S P E C I F I C A T I O N S

BID # 20-0034

JULY 3, 2020

Sedgwick County... working for you

WAITING ROOM

Adult Residential Facility

Sedgwick County Corrections

Sedgwick County, Kansas

HANNEY & ASSOCIATES ARCHITECTS

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ARCHITECTURAL

MECHANICAL

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ELECTRICAL

DIVISION 26 - ELECTRICAL

SECTION 03300

CONCRETE

1. GENERAL

1.1 All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required, especially to refer thereto.

1.2 Where not modified or exceeded by these specifications, or by the drawings, the "Specifications for Structural Concrete for Buildings" ACI 301-16, current edition shall be the specification for all concrete construction for this project, as if hereto attached or herein repeated. ACI and CRSI standards and recommendations included in ACI 301-16 shall likewise become minimum construction standards for this specification.

1.3 Contractor shall consult this document and its reference documents and become thoroughly familiar with their contents. He shall further procure the following documents and keep at least one copy of each on the work and available to the Architect during all concrete operations:

1.3.1	ACI 301-16	Specifications for Structural Concrete
1.3.2	C31-69-80	Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field.
1.3.3	C94-81	Specifications for Ready-Mixed Concrete
1.3.4	C143-78	Method of Test for Slump of Portland Cement Concrete
1.3.5	C173-78	Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method
1.3.6	ACI 318-14	Building Code Requirements for Reinforced Concrete
1.3.7	ACI 347-78-84	Recommended Practice for Concrete Form Work
1.3.8	ACI 306R-16	Recommended Practice for Cold Weather Concreting
1.3.9	ACI 305R-10	Recommended Practice for Hot Weather Concreting
1.3.10	ACI 304R-00	Recommended Practice for Measuring, Mixing and Placing Concrete
1.3.11	CRSI 78	Recommended Practice for Placing Reinforcing Bars

1.4 ALL POURED-IN-PLACE CONCRETE including but not limited to footings, grade beams, floor slabs, toppings, stairs, sidewalks, retaining walls, curbs, light pole bases, concrete parking surfaces and drives.
A. Sealed Concrete Finishing specific to floor slab, note 15 of this specification section.

1.5 All exterior concrete including parking surface and sidewalks shall be poured with a max. slump of 3" and compaction for base under concrete shall be in accordance with the specifications; compaction shall be certified by the Testing Laboratory.

1.6 This section specifies cast-in-place concrete, including formwork, reinforcement concrete, materials, mix design, placement procedures and finishes.

2. SUBMITTALS

2.1 PRODUCT DATA
For each type of manufactured material and product indicated.

2.2 DESIGN MIXES
For each concrete mic, include alternate mix design when characteristics of material, project conditions, assembly, and support of formwork. Design and engineering of formwork are Contractors responsibility.

2.3 FORMWORK SHOP DRAWINGS
Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. Design and engineering of formwork are Contractor's responsibility.

2.4 MATERIAL TEST REPORTS
From a qualified testing agency indicating and interrupting test results for compliance indicated, based on comprehensive testing of current materials.

2.5 MATERIAL CERTIFICATES
Signed by manufacture's certifying that each of the following items complies with requirements:
- 2.5.1 Cementitious materials and aggregates
- 2.5.2 Form materials and form-release agents
- 2.5.3 Steel reinforcement and reinforcement accessories
- 2.5.4 Fiber reinforcement
- 2.5.5 Ad mixtures
- 2.5.6 Waterstops
- 2.5.7 Curing materials
- 2.5.8 Bonding agents
- 2.5.9 Adhesives.
- 2.5.10 Epoxy filler strips
- 2.5.11 Repair materials

3. QUALITY ASSURANCE

3.1.1 INSTALLER QUALIFICATIONS
An experienced installer who has completed concrete Work similar in material, design and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

3.1.2 MANUFACTURER'S QUALIFICATIONS
A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

4. WORK INCLUDED

4.1 This section of the specifications shall include the furnishing of all labor and materials as required in connection with the completion of the following items of concrete – plain and reinforced concrete, or items of a cement nature throughout the building including the following:

- 4.1.1 Furnish and set all lumber and plywood as required concerning the forming of the concrete work.

- 4.1.2 Place all bar, steel mesh, rebar, and like reinforcement for all reinforced concrete work.

