code officials. This aiming may be performed during normal working hours.

6.5 Wherever any battery units or battery packs are installed (including batteries integral to lighting fixtures), connect power to the battery units/packs on the line side of all

lighting and other control switches so it is impossible to de-energize by turning any switch off.

END OF SECTION

1. GENERAL PROVISIONS

1.1 The applicable provisions of the Division 1 General Conditions, Supplemental Conditions, Special Contract Requirements, Amendments and Additions to the General Conditions, and all project addenda are hereby made an integral part of this section.

1.2 These specifications apply to all electrical work performed.

1.3 When apparent conflict exists between these specifications and the contract drawings, within the specifications, or within the drawings, the engineer will determine the intent.

1.4 The term "provide" means "furnish and install". The terms "contractor" and "E.C." mean "electrical contractor", unless otherwise noted. All work indicated in specifications division 16000 and on the electrical drawings is by the electrical contractor, unless otherwise noted.

1.5 The terms "unless otherwise noted" or "unless otherwise indicated" in any form of wording mean "unless specifically indicated otherwise on the electrical drawings, in the electrical specifications, or in the General Conditions and Requirements to the specifications and/or contract". These terms do not mean "unless indicated otherwise on the general construction, mechanical construction, or other disciplines' drawings or specifications", except where specifically so worded on the electrical drawings or electrical specifications.

1.6 Materials and equipment manufacturers and catalog numbers specified constitute the type and quality of design, material, workmanship, ruggedness of construction, resistance to vandalism, exact operating and performance characteristics, features, configuration, dimensions, etc.. Where multiple manufacturers are shown in the drawings and/or specifications, not all manufacturers shown may be capable of providing materials and equipment meeting the specifications, field conditions, etc.. Manufacturers not specifically shown on the drawings or specifications shall be considered, provided the products equal or exceed the requirements of the drawings and specifications (including equaling or exceeding products and/or manufacturers specifically shown on drawings and specifications). Manufacturers, whether shown on the drawings or specifications or not, are acceptable only if they can meet the

specifications, conditions, and requirements specific to this project. Provide materials and equipment as required (include all costs in bid).

1.7 For any equipment indicated on the drawings as furnished by the owner, contact the owner prior to submitting bid to obtain all requirements of such equipment as necessary to provide a complete installation. Provide all ancillary equipment as necessary which is not furnished by the owner but which is required for a complete installation of owner furnished equipment.

2. SCOPE OF WORK

2.1 The work governed by these specifications consists of providing all labor, materials, equipment, services, and related items/work necessary to complete all the electrical work as indicated and described in the drawings and specifications.

2.2 Electrical work includes but is not limited to:

A. Electric service and service equipment
B. Power distribution and wiring
C. Interior and exterior lighting
D. Standby power and emergency lighting
E. Utilization equipment connections
F. Fire alarm system
G. Telephone raceway/pathway system
H. Temporary power and lighting

3. CONTRACT DRAWINGS AND SPECIFICATIONS

3.1 Drawings are diagrammatic and indicate the general arrangement of the various systems and approximate and relative locations of the materials and equipment defined by the specifications. Coordinate with and obtain the approval of the owner, architect, and engineer for the exact locations of all materials and equipment. Check the drawings, specifications, and all fabrication and shop drawings (including fabrication and shop drawings of other trades) to verify space conditions, headroom requirements, characteristics, and for coordination. Where space conditions and headroom requirements appear inadequate, notify the engineer before submitting a bid. No consideration, claims, charges, or compensation will be granted for failure to notify the engineer, or for any alleged misunderstanding of the requirements above. Completely furnish, install, connect, and interconnect all components of all systems in accordance with contract requirements, manufacturer's instructions, applicable codes and standards, and best practices of the trade.

3.2 Minor deviations, variations, changes, and corrections from layouts shown on the drawings (based on coordination, conditions, manufacturer's instructions, codes and standards, shop drawings, and verification of measurements and conditions) are permitted to facilitate construction provided the changes do not represent potential changes in scope of work (see the section of these specifications "Changes to the Scope of Work") and provided the changes are acceptable to the owner, architect, and engineer.

3.3 Before submitting bid, examine and check all drawings and specifications relating to all work, including electrical, mechanical, plumbing, general construction, fire protection, and any other trades' drawings and specifications (as well as Division 1 General Conditions) and become fully informed as to the extent and character of work required and its relation to the work of other trades. No consideration, claims, charges, or compensation will be granted for any alleged misunderstanding of the work to be performed, or the force and intent of these specifications.

4. VISIT TO SITE

4.1 Before estimating work, visit the project site and verify all measurements and field conditions affecting the work. The contractor is fully responsible for the correctness of all measurements and for any connections to existing work. Submission of bid is considered evidence that this contractor has visited and examined the site. No consideration, claims, charges, or compensation will be granted for extra work as a result of the contractor's failure to visit the site or verify conditions and measurements.

5. VERIFICATION OF MEASUREMENTS AND CONDITIONS

5.1 The electrical contractor is solely responsible for verifying field measurements, conditions, and drawing and specifications information (for all trades) before ordering materials and equipment and before commencing work. The electrical contractor is solely responsible for verifying shop drawings (including shop drawings of other trades) before releasing related materials and equipment and before rough in. No consideration, claims, charges, or compensation will be granted due to any differences between the actual dimensions and any dimensions indicated on the drawings.

5.2 Report any apparent discrepancies or conflicts found at once to the engineer for consideration and wait for a decision before proceeding with any work in the affected area.

5.3 The engineer's decisions in cases of discrepancies, conflicts, and related to verification of measurements and conditions are final and binding upon the contractor, make all installation accordingly.

6. EXISTING CONDITIONS AND UTILITIES

6.1 Information and data indicated on the drawings regarding existing conditions (including underground utilities) is from the best available sources. However, no assurance is made as to completeness and/or accuracy.

6.2 Contact all utility companies operating in the project vicinity (water, gas, sewage, electric, telephone, cable television, etc.) and the owner's maintenance department (where applicable) and verify all existing underground systems before any excavation commences. Utilize applicable "one-call" or "before you dig" utilities marking services, including paying all associated fees.

6.3 Relocate any existing underground electrical feeders and wiring in areas of construction and around proposed foundations as required. Include all costs in bid. If any thirdparty owned wiring or equipment interferes with construction, notify the engineer.

7. ITEMS NOT SHOWN OR SPECIFIED

7.1 Provide any items of material not indicated on the drawings and/or not specified, but which are required for the complete and proper installation and/or operation of any part of the work, as if indicated and specified.

7.2 Provide any work not indicated on the drawings and/or not specified, but which is required for compliance with applicable codes and regulations, as if indicated and specified.

7.3 No consideration, claims, charges, or compensation will be granted for performing work required for complete and proper installation/operation or required for compliance with applicable codes and regulations.

8. REGULATIONS AND CODES

8.1 Perform work in accordance with all respective requirements of the latest adopted editions (as of the date of electrical construction permit approval) of all applicable federal, state, and local codes, standards, regulations, ordinances, laws, etc. and industry standards. This includes applicable requirements of the National Electrical Code (NEC), National Fire Protection Association (NFPA), American National Standards Institute (ANSI), Americans with Disabilities Act (ADA) (as well as all related state disabled access and/or barrier free codes and standards and ANSI A117.1), International Building Code (IBC), International Energy Conservation Code (IECC), International Residential Code (IRC), Factory Mutual (FM), Illuminating Engineering Society of North America (IES, IESNA), Institute of Electrical and Electronic Engineers (IEEE), Insulated Power Cable Engineer's Association, National Electrical Contractors' Association (NECA) "Standard of Installation", National Electrical Manufacturer's Association (NEMA), National Electrical Safety Code (N.E.S.C.), Underwriter's Laboratories (UL), United States Department of Labor Occupational Safety and Health Administration (OSHA), utility companies requirements, etc..

8.2 Where listing or labeling (in any form, i.e. UL, CSA, ETL, etc.) is indicated in the drawings or specifications or is otherwise required by the NEC or other applicable code, provide equipment and materials as either listed or labeled by a qualified product evaluating organization (UL, CSA, ETL, or approved equal) acceptable to the local authority having jurisdiction. Include all costs in bid. No consideration, claims, charges, or compensation shall be granted under any circumstance associated with providing listed equipment.

A. The electrical contractor is fully responsible for verifying (before submitting bid) the applicability and extent of code required listing with the local authority. Specifically verify if the municipality has any requirements that "listable" (capable of being listed) products must be "listed". Provide accordingly where applicable.

B. Submission and/or approval of shop drawings (which may or may not show listing) do not relieve the contractor of the responsibility to meet listing requirements.

C. Where products required (by specifications/code) as listed are installed without listing or as non-listed (without prior written approval), the contractor shall remove the products and install listed products at no cost to the owner. Written approval will only be considered if all of the following are satisfied:

1) The contractor is fully responsible for (including all costs) and must prepare and submit any and all information necessary for review and evaluation of products (by the authority having jurisdiction, engineer, architect, and

owner). This includes all processing costs for all parties involved and costs for any special or independent third party inspections, investigations, evaluations, engineering services (including sealing by a registered professional engineer), etc. which may be required or requested in conjunction with approval. In the absence of listing, the contractor is fully responsible for proving that products are acceptable.

2) The contractor must show one (1) or more of the following:

a) That listed products are not available.
b) That providing available listed products involves excessive costs or hardships.
c) That listing of products involves requirements that unreasonably exceed the requirements of the specifications, codes, and project conditions.

3) Products must meet or exceed all specified requirements, industry standards, code requirements, and conditions specific to the project.

4) There must be no change in contract price (except that the owner reserves the right to require credit pricing).

5) Where acceptable to the owner.

8.3 Where NEC article numbers are referenced in the drawings and specifications, they apply to the latest edition. Where the authority having jurisdiction has not adopted the latest edition, refer to the equivalent applicable code requirement article.

9. PERMITS, CERTIFICATES, AND FEES

9.1 Apply for, obtain, pick-up, and pay for (pay all costs associate with) all permits, licenses, certificates, etc., required for execution of the project. Procure all permits immediately upon notice to proceed with the contract. The contractor is fully responsible for verifying all permits, licenses, certificates, etc. which are required. Submit (see the section of these specifications "Summary of Submissions") copies of all permits, licenses, certificates, etc. in conjunction with this project for record. Prepare all information and data for submittal to any authority as required to obtain permits and certification of compliance for the permits. This specifically includes this contractor reproducing contract drawings for permit submission, which shall be sealed by the electrical engineer upon request.

9.2 Obtain and submit (see the section of these specifications "Summary of Submissions") six (6) copies of inspection certificate(s) from authorities having

jurisdiction indicating approval of the electrical installation. Arrange and pay for all electrical inspections (performed by an approved Underwriters Inspection Agency) associated with inspection certificate(s).

9.3 Applicable utility service charges will be paid directly by the owner. Obtain and submit (see the section of these specifications "Summary of Submissions") written estimates from all respective utility companies prior to utilities performing work.

9.4 If and when requested by the owner or owner's representative, the electrical contractor

shall submit to the owner any information necessary as part of the owner's application or submission for applicable grants, rebate programs, reimbursement programs (including, but not limited to, energy rebate programs such as "smart start" or "clean energy"), or other similar/related programs. Submit all required documentation, including, but not limited to, detailed pricing information on materials and/or labor, bills of materials, invoices, receipts, counts, take-offs, other related cost information, submittals, shop drawings, etc.. Compile information in format as required for submission as directed by the owner or owner's representative including tables and other formats as requested.

10. GUARANTEE AND WARRANTIES

10.1 The electrical contractor is fully responsible to guarantee all electrical equipment and work (applies to all materials and equipment, including lamps for luminaires) and is fully responsible for all manufacturers' warranties from material purchase (by the contractor), through the date of final acceptance by the owner, to the expiration date(s) of the guarantee and warranties. Guarantee and provide warranties for a period after the date of final acceptance by the owner as per Division 1 General Conditions, unless longer periods are specifically indicated otherwise on the electrical drawings or specifications. Guarantee/warranty periods of less than one (1) year after date of final acceptance are not permitted under any circumstance.

10.2 Wherever "warranties" are indicated elsewhere in the specifications, provide and submit (see the section of these specifications "Summary of Submissions") written manufacturers' warranties for equipment. Include all costs in bid associated with providing specified warranties periods (including purchasing any required extended or special warranties to meet the specified periods). Submission of written warranties showing periods, conditions, or coverage of less than the periods, conditions, and coverage specified does not relieve the contractor or manufacturers' of the responsibility to provide warranties with periods, conditions, or coverage as specified. Manufacturers' warranties do not relieve the contractor of any responsibility associated with the electrical contractor's guarantee.

10.3 The electrical contractor shall guarantee and respective manufacturers shall warranty equipment and materials from defects in workmanship, materials, and operation. Provide guarantee/warranties including all service, maintenance (excluding routine maintenance), materials, labor, travel, all other work, and all expenses required as part of guarantee/warranties. Provide all guarantee/warranties service at no extra cost to the owner under any circumstance. Provide all guarantee/warranties service in timely manner.

10.4 Completely replace or repair, to the satisfaction of the owner, any equipment (as part of this project) improperly installed or damaged before or after installation until expiration of the guarantee period. Completely replace or repair, to the satisfaction of the owner, any equipment (including equipment installed by any other contractor or party) damaged by the electrical contractor (or any subcontractor thereof).

11. SEQUENCE OF WORK

11.1 Perform work in areas or general sequences (including applicable project phasing) as determined and directed by the owner and architect. Submit (see the section of these specifications "Summary of Submissions") a complete schedule of construction for approval, showing delivery of equipment, erection of equipment, pertinent work related to installation, and when equipment will be placed in operation. Fully coordinate exact sequencing, phasing, and scheduling with all contractors, the architect, and the owner in detail and obtain approval of sequencing, phasing, and scheduling before starting work.

12. CHANGES TO THE SCOPE OF WORK

12.1 Changes to the scope of work include any change effecting the overall nature or cost of the project. Examples of changes to the scope of work include, but are not limited to, additions or deletions of equipment or items of work, substitutions not equivalent or superior to equipment specified, substitutions with characteristics or operation varying from equipment specified, changes which effect the ultimate use or functioning of equipment or areas of the building, changes considered to be "substantial", any change which any party (contractors, sub-contractors, owner, architect, engineers, etc.) believes may involve a possible change in contract price, etc..

12.2 Make all changes to the scope of work in complete accordance with the general conditions of the specifications. Submit (see the section of these specifications "Summary of Submissions") changes to the scope of work immediately upon proposal of changes. Do not proceed with any work associated with or affected by changes to

the scope of work unless the owner approves changes in writing or authorizes proceeding in writing.

12.3 All applicable provisions of the contract drawings and specifications, including addenda and prior changes, apply to all changes to the scope of work, unless specifically indicated otherwise.

12.4 In addition to all requirements of the general conditions, submit all pricing related to changes to the scope of work as indicated below. Pricing will not be reviewed until the required breakdowns (summarized below) are submitted.

12.5 Submit pricing for a proposed change to the scope of work with detailed breakdown as follows.

A. Submit a complete detailed breakdown of all material associated with the proposed change in scope of work. Itemize each unit of material and the respective cost.

B. Submit a complete detailed breakdown of all labor associated with each respective item of the above material breakdown. Itemize labor hours and classification for each item of material. Summarize total labor costs, broken down by worker classification and/or billing rate.

12.6 Where instructed to proceed with a change to the scope of work on a time-and-material (T&M) basis, submit pricing with detailed breakdown as follows.

A. Submit a complete detailed breakdown of all material. Submit copies of all receipts, invoices, and stock material lists.

B. Submit a complete detailed breakdown of all actual labor hours. Submit copies of time sheets. Summarize total labor costs, broken down by worker classification and/or billing rate.

13. TEMPORARY POWER AND LIGHTING

13.1 For this specification section only, the term "responsible" (in any form) means "responsible to pay all costs (pay to the electrical contractor) to erect the described work". For this specification section only, the term "erect" (in any form) means "furnish, install, maintain, and remove".

13.2 The electrical contractor is responsible for temporary power and lighting service/source and distribution during construction. Provide service capacity as required for construction. Provide service including any required utility or private metering.