4.1.3 All concrete as specified herein.

4.1.4 Footings, foundations and floors.

4.1.5 Cement floor finish and sealer as required.

4.1.6 The setting in the concrete of all inserts, hangers, anchors, anchor bolts, ties, rods, etc., as required by the drawings or later sections of these specifications.

4.1.7 All labor and materials of a plain or reinforced concrete nature required by the drawings or later sections of these specifications or for the correct and substantial installation of the work included herein.

4.1.8 Sidewalks, slabs and curbs, as indicated.

4.1.9 All joints materials, curing materials and installation of vapor barriers.

A. Expansion joints and tooled joints as required.

B. Special concrete foundations for mechanical equipment and electrical work as required by the drawings.

C. Shop drawings, inspections and tests.

D. The Asphalt contractor shall be clarified to include finish grading of the paved area stabilization with fly-ash worked into the top 6" of soil, asphalt paving, and all stripping and signage associated with the paved areas. It shall also be clarified that the Earthwork contractor in the general contract shall be responsible for grading of the asphalt paving areas to within ± 1/10 of the finish grading. The General contractor shall be responsible for all sidewalks and curbs as shown on the drawings. The general contractor shall also be responsible for all bollards.

E. Poured in place risers for steam room and stair pans.

5. MATERIALS INSTALLED IN THIS DIVISION AND/OR FURNISHED BY OTHERS

This Contractor shall build into concrete work the following materials, which are furnished by other trades and shall embed and secure same as required.

A. Concrete inserts, hangers, anchors, sleeves for all piping and ductwork as required for all trades.

B. Anchor bolts, plates, dovetail anchor slots, reglets, etc.

C. Loose lintels bearing on concrete work.

D. Door and window frames, bucks, anchors, occurring in concrete work.

6. COOPERATION WITH OTHER CONTRACTORS

This Contractor shall cooperate with all other contractors engaged in work in the building to the end that proper unity of action will facilitate the orderly progress of the work. Shop drawings or other data that may be provided by or for this Contractor for use in the installation of his work shall be given to those contractors who required the information contained therein.

7. MATERIALS

7.1 PORTLAND CEMENT

Portland Cement shall conform to the "Standard Specifications for Portland Cement" (ASTM Serial Designation C150) and shall be Type 1, 1a or 111. High early strength concrete may be used only upon approval of the Architect.

7.2 AGGREGATE

Aggregate shall conform to ASTM Serial Specification C33-90 or 57.

7.2.1 Fine Aggregate:

A. Fine aggregate shall consist of sand having clean, hard, durable uncoated grains, free from deleterious substances and shall range in size from fine to coarse within the following percentages by weight:

Passing No. ..... 4 sleeve..... 95-100 Percent
Passing No. ..... 8 sleeve..... 80-100 Percent
Passing No. ..... 16 sleeve..... 50-85 Percent
Passing No. ..... 30 sleeve..... 25-60 Percent
Passing No. ..... 50 sleeve..... 10-30 Percent
Passing No. ..... 100 sleeve..... 2-10 Percent

B. Volume removed by sedimentation.... not more than 3 percent. Not more than 35 percent shall pass a standard size sieve and be retained on the next smaller sieve.

7.2.2 Coarse Aggregate

A. Coarse aggregate shall consist of crushed stone, gravel or other approved inert materials with similar characteristics or combination thereof, having clean, hard, durable, uncoated particles, free from deleterious matter, meeting graduation requirements of ASTM C33, No. 67. After acceptance of a grading, a variation in the amount passing any sieve size of more than 10 percent of the total will not be permitted. The grading shall be within the following percentages by weight:

Passing a 1" sieve..... 100 Percent
Passing a 3/4" sieve ..... 90-100 Percent
Passing a No. 4 sieve ..... 0-10 Percent
Passing a No. 8 sieve ..... 0-5 Percent

B. The maximum sized aggregate shall be not larger than one-fifth (1/5) of the narrowest dimension between form of the member for which the concrete is to be used nor larger than three-fourths (3/4) of the minimum clear spacing between reinforcing bars, and forms as shown on the drawings.

7.2.3 Soundness The fine and coarse aggregate when subjected to five alternations of the sodium sulfate soundness test (ASTM Designation C88-46T) shall not show an average weighted loss of more than 10 percent for the fine aggregate and 13 percent for the coarse aggregate unless evidence satisfactory to the Architect is furnished that concrete of comparable proportions in which similar materials from the same sources were used has been exposed to natural weathering for a period of at least 5 years without appreciable disintegration.

7.3 MIXING WATER
Mixing water shall be clean and free from oil, acid and injurious amounts of vegetable matter, organic materials, alkalis, salts, or other substances that may be deleterious to concrete or steel.

7.4 EXPANSION JOINT FILLER
Expansion joint filler shall be premoulded and composed of fiber board impregnated with asphalt similar and equal to "Flexcell" as manufactured by the Celotex Company. All joint filler material shall be the thickness of the slab or joint and unless otherwise indicated shall be one-half (1/2) inch thick.

7.5 METAL REINFORCEMENT

7.5.1 Metal reinforcement shall conform to the requirements of the "Standard Specifications for Billet-Steel Bars Concrete Reinforcement." (Serial Designation ASTM A-615-82 of the American Society for Testing Materials.)

7.5.2 Welded wire fabric for concrete reinforcement shall conform to the requirements of the "Standard Specifications for welded steel wire fabric for concrete reinforced" shall conform to ASTM A185-79.

7.6 REINFORCING BAR SUPPORTS
All reinforcing shall be properly and adequately supported at the design heights indicated on the Structural Plans by the use of chair supports. Chair supports with galvanized legs shall be equal to bar supports manufactured by the Dayton Sure Grip & Shore Co., Miamiburgh, Ohio.

7.7 DAMP PROOFING See Division 7, Section 07000.

7.8 EDGE INSULATION See Division 7, Section 07200.

8. EXTREME WEATHER CONDITIONS

8.1 Concrete when deposited in hot weather shall be in strict accordance with ACI 305R-10 "Recommended Practice for Hot Weather Concrete."

8.2 Concrete when deposited in cold weather shall be handled in strict accordance with ACI 306R-16 "Recommended Practice for Cold Weather Concreting."

9. FORMS

9.1 GENERAL
The foundation is designed for a combination of trench and formed footings or walls.

9.1.1 Forms shall conform to shape, lines and dimensions of the members as shown on the Plans. They shall be properly spaced or tied together to maintain position and shape and ensure safety to workmen and passerby. Forms shall be made tight to prevent leakage of mortar.

9.1.2 Formwork for concrete shall be designed and constructed in strict accordance with ACI 347 "Recommended Practice for Concrete Formwork".

9.1.3 If adequate foundations for shores cannot be secured, trussed supports of adequate design shall be provided.

9.2 EXPOSED CONCRETE

9.2.1 Unlined forms shall be used for the face of all exposed concrete walls and all other exposed surfaces where indicated on the Drawings. All forms shall be built in place except that panel forms may be used where a single panel will form an entire area from one reveal to another. The use of panel forms will not be permitted where the joints between adjacent panels must be made on flat surfaces or in any other conspicuous locations.

9.2.2 The contact surface of all unlined forms shall be constructed of 5/8" or 3/4" five-ply Douglas Fir structural plywood of concrete form grade according to Bureau of Standards Commercial Standards CS45-42. All concrete form plywood shall be so designed by grade marking each panel. Full-sized sheets of plywood must be used except where smaller pieces will cover an entire area. The edges of all plywood sheets shall be straightened on the bench to insure close-fitting, tight joints.

9.2.3 When the outside form is erected and reinforcement is in place and before the inside form is erected, the Architect shall be notified and the inside form shall not be placed until work already done is approved. Open joints, which would permit leakage of grout, shall be sufficient cause for rejection of forms.

9.2.4 If, in the opinion of the Architect, pointing of an occasional slightly open joint will prevent leakage, then such pointing shall be done using a material approved by the Architect. Pointing shall be carefully done and there shall be no trace of the pointing mixture on the surfaces of the sheathing.

10. REINFORCEMENT

10.1 Reinforcement shall be detailed, fabricated and placed in strict accordance with SP66-94 "Manual of Standard Practice for Detailing Reinforced Concrete Structures".

10.2 CLEANING

Metal reinforcement before placed shall be thoroughly cleaned of mill and rust scale and of coatings that will destroy or reduce the bond. Reinforcement appreciably reduced in section shall be rejected. Where there is delay in depositing concrete, reinforcement appreciably reduced in section shall be rejected. Where there is delay in depositing concrete, reinforcement shall be reinspected and when necessary, cleaned.