13.3 The electrical contractor is responsible for all temporary lighting, all 120 V power for small construction tools, and all other temporary power not exceeding 120 V or 20 A. Power for large tools and equipment exceeding 120 V or 20 A (including arc welders, etc.) is the responsibility of the contractor requesting such power. Temporary power during construction (exceeding 120 V or 20 A) to permanent equipment installed as part of this project (for installing, testing, operating, etc., including mechanical equipment, elevators, etc.) is the responsibility of the contractor requesting such power.

13.4 Where a general contractor's construction trailer is present, the electrical contractor is responsible for a minimum 60 A, maximum 200 A single phase service to the trailer. Provide service including any required utility or private metering. Temporary service to any other contractor or subcontractor trailer is the responsibility of the contractor requesting such service.

13.5 Where utility power is not available and during shutdowns of utility power, the contractor requesting power under these conditions is responsible for providing portable generator(s), associated temporary wiring, and fuel (as required to meet power requirements during these conditions). Generator power to owner loads during construction is not required (unless specifically indicated on the drawings).

13.6 The electrical contractor is responsible for temporary power to other owner loads, equipment, and wiring as indicated on the drawings.

13.7 The electrical contractor shall erect all temporary power equipment and wiring as required for complete temporary power installation, regardless of the contractor who is responsible for the temporary power.

13.8 Erect all temporary power and lighting during construction in accordance with OSHA and the NEC. This includes required ground fault circuit interrupter (GFCI) protection for personnel and "assured grounding program".

14. TESTING

14.1 After completing installation of equipment and wiring and prior to energizing or placing in service, test all electrical equipment, conductors, systems, and each and every part thereof to insure continuity, proper splicing, freedom from unwanted

grounds, acceptable insulation values, proper operation and functioning, and a complete workmanlike installation to the satisfaction of the engineer and owner.

14.2 Completely test all equipment installed. This includes all equipment furnished and installed by the electrical contractor as well as equipment furnished by others and installed by the electrical contractor and equipment furnished and installed by others and wired by the electrical contractor.

A. Electrical tests of panels, switches, and circuit breakers rated 800 A and less and 600 V and less are not required, except that meg-ohm meter testing is required.

B. Electrical tests of motors 75 kW (100 hp) and less are not required.

C. Electrical tests of individual motor starters are not required.

D. Visual and mechanical checks are required for all equipment (including all panels, switches, circuit breakers, motors, motor starters, and all other equipment) without exception.

14.3 Test all equipment and wiring as per the latest edition of InterNational Electrical Testing Association (NETA) standards (Acceptance Testing Specifications (NETAATS) for new equipment/wiring, unless indicated otherwise. For each piece of equipment, perform testing as shown for that equipment in respective NETA standards. Where equipment is not specifically shown in NETA standards, perform testing as shown for equipment most closely resembling the equipment to be tested. Perform all tests shown in respective NETA standards, unless indicated otherwise. Tests shown as "optional" in NETA standards are not required unless specifically indicated otherwise on the drawings or specifications. Utilize suitable instruments in making all tests, as per NETA standards. Battery, magneto, or similar hand-held testers may be used for preliminary conductor continuity checking but are not acceptable for final results, which must be obtained utilizing proper equipment only (i.e. meg-ohm meter, etc.).

14.4 Provide all testing performed by a NETA accredited independent testing firm employed

by the electrical contractor, unless indicated otherwise. Provide visual and mechanical checks shown in the NETA standards, testing of transformers 225 kVA and less (with primary and secondary voltages 600 V and less only), and testing of panels, switches, and circuit breakers 1,200 A and less and 600 V and less performed by the electrical contractor's direct employees or by the independent testing firm (at the contractor's option). Provide continuity and insulation resistance meg-ohm meter testing of 600 V and less conductors performed by the electrical contractor's direct employees only.

14.5 For all testing performed, submit (see the section of these specifications "Summary of Submissions") complete typewritten and tabulated test results for review and approval by the engineer and owner. Submit test result bound together in a single three-ring binder (one (1) binder per set of test results) including a table of contents. Submit quantity of sets as directed in the General Construction specifications, but in

no case less than three (3) sets. Submit results upon project completion, except under conditions below.

14.6 Where any abnormal, questionable, "failing", or "borderline" test results are encountered or where discrepancies are noted during testing, submit results immediately to the engineer before energizing equipment. Do not energize until authorized in writing by the engineer. Test results submitted under these circumstances are not required to be bound or complete.

15. SUBSTITUTIONS

15.1 Materials and equipment manufacturers and catalog numbers specified constitute the type and quality of design, material, workmanship, ruggedness of construction, resistance to vandalism, exact operating and performance characteristics, features, configuration, dimensions, etc.. The engineer will consider substitutions of similar equipment superior to specified equipment (meeting or exceeding all characteristics of the specified equipment).

15.2 Submit shop drawings associated with substitutions complete with documentation necessary to establish compliance with the specifications (see the sections of these specifications "Shop Drawings" and "Summary of Submissions"). Submit samples of substitutions where requested (see the sections of these specifications "Samples" and "Summary of Submissions"). If documentation and/or samples are not submitted when required, the request for substitution will be denied.

15.3 Determination of compliance with specifications rests with the engineer. When a request for substitution is denied, furnish the equipment specified. The engineer's decisions in cases of substitutions are final and binding upon the contractor, provide equipment accordingly.

15.4 Pay all costs associated with a substitution where granted. For the provisions of this section, "substitutions" includes equipment where characteristics or operation vary significantly from equipment specified (including equipment of the specified manufacturer). This includes costs incurred by any party (electrical contractor, other contractors, sub-contractors, owner, architect, engineers, etc.), costs resulting from differences of details, configuration, ratings, operation, characteristics, and dimensions between the specified and substituted equipment, costs to provide features of the specified equipment which may be manufacturer's options of the substituted equipment, and costs to remove and replace work already installed and any other remedial work as a result of substitutions. Approval of substitutions is conditional that there is no cost change to the contract, unless specifically indicated on the shop drawings submittal and corresponding approval. The electrical

contractor is fully responsible for coordinating with the owner, architect, and other trades to identify all possible cost impacts associated with any substitution before releasing equipment and before any party proceeds with work effected by the substitution.

15.5 Submit bid based on the items as specified. Substitutions will be considered only after a contract has been awarded.

16. SHOP DRAWINGS

16.1 Submit (see the section of these specifications "Summary of Submissions") shop drawings of all equipment and materials proposed to be furnished for review and approval by the engineer. Submit quantity of sets as directed in the general construction specifications, but in no case less than ten (10) sets.

16.2 Submit shop drawings for all equipment and materials including, but not limited to luminaires, solid state energy saving ballasts, raceways, conductors, cable, termination methods, grounding, wiring devices, safety switches, enclosed circuit breakers, branch and distribution panels, transformers, contactors, time clocks, photocells, fire alarm system, emergency power and lighting system equipment, engraved plastic nameplates, and any other items requested by the owner, architect, any code official, or engineer.

16.3 Stamp or mark shop drawings with the contractor's approval, as evidence that they were checked for accuracy and that all dimensions, characteristics, ratings, operation, features, data, relation to existing conditions, and coordination with work and shop drawings of other trades were completely verified before submission. Approval of shop drawings by the engineer does not relieve the contractor of responsibilities to review shop drawings in detail, to comply with drawings and specifications, for errors contained in shop drawings, for coordination, and to provide equipment as listed.

16.4 Where any characteristics, ratings, operations, or features differ from the specified equipment (where not equal to or superior to the characteristics, ratings, operations, and features of the specifications and specified equipment), circle, highlight, or otherwise clearly designate and identify the specific differences.

16.5 In the event that shop drawings are not acceptable to the engineer (including as provided below for conditional approval), submit acceptable shop drawings within seven (7) days of notification.

16.6 Approval of shop drawings, including approval of substitutions, is conditional that there is no cost change to the contract, unless specifically indicated on the shop drawings submittal and corresponding approval.

16.7 Approval of shop drawings is conditional upon the contractor fully and completely complying with all review comments by the owner, architect, and engineer. Where the contractor fails to or is unable to fully and completely comply with every review comment, then the shop drawings are *disapproved* (whether or not they are stamped or noted as "approved" in any manner in any review comment) and must be resubmitted as within seven (7) days (as indicated above). Immediately upon receipt of shop drawing review comments, the contractor is responsible for carefully reviewing all comments in detail and for complying with comments. Where unable to fully satisfy any comment or where the contractor takes exception to any comment, revise and resubmit acceptable shop drawings (or, where taking exception, notify the engineer in writing) within seven (7) days. Where the contractor fails to comply with these requirements (including resubmitting/notifying within the seven (7) day period specified), the contractor shall provide acceptable equipment meeting all specified requirements and all review comments (including removing unacceptable equipment [if installed] and replacing
with acceptable equipment) at no cost to the owner.

16.8 Do not release equipment until shop drawings are approved. The electrical contractor is responsible for all changes where equipment is released before approval and/or where equipment does not comply with all approval conditions.

16.9 In addition to the quantity of shop drawings submitted for approval (see above), submit one (1) copy of *approved* shop drawings to the general contractor, the mechanical contractor, and each other contractor and trade for review and coordination. The electrical contractor is not required to submit copies direct to subcontractors or vendors to other contractors (this is the other contractors' responsibility). The electrical contractor is responsible for all changes and other costs where the electrical contractor fails to submit shop drawings to other parties for coordination.

16.10 Obtain copies of all shop drawings relating in any way to electrical work from all other contractors, subcontractors, and trades. Review shop drawings and coordinate with electrical work. Notify the architect and engineer immediately where discrepancies are found. The electrical contractor is responsible for all changes and other costs where the electrical contractor fails to obtain shop drawings or fails to coordinate shop drawing information. Approval of other trades submittals by the architect or engineers (or lack of review by the architect or engineers) does not relieve the electrical contractor of the responsibility to review other trades shop drawings in detail and for coordination.

16.11 No consideration, claims, charges, or compensation shall be granted under any circumstance associated with any party's failure or delay in properly submitting, transmitting, obtaining, reviewing, and/or coordinating shop drawings.

17. SAMPLES

17.1 Submit (see the section of these specifications "Summary of Submissions") samples of

materials and equipment for approval only where specifically requested by the owner, architect, or engineer. Submit samples along with complete catalog data, installation instructions, operating and maintenance (O&M) information, etc. specifically applying to the samples submitted, to facilitate proper evaluate the quality of the sample. Specifically designate and identify each sample as to the service and location where each sample is to be used on the project.

17.2 Submit samples within 30 days of the engineer's request, except where the sample is ancillary to a substitution. Where samples are ancillary to a substitution, submit samples within seven (7) days of the engineer's request.

18. AS-BUILT DRAWINGS, MANUALS, AND DEMONSTRATION

18.1 Prepare and submit (see the section of these specifications "Summary of Submissions") as-built record drawings showing conditions exactly as installed.

A. Indicate the exact locations and elevations of all equipment and devices and underground, concealed, and hidden work (including raceways, junction and pull boxes, etc.).

B. Indicate exact layout, connections, and conductor routing for all grounding.

C. Indicate all substitutions, including marked-up lighting fixture/luminaire schedule and symbol list as required.

D. For underground work, specifically indicate exact conditions accurately. Where underground wiring does not run straight and direct between visible and obvious equipment, objects, or markers (i.e. markers specifically placed to identify underground work [specifically note the presence and approximate location of all markers on as-built drawings]), clearly, accurately, and exactly *mark* and *dimension* exact underground work (including all bends) from visible permanent landmarks. Acceptable visible permanent landmarks include building walls, retaining walls, curbs, foundations, pole bases, etc.. Lines, joints, and markings

on pavements are not considered permanent (since they would be covered by repaving). Acceptable markers for placement to identify underground work include a 0.9 m (3'0") long piece of 102 mm (4") conduit installed vertically in the ground (top flush with grade) completely filled with concrete (or other similar means providing equivalent visibility, durability, and permanence approved by the engineer). Where the contractor does not include this exact marking/ dimensions on as-built drawings or where marking/dimensions are inaccurate (allowing for a tolerance of not greater than 0.6 m (2'0") away from actual locations), the electrical contractor will be held responsible if underground facilities are damaged in the future (where due to lack of or inaccurate marking/ dimensioning).

18.2 During the progress of work, maintain an accurate record of all deviations, variations, changes, and corrections from the layouts shown on the drawings. Maintain this information on a "record working" set of drawings and specifications kept at the job site.

18.3 Upon completion of work, incorporate all information from the "record working" drawings onto a "marked-up as-built" set of drawings. Submit the "marked-up as-built" drawings to the engineer for review, comment, and approval.

18.4 Following approval of "marked-up as-built" drawings, prepare "final as-built" drawings utilizing the latest version of Autocad (or compatible) software. Submit one (1) set of "final as-built" drawing originals, sets of "final as-built" blueprint drawings as directed in the general construction specifications (but in no case less than three (3) sets), and "final as-built" drawings in disk format. Submit photocopies of all panel circuit directories with "final as-built" drawings.

18.5 Upon completion of work and following approval of "marked-up as-built" drawings, incorporate all information from the "record working" specifications onto "final (marked-up) as-built" specifications. Submit sets of "final as-built" specifications as directed in the general construction specifications (but in no case less than three (3) sets).

18.6 Submit operating and maintenance (O&M) manuals for all new equipment furnished as part of this contract. Provide O&M manuals including installation, operating, and maintenance instructions for the equipment. Wherever "proof-of-purchase" is required as part of any manufacturer's warranty (whether manufacturer's warranty is specified or not), submit with O&M manuals. Where any proof-of-purchase is required but not submitted (or where insufficient information is submitted), the electrical contractor is fully responsible and liable for providing the warranty. Submit all O&M manuals bound together in a single three-ring binder (one binder per

set of manuals) including a table of contents. Submit quantity of sets as directed in the general construction specifications, but in no case less than three (3) sets.

18.7 Explain and demonstrate the complete electrical system and all work installed by the electrical contractor to the owner's operating and maintenance personnel. Demonstration is to instruct owner's personnel in the operation and maintenance of systems as well as to prove to the owner correct and adequate operation of all parts of the electrical system. Provide a demonstration period of one (1) full working day for the general electrical installation (including, but not limited to, contactors, time clocks, customer metering equipment, lighting controllers, dimming cabinets, motor controls [where furnished by the electrical contractor], transformer fan controls, generators, transfer switches, key interlocking schemes, and similar equipment, where applicable). Wherever demonstrations are indicated elsewhere in the specifications for equipment furnished by the electrical contractor (i.e. for fire alarm, dimming, sports lighting, stage lighting, UPS units, MCC's, VFD's, metal clad switchgear, power management, sound/paging, security, CCTV, and similar systems, where applicable), provide the specified additional demonstrations during additional periods of time (above and beyond the period above for the general electrical demonstration). Conduct all demonstrations at the project site and after all systems are fully operational.

19. SUMMARY OF SUBMISSIONS

19.1 Submit items as indicated elsewhere in the specifications (applicable sections are shown for convenience) and as summarized as follows. Information below indicates relative schedule of submission.

19.2 Submit within ten (10) days of receiving notice to proceed; resubmit within seven (7) days of notification:

A. Permits, licenses, certificates (see 16100-9)
B. Schedule of work (see 16100-10)
C. Shop drawings (see 16100-17)

19.3 Submit within 30 days of request (within seven (7) days for substitutions):

A. Samples (see 16100-18)

19.4 Submit during the project as applicable (refer to respective specifications sections for conditions and schedule of submission):

A. Utility service charge estimates (see 16100-9)

B. Scope of work changes, w/ breakdowns (see 16100-11)
C. Test results, abnormal/failing only (16100-15)

19.5 Submit upon substantial completion of the project:

A. Approved inspection certificate(s) (see 16100-9)
B. Written manufacturers' warranties (see 16100-14)
C. Test results (see 16100-15)
D. As-built drawings (see 16100-19)
E. O&M manuals (see 16100-19)
F. Spare parts (where specified elsewhere)

20. SAFETY

20.1 Perform all work and work practices in strict accordance with all applicable local, state,
and federal codes, standards, regulations, and requirements including OSHA (including the proper use and maintenance of personal protective equipment (PPE) and clothing), state labor and industry, the NEC, ASTM, the National Electrical Safety Code, NFPA, etc..