10.3 BENDING AND STRAIGHTENING

10.3.1 Reinforcement shall be carefully formed to the dimensions indicated on the Plans. Cold bends shall be made around a pin having a diameter of six or more times the least dimensions of the reinforcement bars.

10.3.2 Metal reinforcement shall not be bent or straightened in a manner that will injure the material. Bars with kinks or bands not shown on the Plans shall not be used. Heating of reinforcement will be permitted only when the entire operation is approved by the Architect.

10.4 PLACING

10.4.1 Metal reinforcement shall be accurately positioned and secured against displacement by using annealed wire of not less than No. 16 gauge or suitable clips of intersections and shall be supported in a manner that will keep all metal away from the exposed surface of the wall. Structural concrete reinforcement shall be adequately secured in position by concrete or metal chairs and spacers. Nails shall not be driven into the

outside forms to support reinforcement not shall any other device for this purpose come in contact with the outside form except that wood strips shall be inserted between the reinforcement and the forms at intervals to maintain the required clear distance between the reinforcement and the inside and outside surfaces of the concrete.

10.4.2 The strips shall be pulled up and removed from the wall as the level of the concrete rises. The minimum clear distance between any bar and the weather side of all exterior walls shall not be less than two (2") inches. At all, wall surfaces not exposed to the weather a minimum of one (1") inch of concrete cover over all steel shall be provided.

10.5 CONCRETE PROTECTION FOR REINFORCEMENT

Other metal reinforcement shall be protected by the thickness of concrete indicated on the Plans. Where not otherwise shown, the thickness over the reinforcement shall be as follows:

10.5.1 Where concrete is deposited against ground without the use of forms, not less than three inches (3").

10.5.2 Where concrete is exposed to the weather, or exposed to the ground but is placed in forms, not less than two inches (2") for bars #6 through #18 and one and one half inches (1-1/2") for bars #5 and smaller.

10.5.3 In slabs and walls not exposed to the ground or the weather, not less than 3/4".

10.5.4 In beams, girders and columns not exposed to the ground or to the weather, not less then 1-1/2".

10.5.5 In all cases the thickness of concrete over the reinforcement shall be at least equal to the diameter of round bars and one and one-half times the side dimension of square bars.

10.6 SPLICING

10.6.1 Wherever it is necessary to splice reinforcement otherwise than as shown on the Plans, the character of the splice shall be decided by the Architect on the basis of allowable bond stress and the stress in the reinforcement at the splice. Splicing shall not be made at points of maximum stress nor shall adjacent bars be spliced at the same point.

10.6.2 All bars shall be lapped at least 30 bar diameters or 24" minimum unless otherwise noted at all corners and at abrupt changes in directions of walls.

10.6.3 In slabs, beams and girders, splices of reinforcement at points of maximum stress shall generally be avoided. Splices shall provide sufficient lap to transfer the stress between bars by bond and shear.

11. PROPORTIONING AND STRENGTH REQUIREMENTS

11.1 TRIAL BATCHES

The Contractor shall employ and pay for services of a testing laboratory approved by the Architect, who will be responsible for analysis on design of the concrete in accordance with these specifications.

11.2 MEASURING INGREDIENTS

11.2.1 All measurements of fine and coarse aggregates shall be made separately by weight. Proportioning aggregates for fractional sacks of cement will not be permitted unless the cement is weighed for each batch. Weighing equipment shall be arranged to permit making compensation for changes in the weight of moisture contained in the aggregates. Weighing equipment shall meet the approval of the Architect and shall be accurate within one percent of the net load being weighed.

11.2.2 A satisfactory auxiliary device shall be used in connection with the scale beam to indicate or register at least the last 100 lbs. of each of the aggregates required for the batch.

11.2.3 One gallon of water shall be considered as weighing 8.33 lbs.

11.2.4 Portland Cement in standard unopened cloth or paper sacks as packed by the manufacturer may be considered as weighing 94 lbs. per sack. Batches shall be proportioned that only full bags of cement are required for a single batch.

11.3 STRENGTH REQUIREMENTS

All concrete shall have a minimum compressive strength of 3,000 lbs. per square inch at twenty-eight (28) days. Refer to the Structural Notes on the Drawings for additional strength requirements.