20.2 The term "live" means "energized or capable of being energized at any time for any reason, either intentionally or accidentally".

20.3 Suitably protect all live equipment against accidental contact at all times. Install and maintain covers on all live equipment. Where covers are not installed, provide suitable insulating barriers at all live parts. Suitable barriers include arc-resistant NEMA GPO2 or GPO-3 and UL 94 V-0 electrical grade fiberglass reinforced epoxy compound sheets, rubber insulating blankets, suitable thermoplastic insulating materials, etc. as per OSHA, ASTM, and the NEC. Cardboard and similar materials are not acceptable. Provide listed OSHA approved signs reading "Danger: High Voltage" at locations of live parts and on doors/gates leading to rooms/fences/areas containing the equipment and keep doors/gates locked at all times.

20.4 When working on equipment or wiring, properly identify and use lockout devices and tags (in accordance with OSHA requirements) to prevent unauthorized or accidental energizing of equipment and wiring.

20.5 Perform all excavation and work in and associated with excavation in accordance with all safety codes referenced above (include all required sloping, benching, shoring, bracing, supporting, shields, protective systems [fall protection, protection of personnel

in excavation, protection of structures, etc.], ramps, access/egress, warning systems, rescue equipment, etc.). Provide suitable barricades and safety procedures to restrict pedestrian and vehicular access to areas where work is being performed (including open excavations, lay-down areas, clearance space around operating excavation equipment, etc.). Do not leave excavations open when not actually performing associated work (including at night, during week ends, or when working away from excavations). Leaving excavations open for short periods of time will be considered only when approved in writing by the owner and only where suitably protected. Any request for owner's approval must include a written plan on proposed protection and safety procedures. No consideration, claims, charges, or compensation will be granted for any multiple excavations and backfilling needed to satisfy safety requirements.

20.6 When working in, on, or near areas subject to vehicular traffic (including public and private roadways, driveways, parking lots, etc. and including loading and unloading equipment/materials in the vicinity of traffic), perform all work and provide appropriate work zone traffic control in accordance with all safety codes referenced above as well as state department of transportation regulations, requirements, and recommendations. Where requested by the owner, architect, or engineer, submit a traffic control plan detailing proposed work zone traffic control and associated safety procedures.

END OF SECTION

1. GENERAL PROVISIONS

1.1 The applicable requirements and conditions of specifications section "General Provisions" of specifications divisions 16100, General Electrical, and 16300, Electrical Materials, are hereby made an integral part of this section.

1.2 Extent of fire alarm and detection system work is indicated on the drawings and schedules. Types of fire alarm and detection equipment includes the following:

A. Control panel
B. Audio/visual horn/strobes and visual strobes
C. Manual pull stations
D. Smoke, heat, and other automatic fire detectors
E. Duct type smoke detectors

1.3 Provide the fire alarm system (including operation, equipment, devices, wiring, installation, and manufacturer's representative services [programming, testing, adjustment, equipment start-up, as-built documentation, and operation and maintenance documentation and instructions]) in complete accordance with all applicable federal, state, and local codes and standards (including National Electrical Code (NEC), Institute of Electrical and Electronic Engineers (IEEE), National Fire Protection Association (NFPA), Underwriter's Laboratories (UL), Factory Mutual (FM), American National Standards Institute (ANSI), National Electrical Contractors' Association (NECA) "Standard of Installation", Americans with Disabilities Act (ADA), United States Department of Labor Occupational Safety and Health Administration (OSHA), all local municipal authorities having jurisdiction (local authorities), etc.). Provide fire alarm system controls and all new system components (including devices, equipment, modules, interfaces, etc.) listed to operate together. Provide all signaling devices of an ADA approved type and as required for ADA approved audible and visual coverage throughout all areas of the project.

1.4 These specifications are based on a fire alarm system of the addressable analog type.

1.5 Equipment as manufactured by Edwards/EST/UTC, Honeywell (Fire Control Instruments (FCI) and Notifier product lines only), Siemens, and Simplex/Grinnell/Tyco or approved equal shall be considered.

1.6 Only fire alarm equipment which can be programmed by any approved service vendor and which utilizes non-proprietary coding/programming shall be

considered. Only fire alarm manufacturers authorizing at least three (3) independent service vendors in the project area shall be considered. Submit a list of local approved service vendors with shop drawings. Perform manufacturer's representative services (specifically including programming, testing, adjustment, equipment start-up, as-built documentation, and operation and maintenance documentation and instructions) throughout the entire
duration of the project, up through final testing and acceptance of the system by the owner and local authorities, include all costs in bid. *No consideration, claims, charges, or compensation will be granted under any circumstance for manufacturer's representative services (including programming, testing, adjustment, equipment startup, as-built documentation, and operation and maintenance documentation and instructions) during the project (specifically including where associated with changes to the scope of work, alternates, unit prices, allowances, etc.) performed before final testing and acceptance of the system*. Extra claims and/or compensation shall only be considered for changes which are initiated after final testing and acceptance of the system.

2. SUBMITTALS

2.1 Submit shop drawings including, but not limited to, shop drawings on equipment and devices (specifically showing manufacturers, model numbers, and listing information), rough in diagrams, detailed project-specific riser and wiring diagrams (specifically showing conductor/cable types and sizes), installation layout drawings (specifically showing locations of all equipment and devices on floor plans [drawn to scale], equipment, and wiring and information on ceiling height and construction [on architectural background plans which shall be made available to the contractor for this purpose], information showing ADA compliant signaling device audible and visual coverage (specifically show all audible device decibel (dB) and visual device candela
(cd) settings), and specifically showing interfaces with all fire suppression systems [sprinklers, etc.]), installation instructions, written warranty, detailed zone or addressable device lists (showing each system point identifiable from the control panel and the associated numbered address and detailed description), sequence of operation, power supply wiring information, and power consumption/supply/battery sizing and voltage drop calculations. Submit quantity as indicated elsewhere in the specifications to the engineer for review and approval. In addition to submitting to the engineer, submit additional sets (quantity as per local authorities) to the local authorities for review, approval, and permits.

2.2 Include all costs in bid associated with preparing and submitting shop drawing information. This includes sealing (by a registered professional engineer) all submittal information which is submitted to local authorities for review.

2.3 Upon project completion, submit operation and maintenance (O&M) manuals (include with other project O&M manuals). Submit at least three (3) original copies of all fire alarm system software.

2.4 Upon project completion, submit certification of the entire system to the owner and local authorities.

3. FIRE ALARM AND DETECTION SYSTEMS

3.1 Provide Class "B" alarm and detection system products of types, sizes and capacities indicated, which comply with manufacturer's standard design, materials, and components. Construct as required for a complete installation.

3.2 The fire alarm riser diagram on the drawings is a general guide to system architecture and functioning. Provide exact quantities as required (based on floor plan drawings, etc.).

3.4 Provide a complete fire alarm system with the following sequence of operation and functions.

A. Fire Alarm Activation: Actuation of any initiating device (including manual pull stations, automatic smoke, heat, and other fire detectors [including duct detectors, except as specifically provided below], and fire suppression flow/activation switches, etc.) initiates a "fire alarm" and activates all fire alarm signaling, output, and notification devices (including, but not limited to, horns and strobes, elevator interfaces, HVAC equipment shut-downs, door releases, and central station and fire department alarm notification).

B. Trouble Alarm Activation: Any trouble conditions in the fire alarm system (including actuation of fire suppression system tamper/status supervisory switches) initiates a "trouble alarm" and activates central station (and fire department where required) trouble notification and an audio and visual signal at the control panel and remote annunciator (where applicable). "Trouble alarms" do not activate alarm signaling devices or output devices (do not activate elevator interfaces or door releases [or HVAC equipment shut-downs, except as specifically provided as follows]). Only where code officials specifically require in writing that duct smoke detectors NOT initiating a general "fire alarm", duct detectors shall initiate a "duct smoke supervisory alarm" audio and visual signal at the control panel and remote annunciator and activate appropriate central station (and fire department where required) trouble notification.

C. HVAC Equipment Shut-Down: Upon any "fire alarm" (or duct smoke detector activation where duct detectors do not activate fire alarm), shut down HVAC

equipment (including all air handling equipment operating at 0.94 m^3/s (2,000 cfm) or greater and any other equipment specifically indicated on the drawings or mechanical/ATC specifications) and open/close motorized dampers in accordance with all applicable codes and standards. Provide wiring, conduit, relaying, and final connections from the fire alarm system to ATC controls as required. Perform all connections at the ATC controls under the supervision of the mechanical/ATC contractor. For equipment operating at 7.08 m^3/s (15,000 cfm) or greater provide at least two (2) detectors per unit (supply and return).

D. Door Release: Upon any "fire alarm", release all magnetic door holders.

E. Central Station and Fire Department Notification: Provide the fire alarm system to facilitate notifying the local fire department in accordance with codes and local requirements, through the services of an appropriate and central station as required. Coordinate all requirements (relating to fire alarm system equipment and wiring) with the owner, the owner's central station vendor (where applicable), and local authorities. As a minimum, provide an individual and distinct signal from the fire alarm system for each of the following functions in addition to any other functions required by code:

1) Fire Alarm: Upon any "fire alarm" condition initiated any fire alarm device (excluding fire suppression flow/activation and duct smoke detection).

2) Sprinkler Alarm: Upon any "fire alarm" condition initiated by any fire suppression flow/activation switch.

3) Duct Detector Supervisory: Upon activation of any duct smoke detector.

4) Trouble Alarm: Upon any "trouble alarm" condition.

4. MATERIALS, EQUIPMENT, AND DEVICES

4.1 CONTROL PANEL: Provide fire alarm control panel surface mounted where indicated on the drawings and including the following items and/or features:

A. Addressable analog type
B. UL Listed
C. Modular design, solid-state construction
D. Visual alarm and trouble indicators
E. Automatic ground detection
F. Double supervision
G. Alarm verification
H. Dead front construction

I. Supervised signal circuit modules (complete and including modules to synchronize visual indicating devices), Class B type
J. Output devices (elevator interfaces, HVAC equipment shut-downs, door releases, etc.) relaying, field programmable
K. Complete power supply including incoming power overvoltage surge (lightning) protection
L. Battery backup (to operate the system under "normal" and "trouble" conditions for a minimum of 24 hours and then operate the system in "alarm" condition for a minimum of 5 minutes at the end of the 24 hour period), including charger and batteries, fully supervised and automatic
M. Auxiliary contacts, minimum of 10, field programmable
N. Equipment, devices, modules, and wiring as required for central station and fire department notification and tie-in; including telephone dialer, telephone line interface, transmitter, telephone line wiring, etc.
O. Device termination module
P. Detector loop module, Analog type
Q. Integral keyboard display and interface module
R. Provide power to (obtain from power circuit for main control panel) and smoke detector(s) located to provide protection/coverage (in accordance with NFPA-72 requirements) for the main fire alarm control panel, all sub- or slave- control panels, all power supplies, all remote indicating controllers, and related equipment, whether shown on the drawings or not.

Where remote indicating control appliance relays and/or modules are required for control of ADA signaling devices, mount integral to the control panel enclosure or in a single separate enclosure directly adjacent to the control panel. Batteries may be mounted in the control panel enclosure or in a separate single enclosure.

4.3 COMBINATION HORN AND STROBE ASSEMBLIES: Provide combination horn and flashing strobe audible and visual notification appliances with code approved wording "FIRE" as required. Provide listed, flush mounted (mount on flush outlet box), ADA approved type wired using Class "B" supervised circuits. Provide listed for wall or ceiling mounting as applicable. Only appliance types featuring both listed wall mounting models and listed ceiling mounting models or models listed for both wall and ceiling mounting shall be considered. Provide audibly and visually synchronized (utilizing synchronized type appliances in conjunction with suitable synchronizing control modules in signaling circuits) to prevent photosensitive reactions and ensure distinct audible patterns. Provide with adjustable output settings (90, 95, and 99 dBA audible and 15, 30, 75, and 95 or 110 cd visual). Base pricing and wiring and power supply sizing on maximum settings. Lower output settings shall be considered only where they provide audible and visual coverage meeting or exceeding ADA and code requirements (throughout all areas of the project where coverage is required or otherwise shown on the drawings) and where the manufacturer submits

calculations/criteria showing compliant coverage. Include costs in bid to provide additional signaling appliances where necessary to provide compliant coverage.

4.4 STROBE ONLY ASSEMBLIES: Provide flashing strobe visual notification appliances with code approved wording "FIRE" as required. Provide listed, flush mounted (mount on flush outlet box), ADA approved type wired using Class "B" supervised circuits. Provide visually synchronized (utilizing synchronized type appliances in conjunction with suitable synchronizing control modules in signaling circuits) to prevent photosensitive reactions. Provide with adjustable output settings (15, 30, 75, and 95 or 110 cd). Base pricing and wiring and power supply sizing on maximum settings. Lower output settings shall be considered only where they provide audible and visual coverage meeting or exceeding ADA and code requirements (throughout all areas of the project where coverage is required or otherwise shown on the drawings) and where the manufacturer submits calculations/criteria showing compliant coverage. Include costs in bid to provide additional signaling appliances where necessary to provide compliant coverage.

4.5 MANUAL PULL STATIONS: Provide station semi-flush mounted (mount on flush outlet box), of the non-coded double-action type with key reset switch. Provide each pull station individually addressed and interfaced to addressable fire alarm system utilizing a suitable addressable monitor module as required (integral to station or a separate module mounted in the station outlet box).

4.6 SMOKE DETECTORS: Provide detector of the dual chamber, solid state photoelectric, addressable, and analog type arranged for two-wire, non-polarized installation. Provide detector of low profile design, white in color, and with twist-lock base for mounting on standard flush outlet box.

4.7 HEAT DETECTORS: Provide detector functioning on the fixed temperature (rating as indicated on the drawing, unless otherwise required as noted below) and rate-of-rise principals of operation. Provide detector of the addressable and analog type arranged for two-wire, non-polarized installation. Provide detector of low profile design, white in color, and with twist-lock base for mounting on standard flush outlet box. For any area where ambient temperatures may normally exceed 38 degrees C (100 degrees F), such as unconditioned attic spaces or spaces which are not insulated, utilize detectors with temperature ratings as recommended by the detector manufacturer (detectors rated 80 degrees C (175 degrees F) or greater may utilize fixed temperature sensing only (rate-of-rise sensing is not required for these detectors). Verify all requirements associated with temperature ratings with detector manufacturer in detail before purchasing detectors or rough-in (no consideration, claims, charges, or compensation will be granted under any circumstance associated with temperature ratings of heat detectors).

4.8 DUCT TYPE SMOKE DETECTORS: Provide suitable duct housing with detector (as indicated above), sampling tubes (coordinate with ductwork), addressable relay for HVAC shutdown interface, and remote mounted test/reset/indicating station. Arrange addressable relay to shutdown HVAC equipment upon addressable signal from the fire alarm control panel. Provide addressable HVAC shutdown relay either integral to (and part of) duct housing or separately mounted directly adjacent to the duct housing. Detector or housing auxiliary contacts or relay operating only when the individual duct smoke detector is in alarm condition are not acceptable. Where either the HVAC equipment and/or any associated ductwork are new or modified, mechanical contractor shall install detector on ductwork and provide all HVAC shutdown interface wiring from relay to HVAC equipment. Electrical contractor shall furnish detector and associated equipment, provide all wiring and connections to fire alarm system, and install the remote test/reset/indicating station in all circumstances.

4.9 FIRE SUPPRESSION SUPERVISORY AND OTHER ACTUATION DEVICES: Interconnect and monitor every fire suppression system (including foam, chemical, halogen, deluge, pre-action, etc. where applicable) supervisory device to the fire alarm system. Interconnect and monitor every fire actuation device part of or installed along with architectural or mechanical equipment and apparatus (including smoke and/or fire dampers [including those in ducts, at shafts, and for ceiling radiation], smoke and/or fire doors, gates, grills, and shutters, fan control, and other similar equipment/apparatus) to the fire alarm system. Provide suitable addressable monitor modules and all wiring as required for complete connections between each monitored device and the fire alarm system. Supervisory and actuation devices shall be furnished and installed on fire suppression systems, equipment, and apparatus by the respective installing contractor and wired to the fire alarm system by the electrical contractor. Connect supervisory and actuation devices whether shown on the electrical drawings or not. Review fire protection, mechanical, and architectural drawings and coordinate with fire protection, mechanical, and general contractors as required before submitting bid and include all costs in bid.

4.10 SUPERVISORY AND CONTROL DEVICES: Interconnect each supervisory and control device specifically indicated on the drawings to the fire alarm system. Provide suitable addressable monitor modules and all wiring as required for complete connections between each monitored device and the fire alarm system.

4.11 RELAY INTERFACES: Provide a suitable addressable output module as required for control relay interconnection to the addressable fire alarm system. Provide all wiring as required for complete connections to the respective controlled device. Provide output modules for all HVAC/elevator recall and shutdown connections, magnetic door holders, etc..

4.12 Wherever non-addressable ("conventional") style devices remain, are specified, or are otherwise required for the project (i.e. to satisfy code requirements or where addressable devices are not approved by NFPA, UL, or FM for the application) in conjunction with the addressable system, provide each device individually addressed utilizing a suitable addressable monitor module. Verify all requirements before submitting bid and include all costs in bid.

5. LOCKS AND KEYS

5.1 Refer also to the section of this specification "Locks and Keys" of specifications section 16300 "Electrical Materials".

5.2 Provide all fire alarm equipment cabinets and enclosures with locking covers/doors. Provide enclosures and key operated devices (including pull stations and duct detector test/reset stations) keyed alike.

6. INSTALLATION

6.1 Provide fire alarm wiring in complete accordance with all requirements of other sections of the electrical specifications, except as modified below. Utilize wiring methods in accordance with specifications section 16200 "Electrical Work Practices".

6.2 Provide all fire alarm system wiring as directed, recommended, and approved by the system manufacturer and meeting all system manufacturer minimum requirements (including where manufacturer's requirements exceed the requirements of the specifications and the NEC). #14 AWG conductors are the minimum permitted. Provide all wiring utilizing solid conductors. Stranded conductors are permitted only where in accordance with NEC Article 760. The fire alarm system may utilize individual conductors wiring in conduit and/or multi-conductor cables (in conduit where otherwise required by the specifications).

6.3 Provide multi-conductor cables (where utilized) as follows. Provide insulation rated not less than 300 V. Utilize only cables having an overall red jacket and approved by the NEC and NFPA for use with fire alarm systems. Plenum rated cables may be utilized, but only in dry locations (plenum cables, even when installed in conduit, are prohibited in damp and wet locations). In damp locations, utilize only cables specifically listed and identified for use in damp or wet locations. Provide all cables in wet locations (including underground and embedded in concrete slabs at or below grade) specifically designed for outdoor and submerged use and specifically listed and identified for use in wet locations.

6.4 Provide raceways for the fire alarm system dedicated to fire alarm wiring. Fire alarm raceways may not contain wiring of any other system (including power, lighting, controls, telecommunications, etc.). Where fire alarm wiring is recommended or required by the manufacturer to be separated from other fire alarm wiring due to noise, interference, or other concerns, install wiring in separate raceways as required (or physically separate wiring as per manufacturer recommendations where wiring is permitted elsewhere to run without raceway). Paint outlet, junction, device, and other boxes, conduit bodies, and covers associated with the fire alarm system red. Paint exposed fire alarm raceways red.

6.5 Identify fire alarm equipment, devices (as listed below), and wiring as indicated in specifications section "Identification, Nameplates, and Tags" of specifications division 16300, Electrical Materials.

A. Provide an engraved laminated plastic nameplate on the front cover of the fire alarm control panel reading, "FIRE ALARM CONTROL PANEL - 120V, 20A - PP1, CCT. 4"). Indicate the panel and circuit number feeding the control panel. Provide similar nameplates at all power supply units, auxiliary power supplies, and signaling circuit power extender modules.

B. Provide red engraved laminated plastic nameplates with 6.5 mm (1/4") high (minimum) white letters at each pull station reading "IN CASE OF FIRE: SOUND ALARM AND CALL 911" (or "IN CASE OF FIRE: SOUND ALARM AND CALL THE FIRE DEPARTMENT" where the building telephone system does not facilitate directly dialing 911), "FIRE ALARM DOES NOT CALL FIRE DEPARTMENT", or with other wording as directed by the local authorities.

C. Provide two (2) engraved laminated plastic nameplates for each duct type smoke detector, one (1) on the detector housing and one (1) on the remote test/reset/indicating station. List the name and description of the equipment served (i.e. "#AHU-1 - AIR HANDLING UNIT", etc.). Utilize 3.2 mm (1/8") high minimum lettering.

D. Suitably label (in an engineer and owner approved method) all addressable fire alarm devices (manual pull stations, smoke detectors, heat detectors, duct type smoke detector housings, duct smoke detector test/reset/indicating stations, supervised output relay modules, identification modules, etc.) with the respective system address. Labeling annunciator(s) is not required. Labeling signaling devices and magnetic door holders is not required, except that labeling is required for any associated addressable relays.

7. QUALITY ASSURANCE

7.1 Completely test the entire system as per "Testing" in specifications section 16100 "General Electrical". Perform the following additional testing.

7.2 Completely test the entire system to demonstrate proper operation, functioning, capability, and compliance with all code and specification requirements. Inspect equipment, devices, relays, signals, etc. for malfunctioning. Correct malfunctions and retest to demonstrate satisfying the above requirements. Perform all testing in complete accordance with all applicable NFPA-72 standards and testing procedures.

7.3 The electrical contractor and manufacturer's representative shall fully certify (in writing) the entire system and system operation, including documenting successful testing of the system. Submit copies of certification to the owner and local authorities.

7.4 Provide manufacturer's representative services performed by specially trained personnel employed by the fire alarm system manufacturer's representative. Perform manufacturer's representative services (specifically including programming, testing, adjustment, equipment start-up, as-built documentation, and operation and maintenance documentation and instructions) throughout the entire duration of the project, up through final testing and acceptance of the system by the owner and local authorities, include all costs in bid. *No consideration, claims, charges, or compensation will be granted under any circumstance for manufacturer's representative services (including programming, testing, adjustment, equipment start-up, as-built documentation, and operation and maintenance documentation and instructions) during the project (specifically including where associated with changes to the scope of work, alternates, unit prices, allowances, etc.) performed before final testing and acceptance of the system.* Extra claims and/or compensation shall only be considered for changes which are initiated after final testing and acceptance of the system.

7.5 Provide a demonstration period of one (1) full working day to instruct owner's personnel in the operation and maintenance of the system.

8. WARRANTY AND SERVICE CONTRACT

8.1 Provide a written warranty on all equipment in accordance with "Guarantee and Warranties" in specifications section 16100 "General Electrical".

8.2 Make a service contract available to the Owner after the warranty expires. The owner may accept or decline service contract at the owner's discretion.

END OF SECTION

1. GENERAL PROVISIONS

1.1 The applicable requirements and conditions of specifications section "General Provisions" of specifications divisions 16100, General Electrical, and 16300, Electrical Materials, are hereby made an integral part of this section.

1.2 Provide a complete emergency power system consisting of generator set with controller, transfer switch, generator annunciator, all ancillary and accessory equipment, emergency power distribution panels, and all related equipment and wiring. Provide power distribution panels, related equipment, and wiring according to other sections of this specification.

1.3 Provide generator system prototype tested, factory built, production tested, site tested, of the latest commercial design, and with all accessories necessary for complete installation as shown on the drawings and specified herein. Provide equipment meeting the requirements of the National Electrical Code (NEC), the Life Safety Code (NFPA101), and all other applicable codes, standards, and regulations.

1.4 Provide only equipment supplied through a single local manufacturer's representative (distributor) with factory trained and authorized service personnel on staff and single source responsibility for warranty, parts, and service. Submit manufacturer's representative qualifications with shop drawings for review and approval.

1.5 Provide only new equipment of current production of a national firm which manufactures the generator set, generator controls, and transfer switch and assembles the generator sets as a matched unit**.** The transfer switch (only) may be of a different manufacturer (from the generator set and controls) only where the single manufacturer's representative above is factory authorized by <u>both</u> the generator and transfer switch manufacturers (to provide required single-source responsibility for warranty, parts, and service). Refer also to the sections of this specification "Submittals" and "Warranty" for additional information.

1.6 Specifications are based on equipment as manufactured by Kohler. Equal equipment as manufactured by Caterpillar, Cummins/Onan, Generac, MTU Onsite Energy (Katolight/Detroit-Diesel/MDE), and approved equal shall be considered. For transfer switches only, equipment as manufactured by ASCO, Zenith, or approved equal shall be considered in addition to the manufacturers listed above.

1.7 **Provide generator operating on natural gas fuel and configured for outdoor installation. Natural gas generator is <u>ONLY</u> acceptable for use where the natural gas utility company is capable of delivering a flow rate exceeding 125% of the full load fuel consumption of the generator at natural (without the use of pressure boosting devices or pumps) *service* pressure (on the load side of utility meter and**

main regulator) of 5 kPa (20 in. H_2O, 0.725 p.s.i.) or greater for generator rated 350 kW and less. Higher natural pressure is needed for generator rated greater than 350 kW (coordinate service pressure limitations with mechanical engineer). Generator operates at slightly lower operating pressure (verify exact operating pressure range with generator manufacturer) via a regulator (if necessary) located at the generator. These *service* pressure limitations apply even where the actual generator *operating* pressure range is lower. WHERE AVAILABLE NATURAL GAS UTILITY COMPANY SERVICE PRESSURE DOES NOT MEET THE MINIMUM STANDARDS ABOVE, A NATURAL GAS GENERATOR IS *<u>UNACCEPTABLE</u>* (AND A DIESEL GENERATOR MUST BE USED).

2. SUBMITTALS

2.1 Submit shop drawings including catalog cuts and specification sheets showing all standard and optional accessories to be provided, prototype test certification, schematic wiring diagrams, dimension drawings, interconnection diagrams identifying (by terminal number) all interconnections between the generator set, generator controller, transfer switch, and the remote annunciator panel, letter certifying compliance with specifications (see below), and load calculations (see below).

2.2 **Submit (along with shop drawings) sufficient information for the mechanical contractor and mechanical engineer to size and confirm proper natural gas fuel piping installation (including sizing of piping and sizing and required operating characteristics for gas regulators). Coordinate the exact information which must be submitted with the mechanical engineer before submitting shop drawings.**

2.3 Submit (along with shop drawings) a letter from the manufacturer certifying compliance with all requirements of the specifications. Submit certification identifying equipment by serial number and including no exceptions to the specifications, except those stipulated with the submittal.

2.4 Submit (along with shop drawings) a computer generated load calculation prepared by the manufacturer. Generator and related equipment will not be approved unless calculations are submitted. Based on reviewing electrical drawings, list on the load calculation all loads proposed for connection to the generator. The electrical

contractor shall verify and obtain all detailed information on loads as required by the manufacturer to complete the load calculation. Itemize and categorize loads based on operating characteristics. Provide load calculation identifying running and starting loads (including applicable steps of applying loads) and comparing calculated values with generator set maximum ratings. Generator sizing shown on the drawings is based on computerized load calculations performed by the electrical engineer prior to issue of the drawings (based on specified generator system equipment and specified load characteristics) and represents the minimum that will be accepted. Calculations from the manufacturer are required due to variations of standard ratings and electrical characteristics (specifically with respect to motor starting) of generator system equipment available from manufacturers listed in the specifications.

2.5 Submit (along with shop drawings) qualifications of the manufacturer's representative supplying the equipment including factory authorization, summary of warranty coverage, service contacts and procedures (including emergency service telephone numbers), nearest service center location, etc..

2.6 Submit written results for all testing, prior to placing the generator in service.

2.7 Submit complete operation and maintenance (O&M) manuals prior to completion of the project. Submit quantity of sets as indicated elsewhere in the specifications. Submit O&M literature including the following:

A. Installation, operating, & maintenance instructions
B. Overhaul literature
C. General maintenance literature
D. NFPA-101 literature

3. QUALITY ASSURANCE

3.1 To assure the equipment has been designed and built to the highest reliability and quality standards, subject equipment to three (3) separate tests:

A. Design prototype tests
B. Final production tests
C. Site tests

3.2 Design Prototype Tests: Do not subject components of the system (including the generator set, transfer switch, and accessories) to prototype tests since the tests are potentially damaging. Provide prototype tests performed by the manufacturer on similar design prototypes and pre-production models, which will not be sold. Submit certified test data.

A. Generator Set:

1) Maximum power (kW) and apparent power (kVA).
2) Maximum motor starting (kVA) at 30% instantaneous voltage dip.
3) Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1-22.40 and 16.40.
4) Governor speed regulation under steady state and transient conditions.
5) Voltage regulation and transient response.
6) Fuel consumption at 25%, 50%, 75%, and 100% (full) load.
7) Harmonic analysis, voltage wave form deviation, and telephone influence factor (TIF).
8) Three-phase short-circuit.
9) Alternator cooling air flow.
10) Torsion analysis testing to verify freedom from harmful torsion stresses.
11) Endurance testing.

B. Automatic Transfer Switch:

1) Overload, endurance, and short circuit (withstand and closing) at operating voltage as per UL-1008 when enclosed.
2) Temperature rise after the overload and endurance tests to confirm the ability of the transfer switch to carry rated current within allowable temperature limits of insulation in contact with current-carrying parts.

3.3 Final Production Tests: Test equipment as part of this project at the factory prior to shipping. Submit certified test data. If requested by the owner, make arrangements for the owner to witness testing.

A. Generator Set: Perform the following tests under varying load with guards and exhaust system in place.

1) Single-step load pickup.
2) Transient and steady state governing.
3) Safety shutdown devices testing.
4) Voltage regulation.
5) Rated Power.
6) Maximum Power.
7) Rated power factor testing.

B. Automatic Transfer Switch:

1) Ensure proper operation of the individual components, proper overall sequence of operation, and verify that the operating transfer time, voltage, frequency, and the time delay settings comply with the specifications.
2) Perform dielectric strength test per NEMA Standard ICS 1-109.05.
3) Test the control panel for meeting or exceeding the voltage surge withstand capability in accordance with ANSI C37.90a-2978 and the impulse withstand voltage in accordance with NEMA Standard ICS 1-109.

3.4 Site Tests: The electrical contractor is responsible (include costs in bid) for having the manufacturer's local representative perform installation checks, start-up, and load tests at the site. Notify the engineer and owner in advance of the time and date of tests. Perform tests including:

A. Check fuel and fuel system, lubricating oil, coolant and cooling system, exhaust system, generator ventilation, engine electrical system, and heaters (block, generator, and battery) for compliance with manufacturer's recommendations under the environmental conditions present and expected.

B. Adjust all transfer switch and generator timers for proper system coordination before testing.

C. Check accessories that normally function while the set is standing by prior to cranking the engine including block heater(s), battery charger, generator strip heater(s), remote annunciator, etc..

D. Start-up under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement and vibration during starting, running, and stopping, normal and generator system voltages, and phase rotation.

E. Confirm proper functioning under loads with the following two (2) tests. For each test, perform the following. Test by simulating power outage to confirm automatic starting of the generator set, transfer of load, retransfer of load, and generator set shutdown. Monitor engine coolant temperature, oil pressure, battery charge level, voltage, amperes, and frequency throughout the test.

1) Test under full (100%) load conditions by connecting the generator set to external load bank(s) as required. Include load bank use in bid. Include installation and removal of temporary wiring to load bank(s) in bid. Where the project utilizes a single transfer switch, connect the load bank on the load side of the transfer switch. Where the project includes multiple transfer switches, connect either multiple load banks (one for each transfer switch, on load sides) or a single load bank (connected directly to the generator), at the contractor's option.

2) Test under actual building load conditions. Perform this testing when sufficient building load is available. Include costs in bid to perform this testing any time from the date of tests listed above to the date of expiration of project guarantee.

4. WARRANTY

4.1 Provide a written warranty (including duration) on all equipment in accordance with "Guarantee and Warranties" in specifications section 16100 "General Electrical", except that the manufacturer's warranty period shall in no case be less than five (5) years or 1,500 hours of operation (whichever occurs first). Provide warranty complete, comprehensive, and covering all components of the generator system (including engine generator set, controller, annunciator, transfer switch, and all accessories), including parts, labor, and travel, for the entire duration of the warranty. Excluding any component from the warranty is not acceptable. Reducing warranty duration for any component is not acceptable.

4.2 Where the generator set and transfer switch are furnished by separate manufacturers, provide warranties from each manufacturer which are substantially identical, which both meet all provisions of these specifications, and which are both supported by the required single manufacturer's representative. Where warranties substantially differ, do not both meet all provisions of these specifications, are not both supported by the single manufacturer's representative, or where either warranty is voided or restricted based on equipment being furnished by different manufacturers, then provide all equipment as the product of a single manufacturer and covered by a single warranty.

5. ENGINE GENERATOR SET

5.1 Generator Set: Provide engine generator set consisting of engine, generator, controller and indicating panel, and all accessories specified herein. Provide generator set rated as a unit (engine plus generator) for continuous standby duty (defined as continuous for the duration of any power outage). Provide generator set with voltage, phase, and wires (match electrical system ratings) and with minimum kW and kVA ratings as indicated on the drawings. Provide generator set with minimum motor starting kVA rating (at 90% sustained voltage) not less than 400% of the generator kW rating, or as otherwise indicated on the drawings.

5.2 Engine: Provide liquid cooled four (4) stroke cycle natural gas fueled engine, including engine piston displacement (cubic inches/liters), horsepower at governed speed, quantity and arrangement of cylinders, compression ratio, bore, and stroke, as

required to drive the generator to obtain ratings indicated on the drawings and specifications. Provide engine naturally aspirated, turbo-charged, or turbo-charged and after-cooled, and with carburetor. Provide engine with the following:

A. Engine speed controlled by an isochronous governor capable of +/-0.25% steadystate frequency regulation.

B. Positive engagement solenoid shift starting motor, voltage as required.

C. Automatic battery charging alternator with solid-state voltage regulation, voltage and ampere rating as required.

D. Positive displacement full pressure lubrication oil pump, replaceable cartridge oil filters, and dipstick.

E. External oil drain either extending outside of generator frame or which facilitates connecting a drain hose to drain oil into a suitable container outside of the generator frame.

F. Heavy duty dry type replaceable air cleaner elements; air filters containing or utilizing oil are not acceptable.

G. Liquid cooled with unit-mounted high ambient radiator rated 49 degrees C (120 degrees F) or greater, blower fan, coolant pump, thermostat, fan guard, and radiator duct flange to properly cool the engine with up to 120 Pa (0.5" water column) static pressure on the fan.

H. Vibration isolators between the engine-generator and steel base or between the base and the floor.

I. **The generator must be capable of operating on the natural gas fuel supply service available at the captioned project. Where the top pressure limit of the generator's rated natural gas pressure operating range (as shown in shop drawings) exceeds 5 kPa (20 in. H_2O, 0.725 p.s.i., for generator rated 350 kW and less) or exceeds the available utility service pressure (on the load side of utility meter and main regulator), the generator is <u>not acceptable</u> under any circumstance. For generator rated over 350 kW, contact the engineer for rated operating pressure limitations.**

5.3 Generator: Provide permanent magnet generator (PMG) of the salient-pole brush-less type, 12-lead connectable, self-ventilated of drip-proof construction, with amortisseur rotor windings, and skewed for smooth voltage waveform. Provide insulation meeting NEMA standard (MG1-22.40 and 16.40) for Class H and with

epoxy varnish fungus resistant as per MIL 1-24092. Provide temperature rise of the rotor and stator limited to NEMA class F ratings. Provide excitation system of brush-less construction controlled by a solid-state voltage regulator capable of maintaining voltage within +/-2% at any constant load from 0% to 100% of rating. Provide regulator isolated to prevent tracking when connected to SCR loads and provide individual adjustments for voltage range, stability, and volts-per-hertz and protected from the environment by conformal coating. Provide generator with the following:

A. Voltage dip not exceeding 20% and recovering to 2% of rated voltage upon onestep application of any load up to 90% of the rated load at 0.80 power factor.

B. Capable of sustaining at least 250% of rated current for at least 10 seconds under a three-phase symmetrical short by inherent design or by the addition of a current boost system.

C. Factory installed line current sensing line circuit breaker(s) (capable of being manually reset) of the fully-adjustable solid state electronic trip type with inverse time versus current response protecting the generator from damage due to its own high current capability and for coordination with down-stream overcurrent devices. Mount circuit breaker(s) integral to generator set. Provide circuit breaker quantity and rating as indicated on the drawings or as otherwise required to protect the generator. Provide so the breaker will not trip within the 10 seconds at 250% current specified above to allow selective tripping of down-stream overcurrent devices under fault conditions. Automatic resetting breaker is not acceptable (to prevent restoring voltage to a fault or if performing maintenance). Field current sensing breaker is not acceptable.

D. With single maintenance-free bearing, directly connected the engine flywheel to the generator rotor with a semi-flexible coupling.

E. "Oversized" if necessary to provide specified starting kVA rating for motors and similar equipment and facilitating large single phase loads.

F. Arranged to provide 1% voltage regulation.

G. Factory provisions for bonding the neutral conductor at the generator set. Bond as a "separately derived system", as per the NEC.

6. CONTROLLER AND INDICATING PANEL

6.1 Provide controller with integral indicating panel mounted on or integral to and vibration isolated from the generator set. Provide facing to the rear of the generator set (opposite end from the cooling radiator).

6.2 Provide microprocessor based solid-state logic controller with all control panel circuitry of plug-in design for quick replacement. Utilize relays only in high-current circuits. Provide circuit boards moisture proof and capable of operation from -40 to +85 degrees C (-40 to +185 degrees F).

6.3 Provide NFPA-110 controller with complete diagnostic testing to facilitate owner's maintenance personnel testing controller performance without operating the generator set. Utilize one (1) of the following two (2) options at the manufacturer's discretion:

A. Provide diagnostic functions accessed directly from the control panel utilizing alphanumeric display (minimum 32 character) with selection push-buttons integral to the controller (Caterpillar "EMCP II" series, Cummins/Onan "PowerCommand" series, Katolight #MPC 8-32 #KDGC-2000 series, or approved equal).

B. Provide diagnostics utilizing a plug-in diagnostic testing device. Provide controller with suitable connection harness to facilitate plug-in testing device. Furnish and turn over to the owner one (1) plug-in testing device (Kohler "Fast Check" series or approved equal).

6.4 Provide with the following features:

A. Fused DC circuit.

B. Complete two-wire start/stop control operating on closure of remote contact(s).

C. Speed sensing and a second independent starter motor disengagement system protecting starter from engaging with a moving flywheel. Battery charging alternator voltage is not acceptable for this purpose.

D. Starting system designed to restart in the event of a false engine start, by permitting the engine to completely stop and then reengage the starter.

E. Cranking cycle control with 15-second ON and OFF cranking periods.

F. Over-crank protection to open the cranking circuit after 75 seconds if the engine fails to start.

G. Protection to shut down the engine upon overvoltage (15% or more overvoltage for one (1) second or more), high coolant temperature, low oil pressure, and overspeed. Provide "pre-alarm" signals to warn of impending high coolant temperature and low oil pressure shutdown.

H. All controller accessories to facilitate instrument panel devices and indicators specified below.

I. Switch(es)/push-buttons as required to select from the following minimum functions:

1) AUTO: Permits normal functioning, generator operates based on remote starting contact position
2) OFF: Disables operation regardless of the status of remote starting contacts and provides immediate shutdown in case of emergency
3) RUN: Starts and runs the engine regardless of the status of remote starting contacts
4) RESET: Resets the controller after any controller or generator fault condition (this function may be combined with the OFF function above)

6.5 Provide instrument panel integral to the controller including:

Dual range voltmeter 90 mm (3.5"), 2% accuracy *
B. Dual range ammeter 90 mm (3.5"), 2% accuracy *
C. Voltmeter-ammeter phase selector switch *
D. Where dual scale voltmeters or ammeters are used, provide light emitting diode (LED) indicating lights for high or low meter scale
E. Frequency meter 3.5", 0.5% accuracy; either direct reading pointer style with 45 to 65 Hz scale or digital reading measuring to 1/100 Hz (i.e. "60.00 Hz") *
F. Battery charging voltmeter, 51 mm (2"), 2% accuracy *
G. Coolant temperature gauge, 51 mm (2"), 2% accuracy *
H. Oil pressure gauge, 51 mm (2"), 2% accuracy *
I. Running time meter
J. Tachometer *
K. Watt meter *
L. Panel illuminating light(s)
M. Speed potentiometer (in conjunction with isochronous governor)
N. Voltage adjust rheostat
O. Local emergency stop feature (mushroom style push-button)
P. Alarm horn with silencer switch per NFPA 110

* Indicates that where the metered parameter is displayed on an alphanumeric display (minimum 32 character) integral to the controller or where the switch

function is replaced by equivalent push-button functions at the alphanumeric display, omitting the instrument will be considered. NOTE: If a device is proposed for omission under this provision, specifically request this on the manufacturer's submittal cover sheet or a manufacturer's letter attached to the submittal; otherwise the omission will not be considered.

6.6 Provide LED indicating lights (incandescent is not acceptable) integral to the controller for each of the following, along with test button for indicating lights:

A. Auxiliary Shutdown (Red) *
B. Auxiliary Pre-alarm (Yellow) *
C. Switch "Not-in-Auto" (Flashing Red)
D. Over-crank (Red) *
E. Emergency Stop (Red)
F. High Coolant Temperature (Red) *
G. Pre-high Coolant Temperature (Yellow) *
H. Over-speed (Red) *
I. Low Oil Pressure (Red) *
J. Pre-low Oil Pressure (Yellow) *
K. Battery Charger Fault (Red) *
L. Low Battery Voltage (Red) *
M. Low Fuel (Red) *
N. System Ready (Green) *
O. Low Coolant Temperature (Red) *

* Indicates that where the condition is displayed on an alphanumeric display (minimum 32 character) integral to the controller, omitting the indicating light will be considered. If any indicating light is omitted, provide a "common prealarm" light and a "common alarm" light on the control panel. NOTE: If a light is proposed for omission under this provision, specifically request this on the manufacturer's submittal cover sheet or a manufacturer's letter attached to the submittal; otherwise the omission will not be considered.

6.7 Provide relays/contacts for each indicating light signal above, plus additional relays/contacts for the following:

A. Run relay kit (minimum three (3) SPDT contacts)
B. Common failure relay kit (min. one (1) SPDT contact) C. Dry contact kit (minimum three (3) SPDT contacts)

7. ACCESSORIES

7.1 Provide the following accessory equipment integral to the generator set:

A. Complete oil drain kit.

B. Engine block/coolant heater, with thermostat control.

C. Battery rack, battery cables, and battery capable of delivering the manufacturer's recommended minimum cold-cranking amperes at -18 degrees C (0 degrees F).

D. Battery heater, with thermostat control.

E. Generator strip heater.

F. 10 A (minimum) automatic float and equalize battery charger with +/-2% constant voltage regulation from no load to full load over +/-10% AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated for ambient from -40 to +50 degrees C (-40 to +122 Degrees F), 5% accurate voltmeter and ammeter, fused, reverse polarity and transient protected. Provide optional alarm circuit board to meet the requirements of NFPA 110 for low battery voltage, high battery voltage, and battery charger malfunction. Mount the battery charger integral to generator outdoor enclosure only. Do not mount the battery charger at transfer switches or remote from the generator.

G. The electrical contractor shall furnish and the mechanical contractor shall install gas-proof, seamless, stainless steel, and flexible exhaust connections, exhaust silencer rated for hospital grade (industrial, residential, and critical grade silencers are not acceptable) application (reducing total engine exhaust noise by approximately 32 to 42 dBA), tailpipe/rain cap kit, and insulation blankets on turbocharger (where applicable), exhaust manifold, and factory exhaust elbows.

7.2 The electrical contractor shall furnish and the mechanical contractor shall install the following accessory equipment. The electrical contractor shall wire equipment, including all control wiring interconnections to the generator.

A. Flexible fuel lines, fuel line gas strainer, and NFPA-110 manual valve and gas solenoid bypass.

7.3 Provide the complete generator set (including all accessories) installed within an overall weatherproof housing enclosure. Provide enclosure including ample louvers for generator cooling and with removable, lockable side panels for servicing and to prevent tampering. Provide electrostatic applied powder coat enclosure finish as per

architect. Include costs in bid for any standard or optional factory finish or for primer coating only to facilitate final painting in field by the general contractor.

8. REMOTE GENERATOR ANNUNCIATOR

8.1 Provide a remote audio-visual generator annunciator (alarm panel), flush mounted, located directly adjacent to the building fire alarm annunciator (or fire alarm control panel where fire alarm system does not include an annunciator), unless another location

is shown on the electrical drawings. Provide including the following:

A. Alarm horn with silencing switch sounding for any condition indicated by (*).

B. LED indicating lights (incandescent is not acceptable) for the following, along with a test button for indicating lights:

1) System Ready (Green)
2) Utility Line Power (Green)
3) Generator Supplying Power (Green)
4) Generator Running (Green) - Optional
5) Battery Charger Fault (Red)
6) Low Battery Voltage (Red)
7) High Battery Voltage (Red) - Optional
8) Normal Battery Voltage (Green) - Optional
9) Pre-low Oil Pressure (Yellow) *
10) Low Oil Pressure (Red) *
12) Pre-high Coolant Temperature (Yellow) *
13) High Coolant Temperature (Red) *
14) Low Coolant Temperature (Red) *
15) Low Coolant Level (Red) * - Optional
16) Over-crank (Red) *
17) Over-speed (Red) *
18) Low Fuel (Red) *
19) Pre-auxiliary Alarm (Yellow) *
20) Auxiliary Alarm (Red) *
21) Switch "Not-in-Auto" (Flashing Red) *
22) Emergency Stop (Red)

9. AUTOMATIC TRANSFER SWITCH

9.1 Provide automatic transfer switches of the microprocessor logic type featuring both open-transition and delayed-programmed-transition operating modes (field-selectable), Kohler #KCP/KSP series, or approved equal.

9.2 Provide quantity, phase conductor poles, and ampacity as indicated on the drawings. Provide switch rated 600 V with control/operating voltage as required. Provide NEMA-1 enclosure.

9.3 Provide transfer mechanism as a specification grade double-throw switch (single "rocker" switch or two (2) switches positively interlocked by direct connection to inline solenoid shaft) mechanically held and electrically operated by a single-coil linear solenoid. Provide transfer mechanism main contacts accessible for inspection and servicing (contacts may be located behind removable covers). Transfer mechanism utilizing two (2) mechanically interlocked or linked circuit breakers or molded case
switches is not acceptable. Geared operator, motor driven operator, and transfer mechanism utilizing two (2) or more operators are not acceptable.

9.4 Provide with switched neutral pole (in addition to quantity of poles indicated on the drawings) and connect the generator system as a "separately derived system" as defined by the NEC. Provide switched neutral pole of the "overlapping" make-before-break style where available from the manufacturer. Solid neutral bus is not acceptable under any circumstance.

9.5 Provide with the following features:

A. Switch(es)/push-buttons as required to select from the following minimum functions:

1) AUTO: Permits normal functioning
2) TEST: Simulates normal power failure
3) OFF: Disables operation

B. LED indicating lights (incandescent is not acceptable) for the following, along with a test button for indicating lights:

1) Normal power supply (Green)
2) Generator power supply (Red)
3) Test switch not-in-auto (white or amber): Lights if switch(es)/push-buttons select any function other than "AUTO"

C. Provide voltage monitoring of both normal and generator sources, with differential voltage sensing and adjustable normal source voltage sensing

(nominal 72%-100% for pickup, 70%-98% for dropout). Provide three-phase normal source sensing and three phase or single phase generator source sensing.

D. Provide the following adjustable time delay features (except engine starting time delay may be fixed or adjustable) with nominal time/range as shown:

1) Engine starting (3 seconds)
2) Normal to generator transfer (0.6-60 seconds), set not more than 10 seconds
3) Generator to normal retransfer (1-30 minutes)
4) Programmed transition (0-10 seconds)
5) Engine cool-down (1-30 minutes)

E. Main shaft auxiliary contacts (2 N.O. and 2 N.C.).

F. One (1) channel generator exercising time clock, with load/no-load selector switch, with digital control (electromechanical type is not acceptable), of the seven (7) day type, with an illuminated LED visible with the enclosure cover open. Provide coil and contact voltage coordinated with generator and transfer switch controls.

G. Provide with in-phase and frequency monitoring to prevent retransfer unless phase angles and frequencies of the normal and generator sources are within 20 degrees and 2 Hz, respectively.

10. INSTALLATION

10.1 Install generator set, automatic transfer switch(es), and remote annunciator at respective locations as shown on the drawings. Mount generator set and any other floor/ground mounted equipment on suitable pads as per specifications section "Housekeeping and Equipment Pads" of specifications division 16200, Electrical Work Practices. Provide pads in complete accordance with equipment manufacturer's requirements and recommendations. For the generator pad, submit shop drawings of exact pad construction, fabrication, and characteristics and include sealing (by a registered professional engineer) shop drawings where requested by local authorities for review.

10.2 Coordinate exact equipment layout and locations with the architect, owner, and all other trades (including mechanical contractor) as required for a complete installation.

10.3 Mount the generator controller, battery rack, battery cables, battery heater, batteries, and battery charger integral to generator outdoor enclosure only. Do not mount the battery charger at transfer switches or remote from the generator.

10.4 Provide the engine exhaust silencer factory mounted within or atop the generator weatherproof enclosure utilizing flexible exhaust connection and manufacturer brackets and hardware. Provide the exhaust tailpipe/rain cap kit factory mounted atop the generator weatherproof enclosure. Provide the complete exhaust system factory installed by the manufacturer.

10.5 The mechanical contractor shall install electrical contractor furnished mechanical accessories as specified above.

10.6 **The mechanical contractor shall provide the complete fuel system serving the generator (including appropriately sized piping and suitable gas regulator serving the generator; fully coordinate fuel system with the mechanical engineer and mechanical contractor) The gas regulator (if needed) must be dedicated to serving the generator only and must be located at the generator (only). Generator must be supplied directly from the natural gas utility service without any intermediate regulators.**

10.7 Provide engraved laminated plastic nameplates at all generator system equipment and equipment fed from the generator system as per specifications section "Identification, Nameplates, and Tags" of specifications division 16300, Electrical Materials, except utilize red nameplates with white letters. This includes nameplates at the generator set, transfer switch, emergency branch/distribution panels, remote mounted generator accessories, switches serving generator set accessories, and related equipment.

A. Provide generator nameplate with wording similar to the following example (fill in the proper ratings):

Name (10 mm (3/8") lettering):	EMERGENCY GENERATOR
Voltage and Phase:	120/240V-1PH-3W
Ratings and circuit breaker amperes:	45KW, 56KVA, 200A
Fuel Source:	NATURAL GAS
Remarks (3.2 mm (1/8") lettering):	(list multiple ATS's) *

* Where the generator serves two (2) or more transfer switches, list locations of transfer switches in the remarks.

B. Provide nameplates for transfer switches similar to nameplates for safety switches and enclosed circuit breakers, except with remarks indicating the panel and circuit number, transformer, or generator feeding both the normal and emergency sources (provide description describing load fed from the transfer switch).

C. Provide nameplates for electrical accessories (block/coolant, generator strip, and battery heaters and battery charger) similar to nameplates for safety switches and enclosed circuit breakers.

D. Provide red engraved laminated plastic nameplates at each of the generator annunciator and the building service disconnect reading, "NATURAL GAS EMERGENCY GENERATOR LOCATED OUTDOORS AT...", and describe the generator location.

E. The electrical contractor shall provide tags (of an engineer and code approved type) at all fuel line shutoff valves and fuel supply equipment serving the generator reading, "EMERGENCY POWER SUPPLY - NOT TO BE SHUT OFF DURING AN EMERGENCY" or similar wording as directed by local authorities. Coordinate locations and requirements with mechanical contractor and mechanical engineer.

10.8 Provide complete interconnection, control, and intercommunication wiring between all generator system components as required for a complete installation. This includes wiring between any and all of the equipment and components as follows, where applicable: generator set (including engine, generator, controller and indicating panel, and all accessories), transfer switch(es), remote generator annunciator, elevator controls, outdoor lighting controls, fuel supply equipment, ventilation louvers, etc.. Where the system includes more than one (1) transfer switch, connect generator run contacts in each transfer switch in parallel so activation of any one (1) or more transfer switch operates the generator. Provide all control wiring in complete accordance with the NEC (including maintaining separation from other wiring and systems and fire rating of wiring [including where required for high-rise structures, places of assembly, and fire pump transfer switches], as required).

10.9 Completely connect, ground, and bond the generator set and complete generator power system in accordance with all applicable NEC requirements for a "separately derived system". Include the following:

A. Systems Definitions:

1) Normal Source System: The **separately derived** normal (utility) power system fed by the utility electric service and which feeds normal power to the automatic transfer switch.

2) Generator Source System: The **separately derived** generator power system originating at the generator and which feeds generator power to the automatic transfer switch.

3) Emergency Distribution System: The system originating at the load side of the automatic transfer switch, including all distribution, branch wiring, and equipment as part of the emergency power system (excluding the "Normal Source System" and the "Generator Source System" defined above).

B. Generator Neutral Bonding: Provide the generator set with provisions for bonding the neutral conductor and bond in accordance with the NEC.

C. Generator Grounding: Ground the generator as per specifications section "Grounding" of specifications division 16200, Electrical Work Practices (including using grounding materials as per specifications section "Grounding Materials" of specifications division 16300, Electrical Materials). Provide grounding electrode connections at the generator (including driven (made) grounding electrodes and other applicable connections) as required by the NEC and in addition to all grounding electrode connections as part of the "Normal Source System". Connect the grounding electrode connections at the generator to the grounding electrode system for the "Normal Source System" to form a common and complete grounding electrode system throughout the building.

D. Switched Neutral at Transfer Switch: Provide the automatic transfer switch with switched neutral pole to facilitate the following:

1) Separating and isolating neutral conductors from each of the "Normal Source System" and the "Generator Source System" (except for brief intervals during transfer or re-transfer).

2) Connecting the "Emergency Distribution System" neutral conductor to either the "Normal Source System" or the "Generator Source System" (along with phase conductors) depending on the transfer switch position.

E. Install wiring of the "Normal Source System", the "Generator Source System", and the "Emergency Distribution System" so the neutral conductors of each respective system do not connect at any point to the any neutral conductor of any other system, except under the following specific conditions:

1) The switched neutral pole of the automatic transfer switch shall connect the neutral conductor of the "Emergency Distribution System" to the neutral conductor of the "Normal Source System" only when the automatic transfer switch is in the "normal" position. No other connection between any "Emergency Distribution System" neutral conductor and any "Normal Source System" neutral conductor is permitted under any circumstance.

2) The switched neutral pole of the automatic transfer switch shall connect the neutral conductor of the "Emergency Distribution System" to the neutral conductor of the "Generator Source System" only when the automatic transfer switch is in the "generator" position. No other connection between any "Emergency Distribution System" neutral conductor and any "Generator Source System" neutral conductor is permitted under any circumstance.

3) No connection between any "Normal Source System" neutral conductor and any "Generator Source System" neutral conductor is permitted under any circumstance (except that both neutral bonding points below shall connect to a common grounding electrode system). Bond the neutral conductor of the "Normal Source System" to the grounding electrode system at the point where the "Normal Source System" originates or receives its supply. Bond the neutral conductor of the "Generator Source System" to the grounding electrode system at the generator.

4) Do not bond or connect the "Emergency Distribution System" neutral conductor to any grounding conductor under any circumstance (neutral is bonded at the sources of the "Normal Source System" and the "Generator Source System" and connected via the transfer switch).

10.10 Completely fill the generator with all fluids as recommended by the manufacturer (including lubricating oil, antifreeze coolant, battery fluid, etc.).

10.11 Set all generator, transfer switch, and load control timers and relays as recommended by the manufacturer (with settings complying with all applicable codes).

10.12 Provide conduit stub-ups at the generator completely enclosed inside of the generator enclosure. Exposed conduits outside of the generator enclosure are permitted only where specifically approved in writing by the engineer before installation and where the generator base does not have any space facilitating enclosing conduit stubs.

END OF SECTION

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide **1-inch** annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, castbrass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials. END

OF SECTION 220518

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces. B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 (DN 100) and larger.
2. Handlever: For quarter-turn valves smaller than

NPS 4 . H. Valves in Insulated Piping:

1. Include 2-inch (50-mm) stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

A. One-Piece, Brass Ball Valves:

1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig (2760 kPa).
c. Body Design: One piece.
d. Body Material: Forged brass or bronze.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Brass or stainless steel.
h. Ball: Chrome-plated brass or stainless steel.
i. Port: Reduced.

B. Two-Piece, Brass Ball Valves with Full Port and Brass Trim:

1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

2.3 BRONZE BALL VALVES

A. One-Piece, Bronze Ball Valves with Bronze Trim:

1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig (2760 kPa).
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Bronze.
h. Ball: Chrome-plated brass.

i. Port: Reduced.

B. Two-Piece, Bronze Ball Valves with Full Port, and Bronze or Brass Trim:

1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Bronze or brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solderjoint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. One piece, brass ball valve.
3. One piece, bronze ball valve with bronze trim.
4. Two-piece, brass ball valves with full port and brass trim.
5. Two-piece, bronze ball valves with full port and bronze or brass trim.

END OF SECTION 220523.12

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bronze swing check valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set check valves in either closed or open position. B. Use the following

precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NSF Compliance: NSF 61for valve materials for potable-water service.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE LIFT CHECK VALVES

2.3 BRONZE SWING CHECK VALVES

A. Class 125, Bronze, Swing Check Valves with Bronze Disc:

1. Description:

    a. Standard: MSS SP-80, Type 3.
    b. CWP Rating: 200 psig (1380 kPa).
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded or soldered. See valve schedule articles.
    f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Description:

    a. Standard: MSS SP-80, Type 3.
    b. CWP Rating: 300 psig (2070 kPa).
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded or soldered. See valve schedule articles.
    f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. End Connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded or soldered.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.
3. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded.
4. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Bronze swing check valves, Class 125, bronze disc with soldered end connections.

END OF SECTION 220523.14

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Fastener systems.
4. Pipe stands.

B. Related Sections:
1. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A.

Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Pipe stands.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel. B. Copper

Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

A.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 THERMAL-HANGER SHIELD INSERTS

Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa)] minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless-] steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.4 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

A.

D. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structuralsteel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.5 MISCELLANEOUS MATERIALS

Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

A.

F. Install lateral bracing with pipe hangers and supports to prevent swaying.

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping. J. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
    e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicateinsulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.3 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.4 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbonsteel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steelpipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel Ibeams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel Ibeams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads: a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 11/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe labels
2. Valve tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.2 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses. 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to [25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions. C. Pipe Label Color Schedule:

1. Domestic Water Piping

    a. Background: Safety green.
    b. Letter Colors: White.

2. Sanitary Waste Piping:

    a. Background Color: Safety black.
    b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

    a. Cold Water: 1-1/2 inches (50 mm) round.
    b. Hot Water: 1-1/2 inches (38 mm) round.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Aboveground Piping Insulation Schedule," articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Block Insulation: ASTM C 552, Type I.
2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. H. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.4 SECUREMENTS A.

Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer. I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [2 inches (50 mm)] [4 inches (100 mm)] o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions. C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles. B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation

at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant. B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant. C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands. D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. C. Insulation Installation on Pipe Fittings and Elbows:

    1. Install mitered sections of pipe insulation.
    2. Secure insulation materials and seal seams with manufacturer's recommended

adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant. B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant. C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE A.

Domestic Cold Water:

1. NPS 1 (DN 25) and Smaller: Insulation shall be one of the following:

   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

2. NPS 1-1/4 (DN 32) and Larger: Insulation shall be one of the following:

   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm)

thick. B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:

   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

2. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:

   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE A.

Domestic Water Piping:

1. All Pipe Sizes: Insulation shall be the following:

   a. Flexible Elastomeric: 2 inches (50 mm) thick.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Aboveground domestic water pipes, tubes, and fittings inside buildings. B.

Related Requirements:

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner and obtain approval no fewer than five business days in advance of proposed interruption of water service.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

C. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends. D. Copper Pressure-Seal-Joint Fittings:

1. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, Oring seal in each end.
2. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for generalduty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS A.

General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. B. Dielectric Unions:

1. Standard: ASSE 1079.
2. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
3. End Connections: Solder-joint copper alloy and threaded ferrous. C. Dielectric

Flanges:

1. Standard: ASSE 1079.
2. Factory-fabricated, bolted, companion-flange assembly.
3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties." D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install domestic water piping level and plumb.

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space. I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated. K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers. C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod. 7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod. F. Install supports for vertical copper tubing every 10 feet (3 m).

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment." B. Label pressure piping with system operating pressure.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction. B.

        Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of watersample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-copper, solderjoint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-sealjoint fittings; and pressure-sealed joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-copper, solderjoint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-sealjoint fittings; and pressure-sealed joints.

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
2. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Drain valves.
3. Water-hammer arresters.
4. Air vents.
5. Flexible connectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze.

2.4 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.5 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.6 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C).
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: [NPS 3/8 (DN 10)] [NPS 1/2 (DN 15)] minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.7 FLEXIBLE CONNECTORS

A. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water-hammer arresters in water piping according to PDI-WH 201.

B. Install air vents at high points of water piping.

3.2 FIELD QUALITY CONTROL

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than five business days in advance of proposed interruption of sanitary waste service.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS A.

Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Cast-Iron, Hubless-Piping Couplings:

1. Standard: ASTM C 1277.
2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 SPECIALTY PIPE FITTINGS A.

Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

a. Standard: ASTM C 1173.
b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

c. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Standard: ASTM C 1460.
b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install aboveground ABS piping according to ASTM D 2661.

O. Install underground ABS piping according to ASTM D 2321.

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION A.

Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
b. NPS 2 (DN 50) and Larger: Pressure

transition couplings. B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
4. Dielectric Fittings for [NPS 5 (DN 125)] and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical Piping: MSS Type 8 or Type 42, clamps. 6. Install individual, straight, horizontal piping runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting[, valve,] and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

H. Install hangers for ABS piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.

2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

I. Install supports for vertical ABS piping every 48 inches (1200 mm).

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for backwater valves drains specified in Section 221319 "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Soil and waste piping NPS 4 (DN 100) shall be of the following:

1. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints for piping within building or below grade.
2. ABS pipe, ABS socket fittings, and solvent-cemented joints for temporary exposed piping at temporary trailers.

C. Vent piping NPS 4 (DN 100) and smaller shall be of the following:

1. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints for piping within building or below grade.
2. Galvanized-steel pipe, drainage fittings, and threaded joints.
3. ABS pipe, ABS socket fittings, and solvent-cemented joints for temporary exposed piping at temporary trailers.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.
3. Miscellaneous sanitary drainage piping specialties.
4. Flashing materials.
5. Grease interceptors.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

Grease interceptors.

1.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.7 CLEANOUTS

A. Exposed Metal Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size. B. Metal Floor Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:
2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Threaded.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

14. Standard: ASME A112.3.1.

15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

1.8 FLOOR DRAINS

A. Cast-Iron Floor Drains and Floor Sinks:

1. Standard: ASME A112.6.3.
2. Pattern: Floor drain/sink.
3. Body Material: Gray iron.
4. Seepage Flange: Required.
5. Anchor Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Backwater Valve: Not required.
9. Sediment Bucket: Required.
10. Top or Strainer Material: Bronze.
11. Top of Body and Strainer Finish: Nickel bronze.
12. Top Shape: Round (Floor Drain) or Square (Floor Sink).
13. Top Loading Classification: Medium Duty.
14. Funnel: Not required.
15. Trap Material: Cast iron.
16. Trap Pattern: Deep-seal P-trap.

1.9 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES A.

Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

    a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
    b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

1.10 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1.

General Use: 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.

2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.

3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness. B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed. D. Solder: ASTM B 32, lead-free alloy.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

1.11 GREASE INTERCEPTORS

A. Grease Interceptors:

1. Cast-Iron or Steel Grease Interceptors:

2. Standard: ASME A112.14.3, for intercepting and retaining fats, oils, and greases from food preparation wastewater.
3. Plumbing and Drainage Institute Seal: Required.
4. Body Material: Cast iron.
5. Interior Lining: Corrosion-resistant enamel.
6. Exterior Coating: Corrosion-resistant enamel.
7. Inlet and Outlet Size: 3”.
8. End Connections: Threaded.
9. Mounting: Above floor.
10. Flow-Control Fitting: Required.
11. Operation: Manual cleaning.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Equipment Mounting:

1. Install grease interceptors on corrosion proof, temporary base.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
    b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install deep-seal traps on floor drains and other waste outlets, if indicated.

G. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
2. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

H. Install wood-blocking reinforcement for wall-mounting-type specialties.

2.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.

2.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Set flashing on floors and roofs in solid coating of bituminous cement.

C. Secure flashing into sleeve and specialty clamping ring or device.

D. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."

E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

2.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Grease interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying

unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

2.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2.6 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6 (DN 150)": Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs above Grade:

   a. Piping Smaller Than NPS 6 (DN 150)]: Galvanized-steel-pipe sleeves.

3. Interior Partitions:

   a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

ESCUTCHEONS FOR HVAC PIPING

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, cast brass type.
b. Insulated Piping: One-piece, cast brass type.

2. Escutcheons for Existing Piping:

a. Insulated Piping: Split-casting, brass type with concealed hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials. END

OF SECTION 230518

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Venturi flowmeters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS A.

Standard: ASME B40.200.

B. Case: Liquid-filled type; stainless steel with 3-inch (76-mm) nominal diameter.

C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

E. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

G. Window: Plain glass.

H. Ring: Stainless steel.

I. Element: Bimetal coil.

J. Pointer: Dark-colored metal.

K. Accuracy: Plus or minus 1 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1 ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/4 or NPS 1/2 (DN 8 or DN 15) pipe threads.

C. Valves: Brass ball, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Description: Test-station fitting made for insertion into piping tee fitting.

B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

C. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

E. Core Inserts: EPDM self-sealing rubber.

2.6 FLOWMETERS

A. Venturi Flowmeters:

1. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.

    a. Design: Differential-pressure-type measurement for water.
    b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
    c. Minimum Pressure Rating: 250 psig (1725 kPa).
    d. Minimum Temperature Rating: 250 deg F (121 deg C).
    e. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
    f. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
    g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.

4. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element. a. Scale: Gallons per minute (Liters per second).
    b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
5. Display: Shows rate of flow.
6. Conversion Chart: Flow rate data compatible with sensor.
7. Operating Instructions: Include complete instructions with each flowmeter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids (except steam).

K. Install valve and syphon fitting in piping for each pressure gage for steam.

L. Install test plugs in piping tees.

M. Install flow indicators in piping systems in accessible positions for easy viewing.

N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

O. Install flowmeter elements in accessible positions in piping systems.

P. Install wafer-orifice flowmeter elements between pipe flanges.

Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

R. Install permanent indicators on walls or brackets in accessible and readable positions.

S. Install connection fittings in accessible locations for attachment to portable indicators.

T. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

U. Install thermometers in the following locations:
   1. Where indicated on the drawings.

V. Install pressure gages in the following locations:

   1. Where indicated on the drawings.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:

1. Liquid-filled, bimetallic-actuated type.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at inlet and outlet of each chilled-water coil shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.

B. Pressure gages at suction and discharge of each pump shall be the following:

1. Liquid-filled, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi (0 to 600 kPa).

B. Scale Range for Steam Piping: 0 to 100 psi (0 to 600 kPa).

3.8 FLOWMETER SCHEDULE

A. Flowmeters for Chilled-Water Piping: Venturi type.

END OF SECTION 230519

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Steel ball valves.
3. Iron ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces. B. Use the

following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.1 for power piping valves.
7. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted. D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Handlever: For quarter-turn valves smaller than NPS 4 (DN 100). H.

Valves in Insulated Piping:

1. Include 2-inch (50-mm) stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Two-Piece Brass Ball Valves with Full Port and Stainless-Steel Trim:

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 STEEL BALL VALVES

A. Class 150 Steel Ball Valves with Full Port and Stainless-Steel Trim:

1. Description:

a. Standard: MSS SP-72.
b. CWP Rating: 285 psig (1964 kPa).
c. Body Design: Split body.
d. Body Material: Carbon steel, ASTM A 216, Type WCB.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

2.4 IRON BALL VALVES

A. Class 125 Iron Ball Valves:

1. Description:

a. Standard: MSS SP-72.
b. CWP Rating: 200 psig (1380 kPa).

c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted. B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solderjoint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.4 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Two piece, full port, brass with stainless-steel trim.

1. Valves may be provided with solder-joint ends instead of threaded ends. B.

Pipe NPS 2-1/2 (DN 65) and Larger: Iron ball valves.

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Steel Ball Valves: Class 150.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Two piece, full port, brass with stainless-steel trim.

1. Valves may be provided with solder-joint ends instead of threaded ends.

3.6 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Two piece, full port, brass with stainless-steel trim.

END OF SECTION 230523.12

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports. B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel. B. Copper

Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and Ubolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Hot-dipped galvanized.
7. Paint Coating: Epoxy.
8. Plastic Coating: PVC.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration. D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuousthread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainlesssteel, roller-type pipe support. E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structuralsteel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbonsteel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65)

and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping. N. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to [1 inches (40 mm).

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in other sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
6. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
7. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
9. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
10. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

12. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steelpipe base stanchion support and cast-iron floor flange.
13. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
14. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
15. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
16. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
17. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel Ibeams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel Ibeams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads: a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 11/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Stencils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: None.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

5. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate. B.

Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances.

2.3 STENCILS

A. Stencils for Ducts:

1. Lettering Size: Minimum letter height of 1-1/4 inches (32 mm) for viewing distances up to 15 feet (4-1/2 m) and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Aluminum.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

B. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Lettering Size: Minimum letter height of 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Aluminum.

3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet (15 m) along each run. Reduce intervals to 12 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions. D. Pipe Label Color Schedule:

1. Heating Water Piping: White letters on a safety-green background.

3.5 DUCT LABEL INSTALLATION

A. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 25 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article. C. Certified TAB reports.

D. Sample report forms.

E. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by Architect and Commissioning Authority.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1,
Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed. G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heatrecovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Architect and Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, fullheating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

    a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances. C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

B. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

C. Set calibrated balancing valves, if installed, at calculated presettings.

D. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

E. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

F. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

H. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

I. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

D. Check settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.9 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

3.11 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems. Obtain approval for final report from Architect and Commissioning Authority.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration. B.

Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.

    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

    1. Quantities of outdoor, supply, return, and exhaust airflows.
    2. Water and steam flow rates.
    3. Duct, outlet, and inlet sizes.
    4. Pipe and valve sizes and locations.
    5. Terminal units.
    6. Balancing stations.
    7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

    1. Unit Data:

        a. Unit identification.
        b. Location.
        c. Make and type.
        d. Model number and unit size.
        e. Manufacturer's serial number.
        f. Unit arrangement and class.
        g. Discharge arrangement.

h. Sheave make, size in inches (mm), and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Filter static-pressure differential in inches wg (Pa).
f. Preheat-coil static-pressure differential in inches wg (Pa).
g. Cooling-coil static-pressure differential in inches wg (Pa).
h. Heating-coil static-pressure differential in inches wg (Pa).
i. Outdoor airflow in cfm (L/s).
j. Return airflow in cfm (L/s).
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position. F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch (mm) o.c.
f. Make and model number.
g. Face area in sq. ft. (sq. m).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Average face velocity in fpm (m/s).
c. Air pressure drop in inches wg (Pa).
d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).

f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Water flow rate in gpm (L/s).
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches (mm), and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm (L/s).
    b. Total system static pressure in inches wg (Pa).
    c. Fan rpm.
    d. Discharge static pressure in inches wg (Pa).
    e. Suction static pressure in inches wg (Pa).

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F (deg C).
    d. Duct static pressure in inches wg (Pa).
    e. Duct size in inches (mm).
    f. Duct area in sq. ft. (sq. m).
    g. Indicated air flow rate in cfm (L/s).
    h. Indicated velocity in fpm (m/s).
    i. Actual air flow rate in cfm (L/s).
    j. Actual average velocity in fpm (m/s).
    k. Barometric pressure in psig (Pa). I. Air-Terminal-Device Reports:

1. Unit Data:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Apparatus used for test.
    d. Area served.
    e. Make.
    f. Number from system diagram.
    g. Type and model number.
    h. Size.
    i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm (L/s).
    b. Air velocity in fpm (m/s).
    c. Preliminary air flow rate as needed in cfm (L/s).
    d. Preliminary velocity as needed in fpm (m/s).

e. Final air flow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.

d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Entering-water temperature in deg F (deg C).
c. Leaving-water temperature in deg F (deg C).
d. Water pressure drop in feet of head or psig (kPa).
e. Entering-air temperature in deg F (deg C).
f. Leaving-air temperature in deg F (deg C). K. Instrument Calibration

Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply air.
2. Indoor, exposed supply and air. B. Related Sections:

1. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed. C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated. B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers." D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9mm) dry film thickness.
2. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.

4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8mm) dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fireresistant lagging cloths over duct insulation.
3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
4. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic

Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

2.8 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.9 SECUREMENTS A.

Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 3/4 inch (19 mm) wide with wing seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm)] wide with wing seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application. B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch(2.6-mm-) diameter shank, length to suit depth of insulation indicated.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates. C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).

1. Comply with requirements in Section 078413 "Penetration Firestopping"irestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

DUCT INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitordischarge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outwardclinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or fieldapplied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vaporbarrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c. B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitordischarge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outwardclinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or fieldapplied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vaporbarrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and

inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainlesssteel bands 12 inches (300 mm) o.c. and at end joints.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and air. B.

Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Flexible connectors.
3. Vibration-control devices.
4. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, rectangular, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 1.5-lb/cu. ft. (24-kg/cu. m) nominal density.

B. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 1.5-lb/cu. ft. (24-kg/cu. m). C.

Exposed, rectangular, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m)

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Heating hot-water piping, indoors. B.

Related Sections:

1. Section 230713 "Duct Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed. C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied. B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

2.3 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fireresistant lagging cloths over pipe insulation.

3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
4. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
d. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.8 SECUREMENTS A.

Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 3/4 inch (19 mm)] wide with wing seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm)] wide with wing seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer. I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [2 inches (50 mm)] [4 inches (100 mm)] o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles. B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the

insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainlesssteel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainlesssteel bands 12 inches (300 mm) o.c. and at end joints.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extend of inspection shall be limited to no more than two locations on each system type insulated.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and Below:

1. NPS 12 (DN 300) and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (50 mm) thick.

END OF SECTION 230719

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports. B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, ductmounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS A.

Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

B. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction. 6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.

b. Air outlets and inlets.
c. Speakers.

d. Sprinklers.
e. Access panels.
f. Perimeter moldings. B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports and AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1,
Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, ductsupport intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, ductsupport intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections. B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL. B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches (76 mm).
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers." C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Test the following systems:

    a. Supply Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
    b. Exhaust Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give sevendays' advance notice for testing. C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new and existing duct system(s) before starting equipment/systems.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process. C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems. E.

Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE A.

Supply Ducts:

1. Ducts Connected to Constant-Volume Air-Handling Units:

    a. Pressure Class: Positive 3-inch wg (750 Pa).
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive 2-inch wg (750 Pa)>.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6. B. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

    a. Pressure Class: Negative 2-inch wg (500 Pa).
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

C. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel. D. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 4-2, "Rectangular Elbows." a. Velocity 1000 fpm (5 m/s) or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 31,

"Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow. 4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam. E.

Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
   c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral. END

OF SECTION 233113

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Flexible ducts.
2. Manual volume dampers.
3. Flange connectors.
4. Turning vanes.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Duct accessory hardware.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following: a. Special fittings.
   b. Manual volume damper installations.
   c. Control-damper installations.
   d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
   e. Duct security bars.
   f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved. B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: **G90 (Z275)**.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a **No. 2** finish for concealed ducts and No. 4 finish for exposed ducts.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 FLEXIBLE DUCTS

A. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20 m/s).
3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Standard leakage rating.
2. Suitable for horizontal or vertical applications.
3. Frames:

a. Frame: Hat-shaped, **0.094-inch- (2.4-mm-) thick, galvanized sheet steel**.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. **Galvanized**-steel, 0.064 inch (1.62 mm) thick.

5. Blade Axles: **Galvanized steel**.
6. Bearings:

a. **Oil-impregnated bronze**.
b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Galvanized steel. B. Jackshaft:

1. Size: **0.5-inch (13-mm)** diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zincplated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 FLANGE CONNECTORS

A. Description: R**oll-formed**, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gage and Shape: Match connecting ductwork.

2.6 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single wall for ducts up to [**48 inches (1200 mm)**] <**Insert dimension**> wide and double wall for larger dimensions.

2.7 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inch (25-by-25-mm)butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors up to **18 Inches (460 mm)**] Square: **Two hinges** and two sash locks.
b. Access Doors up to 24 by 48 Inches (600 by 1200 mm): **Four hinges** and two compression latches.

2.8 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip **3-1/2 inches (89 mm)** wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.

1. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m).
2. Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.

3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.9 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

2. Install aluminum volume dampers in aluminum ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Control devices requiring inspection.
3. Elsewhere as indicated.

G. Install access doors with swing against duct static pressure.

H. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
5. Body Access: 25 by 14 inches (635 by 355 mm).
6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).

I. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

J. Install flexible connectors to connect ducts to equipment.

K. Connect flexible ducts to metal ducts with **draw bands**.

L. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers B.

Related Sections:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

6.

PART 2 - PRODUCTS

A. Basis of Design Manufacturer:

1. Titus

B. Other Acceptable Manufacturers:

1. Price
2. Tuttle & Bailey
3. Krueger

2.2 Ceiling Diffusers/Ceiling Exhaust Registers A.

Refer to project drawings for products.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Manually clean existing diffusers and registers that are to be reused.

B. Install diffusers, registers, and grilles level and plumb.

C. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 Summary

A. Section includes Kawneer Architectural Aluminum Windows including perimeter trims, stools, accessories, shims and anchors, and perimeter sealing of window units.
   1. Types of aluminum windows include:
      a. Kawneer Series 8400TL Thermal Windows
      b. Model 8410TL Fixed Window
      c. 4" (101.6 mm) frame depth
      d. AW-PG100-FW

1.3 Definitions

A. Definitions: For fenestration industry standard terminology and definitions refer to American Architectural Manufactures Association (AAMA) – AAMA Glossary (AAMA AG).

1.4 Performance Requirements

A. General Performance: Aluminum-framed window system shall withstand the effects of the following performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Window System Performance Requirements:

   1. Performance Requirements: Provide aluminum windows of performance indicated that comply with AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS)
      a. Performance Class and Grade: AW-PG100-FW

   2. Air Infiltration: The test specimen shall be tested in accordance with ASTM E 283 at a minimum window size of 60" x 99" (1524 x 2515 mm). The air infiltration rate shall not exceed 0.10 cfm/ft^2 at a static air pressure differential of 6.24 psf (300 Pa).

   3. Water Resistance: The test specimen shall be tested in accordance with ASTM E 547 and ASTM E 331 at a minimum window size of 60" x 99" (1524 x 2515 mm). There shall be no leakage as defined in the test method at a static air pressure differential of 12 psf (574 Pa).

   4. Uniform Load Deflection: A minimum static air pressure difference of 100 psf (4788 Pa) shall be applied in the positive and negative direction in accordance with ASTM E 330. There shall be no deflection in excess of L/175 of the span of any framing member.

   5. Uniform Load Structural Test: A minimum static air pressure difference of 150 psf (7182 Pa) shall be applied in the positive and negative direction in accordance with ASTM E 330. The unit shall be evaluated after each load.

   6. Component Testing: Window components shall be tested in accordance with procedures described in AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS).

   7. Thermal Transmittance Test (U-Factor): When tested in accordance with AAMA 1503, the conductive thermal transmittance (U-Factor) shall not be more than .48 BTU/hr/sf/°F or (___) BTU/hr/sf/°F per AAMA 507 or NFRC 100 when using project specified glass.

   8. Condensation Resistance Test (CRF): When tested in accordance with AAMA 1503 with 1" (25,4 mm) insulating clear glass, the condensation resistance factor shall not be less than (CRF_f 67) frame and (CRF_g 66) glass.

   9. Sound Performance: When tested in accordance with ASTM E 90 and E 413, the sound transmission loss (STL) shall not be less than 39.

   10. Thermal Barrier Tests: Testing shall be in general accordance with AAMA 505 Dry Shrinkage and Composite Thermal Cycling test procedure, AAMA TIR-A8, Structural Performance of Composite Thermal Barrier systems.

1.5 Submittals

A. Product Data: Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.

B. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances and installation details.

C. Samples for Initial Selection: For units with factory-applied color finishes including samples of hardware and accessories involving color selection.

D. Samples for Verification: For aluminum windows and components required.

E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for each type, class, grade, and size of aluminum window. Test results based on use of downsized test units will not be accepted.

1.6 Quality Assurance

A. Installer Qualifications: An installer which has had successful experiences with installation of the same or similar units required for this project and other projects of similar size and scope.

B. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by inclusion of test reports, and calculations.

C. Source Limitations: Obtain aluminum windows through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of aluminum windows and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements." Do not modify size and dimensional requirements.
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup for type(s) of window(s) indicated, in location(s) shown on Drawings.

F. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 Project Conditions

A. Field Measurements: Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 Warranty

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty.
   1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by manufacturer.

B. Insulating Glass: Warranted to be free from defects (excluding breakage) for a period of five (5) years.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Basis-of-Design Product:
   1. Kawneer Company Inc.
   2. Series 8400TL Thermal Windows
   3. Model 8410TL Fixed Window
   4. 4" (101.6 mm) frame depth
   5. AW-PG100FW

.Substitutions: Refer to Substitutions Section for procedures and submission requirements.
   6. Pre-Contract (Bidding Period) Substitutions: Submit written requests ten (10) days prior to bid date.
   7. Post-Contract (Construction Period) Substitutions: Submit written request in order to avoid window installation and construction delays.
   8. Product Literature and Drawings: Submit product literature and drawings modified to suit specific project requirements and job conditions.
   9. Certificates: Submit certificate(s) certifying substitute manufacturer (1) attesting to adherence to specification requirements for window system performance criteria, and (2) has been engaged in the design, manufacturer and fabrication of aluminum windows for a period of not less than ten (10) years. (Company Name)
   10. Test Reports: Submit test reports verifying compliance with each test requirement required by the project.
   11. Samples: Provide samples of typical product sections and finish samples in manufacturer's standard sizes.

B. Substitution Acceptance: Acceptance will be in written form, either as an addendum or modification, and documented by a formal change order signed by the Owner and Contractor.

2.2 Materials

A. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070" (1.78 mm) wall thickness at any location for the main frame and sash members.

B. Thermal Barrier:
   1. Thermal Barrier: The thermal barrier shall be Kawneer IsoLock™ with a nominal 3/8" (6.5 mm) separation consisting of a two-part, chemically curing high density polyurethane which is mechanically and adhesively bonded to the aluminum.

C. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.

D. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

E. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

F. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

2.3 Window System

A. Series 8400TL Thermal Windows - Fixed Window.

2.4 Glazing

A. Glass and Glazing Materials: Refer to Division 08 Section “Glazing” for glass units and glazing requirements applicable to glazed aluminum window units.

B. Glazing System: Glazing method shall be a wet/dry type in accordance with manufacturer’s standards. Exterior glazing shall be silicone back bedding sealant. Interior glazing shall be snap-in type glazing beads with an interior gasket in accordance with AAMA 702 or ASTM C864.

2.5 Hardware

A. General: None required.

2.6 Accessories

A. General: None required.

2.7 Fabrication

A. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fit joints; make joints flush, hairline and weatherproof.
3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

B. Window Frame Joinery: Mitered and mechanically clipped and/or staked, factory sealed frame and vent corner joints.

C. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

D. Fabricate aluminum windows that are re-glazable without dismantling sash or framing.

E. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

F. Sub frames: Provide sub frames with anchors for window units as shown, of profile and dimensions indicated but not less than 0.093-inch (2.4-mm) thick extruded aluminum. Miter or cope corners, and join with concealed mechanical joint fasteners. Finish to match window units. Provide sub frames capable of withstanding design loads of window units.

G. Factory-Glazed Fabrication: Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section “Glazing” and with AAMA/WDMA/CSA 101/I.S.2/A440-08 (NAFS).

H. Glazing Stops: Provide snap-on glazing stops coordinated with Division 08 Section “Glazing” and glazing system indicated. Provide glazing stops to match frame.

2.8 Aluminum Finishes

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Factory Finishing:

1. Kawneer Permanodic™ AA-M10C21A31, AAMA 611, Architectural Class II Clear Anodic Coating (Color #17 Clear) (Standard).

PART 3 - EXECUTION

3.1 Examination

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, levelness of sill plate and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weather tight window installation.
   1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
   2. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches (76.2 mm) of opening.
   3. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.

B. Install aluminum framed window system level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weather tight construction.

D. Install aluminum framed window system and components to drain condensation, water penetrating joints, and moisture migrating within system to the exterior.

E. Separate aluminum from dissimilar materials to prevent corrosion or electrolytic action at points of contact.

3.3 Field Quality Control

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
   1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows shall take place as follows:
   1. Testing Methodology: Testing Standard shall be per AAMA 502 including reference to ASTM E 783 for Air Infiltration Test and ASTM E 1105 for Water Penetration Test.
      a. Air Infiltration Test: Conduct test in accordance with ASTM E 783 at a minimum uniform static test pressure of 1.57 psf (75 Pa) for CW or 6.24 psf (300 Pa) for AW. The maximum allowable rates of air leakage for field testing shall not exceed 1.5 times the project specifications.
      b. Water Infiltration Test: Water penetration resistance tests shall be conducted in accordance with ASTM E 1105 at a static test pressure equal to 2/3 the specified water test pressure.
   2. Testing Extent: Architect shall select window units to be tested as soon as a representative portion of the project has been installed, glazed, perimeter caulked and cured. Conduct tests for air infiltration and water penetration with manufacturer's representative present.
   3. Test Reports: Shall be prepared according to AAMA 502.

3.4 Adjusting, Cleaning, And Protection

A. Adjust operating sashes, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weather tight closure. Lubricate hardware and moving parts.

B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

C. Clean glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.

D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

E. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

DISCLAIMER STATEMENT

This guide specification is intended to be used by a qualified construction specifier. The guide specification is not intended to be verbatim as a project specification without appropriate modifications for the specific use intended. The guide specification must be used and coordinated with the procedures of each design firm, and the particular requirements of a specific construction project.

END OF SECTION 085113

MISCELLANEOUS SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Fire Extinguishers

1.3 QUALITY ASSURANCE

A. Inserts and Anchorages:

1. Furnish inserts, reinforcing members and anchoring devices appropriate for the on the metal stud and GWB partitions.

1.4 SUBMITTALS

A. Catalogue sheets that include manufacturer's specifications and installation instructions.

1.5 PRODUCT HANDLING

A. Adequately protect finished products from damage during shipping and storage at the project site. Protect installed products until acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fire Extinguishers shall be provided by the Owner’s vendor with quantity as indicated on plans and as required by code. The Contractor shall coordinate with the Owner and their required mounting and installation requirements. The Contractor shall paint the F.E. marking as specified in Section 9.

B. The extinguishers shall be Red Line A-10-E, ABC dry chemical, 10 lb.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which fire extinguishers are to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install all equipment according to manufacturer's recommendations. Coordinate installation with Owners requirements.

END OF SECTION

SECTION 033510
SPECIAL CONCRETE FLOOR FINISHES:
DRY POLISHED CONCRETE SURFACES

1.1 SUMMARY

A. Section Includes: All equipment labor, tools and training for the contracted work.
B. Base Bid:
   1. Polished Concrete – Floorcare USA/L&M-FGS PermaShine Dry Concrete Polishing System at designated areas or equal
   2. Five resin-bound, sequential diamond grit passes, last grit level to be determined by owner. Additional passes may be required if floor does not meet floor finish criteria.
   3. Two coat application of penetrating sealer/hardener/densifier FGS Hardener Plus or equal
C. Related Sections: 03 30 00 Cast-in-place concrete
   1. Minimum concrete compressive strength of 23MPa (3500 psi)
   2. Normal weight concrete and no lightweight aggregate
   3. Non-air entrained
   4. Natural concrete slump of 114.3 to 127-mm (4.5 to 5 in.) admixtures may be used.
   5. Flatness requirements: ASTM International E115; minimum (laser screed installed is preferred to achieve best results)
      a. Overall FF50 or higher
      b. Local FF35 or higher
      c. Overall FL not required
      d. Local FL not required
   6. Tight hard troweled (three passes) concrete. No burn marks. Reference American Concrete Institute (ACI) 302.1 R, Guide for Concrete Floor and Slab Construction, class 5 or class 6 floor.
   7. Curing options
      a. ASTM International C 309, Standard Specification for liquid membrane-forming compounds for curing concrete. Preferred curing compound: L&M Cure
      b. No acrylic curing and sealing compounds
      c. ASTM C 171, Standard Specification for sheet materials for curing concrete.
      d. Damp curing, seven-day cure; with concrete being properly cured at optimum temperatures and atmospheric conditions if in a controlled environment (high water to cement mix ratio design MUST BE AVOIDED)
   8. Confirmation of minimum concrete specifications being met
      a. GC or Concrete Contractor must provide concrete polisher written confirmation from independent, 3rd party test firm that the slab meets minimum stated guidelines and quality

standards prior to implementing polishing process.

1. Section 07 92 16 Semi-Rigid Joint Sealants

D. Allowances: Refer to Section 01 21 00 for allowances involving the work in this section.

1.2 REFERENCES

A. Valid and current certificate of training for FGS PermaShine installer
B. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute
C. ACI 301 – Specifications for Structural Concrete for Buildings; American Concrete Institute
D. ACI 302.1R – Guide for Concrete Floor and Slab Construction; American Concrete Institute
E. ASTM C 779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces, procedure A.
F. ASTM E 1155 - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers; 1996
G. NFSI Test Method 101-A - National Floor Safety Institute Standard for evaluating high traction flooring materials, coatings and finishes. www.nfsi.org.

1.3 SUBMITTALS

A. General: Submit in accordance with Section 01 33 00
B. Product Data:
    1. Submit manufacturer's descriptive literature and product technical data sheet, product specifications and Material Safety Data Sheets (MSDS) for each product.
    2. Submit a letter of certification from the National Floor Safety Institute confirming the system has been tested and passed phase two level of certification when tested by method 101-A.
    3. Preparation and concrete grinding procedures.
    4. Confirm two applications of the FGS Hardener Plus liquid.
    5. Joint filing, crack repair and/or surface repair products and protocols.
    6. Maintenance Data: provide data on maintenance renewal of applied treatments.
    7. Colored Concrete, Dye selection guides.
    8. Current Certified FGS PermaShine Installer documentation.

C. Shop Drawings:
    1. Indicate typical layout including dimensions and floor grinding schedule.
    2. Plan view of the floor and joints clearly marked for the work and

the sealer.

3. Indicate areas to receive colored surface treatment.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualification: Company specializing in products and procedures specified in this Section with three years experience.

B. Installer Qualifications: Acceptable to Manufacturer with documented current FGS certificate and performance on projects of a similar nature.

C. Mock up
   a. Construct mock-up area under conditions similar to those which will exist during actual placement, at least 100 square feet, with curing methods and treatments applied.
   b. Locate where directed.
   c. Mock-up may remain as part of the Work if satisfactory and protected from damage.

D. Protection: The Concrete floor finish is the final finish. General Contractor responsible for, but not limited to:
   a. Protect from all petroleum stains during construction
   b. Diaper all hydraulic powered equipment.
   c. Do not park vehicles on inside slab.
   d. No pipe cutting machines will be used on inside floor slab.
   e. Do not place reinforcing steel on interior slab, to avoid rust stains.
   f. Do not use acids or acidic detergents on slab.
   g. Inform all trades that the slab is to be protected at all times.
   h. Mechanically scrub floor with approved cleaner, FGS Conditioner, once a day for 7 days immediately prior to final acceptance per floor system manufacturer.

1.5 PRE-INSTALLATION MEETING

A. General contractor will convene all parties and conduct pre-installation meeting in accordance with Section 01 31 00.

B. Convene pre-installation meeting a minimum of seven days prior to placement of concrete for work of this section. Assure purchase of specified materials for fielding sample work or mock- ups.

C. Review Pre-installation Check list.

1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with requirements of Section 01 65 00 and Section 01 66 00.

B. Protect packaging and product and from damage, loss and freezing.

C. General Contractor shall assure proper materials and amounts have been procured and applied to the project. Written confirmation shall be submitted prior to issuance of warranty.

1.7 WARRANTY

A. Comply with provisions of Section 01 78 00.
B. Warrant installed units to be free from defects in material and workmanship for one year.
C. Include coverage for the use of FGS Conditioner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Floorcare USA and L&M Construction Chemicals, Inc. 14851 Calhoun Road, Omaha, NE 68152 Toll Free (800) 362-3331, 402-453-6600, www.lmcc.com, www.fgs-permashine.com

2.2 MANUFACTURERS AND PRODUCTS

A. Acceptable Products and Manufacturers:

1. FGS Hardener Plus, liquid type, hardener, sealer, and densifier by L&M Construction Chemicals, Inc. Omaha, NE
2. Joint Tite 750, plural component, polyurea polymer, semi-rigid joint filler by L&M Construction Chemicals, Inc. Omaha, NE
3. Petrotex, Oil repellent sealer by L&M Construction Chemicals, Inc. Omaha, NE
4. Vivid Concrete Dyes, by L&M Construction Chemicals, Inc. Omaha, Nebraska.
5. FGS Concrete Conditioner, liquid type, by L&M Construction Chemicals, Inc., Omaha, Nebraska.

or Equal

2.3 EQUIPMENT

A. Only as approved by the L&M/FGS system manufacturer.
B. Includes: Elliptical and/or planetary grinding and polishing equipment
C. High Performance, Pulse vacuum units, with heppa filters.
D. Mechanical plural component pumps for joint and crack filler material.

2.4 FINISHES

The degree of polish and finish level, as well as the number of passes to be determined by condition of the floor and by the Approved Applicator and the owner's representative on field mock up.
Levels of possible finish to be Medium Gloss – 1500 grit finish

A. Two applications of FGS Hardener Plus liquid or equal as applied by certified installers after final polish step is completed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions and proceed with work in accordance with Section 01 71 00
B. Verify that concrete surfaces are acceptable to receive the work of this section.Concrete shall have been cured a minimum of 28 days, or shall attain a minimum of 3,500 psi prior to beginning any part of the L&M/FGS system. Exceptions must be confirmed in writing by L&M /FGS System manufacturer.

3.2 PREPARATION
A. Examine the surface to determine soundness of the concrete for polishing
B. Remove all surface contamination to permit effective polishing

3.3 FLOOR FINISHING
A. Finish concrete floor surfaces in accordance with ACI 302.1R. Paragraph 8.3.11. Class 5 and class 6 floors.
B. Concrete surfaces that are scheduled to be polished require a hard steel-trowel finish (three passes) during placement.

3.4 FLOOR SURFACE TREATMENT

A. Install FGS Hardener Plus or equal in accordance with manufacturer's printed instructions.
B. Install with dry polishing and airborne concrete dust-free conditions.

3.5 FIELD QUALITY CONTROL
A. General: Comply with requirements of Section 01 45 00
B. Inspection by manufacturer's representative for proper installation

3.6 ADJUSTMENTS:
The following may incur additional charges over and above the contract amount.
A. Polishing to higher gloss as the work requires
B. Filling of joints to ensure smooth traffic passage over joints

3.7 CLEANING
A. Prior to final acceptance, the FGS Treated floor shall be mechanically

scrubbed for seven days with soft to medium pads (white or red pads) with approved cleaning solution.

B. Cleaning solution is FGS Concrete Conditioner liquid by L&M Construction Chemicals, Inc. Omaha, NE.

END OF SECTION