11.4 WATER-CEMENT RATIO

The proportioning of materials shall be based on the requirements for a plastic and workable mix with the use of not less than 5-1/2 sacks of cement per cubic yard and no more water than is necessary to gain desired strength, expressed in terms of the quantity of cement. The water in the aggregate must be included in the quantity specified and subtracted from the amount added to the mixture. It shall be measured by methods satisfactory to the Architect which will give results within one (1) pound for each one hundred (100) pounds of aggregate.

11.5 PROPORTIONING AND CONSISTENCY

11.5.1 The proportions of aggregate to cement shall produce concrete that can be thoroughly compacted.

11.5.2 The combined aggregate shall be of such composition of sizes that when separated by the No. 4 standard sieve, the weight retained on the sieve shall be not less than one-half (1/2) nor more than two-thirds (2/3) of the total based on dry materials, except where adjustment is necessary in the opinion of the Architect for casting in special details. In all cases, the regular mix can be used for casting details, except where detail is intricate it may be necessary to reduce the amount of coarse aggregate.

11.6 QUALITY CONTROL

Determination of Maximum Water Content: The strength quality of the concrete proposed for use shall be established by tests made in advance of the beginning of operations using consistencies suitable for the work meeting the requirements of these specifications. Trial design batches and testing shall be the responsibility of the Contractor. Certified copies of all tests and proportions used therein shall be furnished to the Architect for approval. Specimens shall be made and cured in accordance with ASTM Standard C192-49. A curve representing the relation between the water content and the average 28-day compressive strength shall be established for a range of values including the compressive strength specified herein. The curves shall be established by at least three (3) points, each point representing average values from at least 4 test specimens. The maximum allowable water content for the concrete to be used in the work shall be as determined from this curve and shall correspond to a strength

fifteen (15) percent greater than specified. No substitutions shall be made in the materials used in the work without additional tests in accordance herewith to show that the quality of the concrete is satisfactory.

12. CONCRETE MIXING PLANT

Job mixed concrete will not be allowed. Concrete shall be batched at a central plant and conveyed to the job in mixing trucks. Ready-mix concrete shall conform to ASTM Tentative Specifications C94.

It shall be the responsibility of the Contractor to maintain a proper and uniform air content as determined by test at the jobsite and variations in air content beyond the specified limits for two consecutive tests shall be sufficient cause for rejection of all concrete until evidence of adequate corrective measures has been furnished the Architect.

13. DEPOSITING CONCRETE

13.1 CLEANING EQUIPMENT

Before beginning a run of concrete hardened concrete and foreign materials shall be removed from the inner surfaces of the mixing and conveying equipment. All conveyances, buggies, or barrows shall be kept clean during the placing of the concrete.

13.2 TRANSPORTATION

Concrete shall be handled from the mixer to the place of final deposit in cars, buggies or conveyers. The concrete shall not be spouted nor delivered by spout or trough from the hoists, not dumped into carts with a free fall from the mixer of more than three feet. Every possible precaution shall be kept on temporary runways built over the floor system and runway supports shall not bear upon reinforcement steel or fresh concrete.

13.3 TIME OF PLACING

Concrete shall not be placed until all reinforcement is secured and properly fastened in its correct position, nor until the trenches have been inspected and approved by the Architect, nor until all sleeves, hangers, pipers, conduits, bolts, wires and any other fixtures required to be embedded therein have been placed and anchored by the Contractor not until the trenches and reinforcement have been cleaned. Concrete shall not be placed at any time except under the direct supervision of the Architect nor outside of regular working hours unless the Architect is notified at least 4 hours in advance and the Architect's superintendent or inspector is on the job.

13.4 PREPARATION FOR PLACING

13.4.1 Water shall be removed for excavations before concrete is deposited. Any flow of water shall be diverted through proper side drains and shall be removed without washing over freshly deposited concrete. Hardened concrete, debris and foreign materials shall be removed from interior of forms, unless lines, shall be oiled or except in freezing weather, wet with water in advance of concrete placement to prevent seepage of cement grout from the mix.

13.4.2 Reinforcement shall be secured in position, inspected and approved by the Architect before placing concrete. All concrete placed in violation of this provision shall be rejected and removed. Runways or other means approved by the Architect shall be provided for wheeled equipment to convey concrete to points of deposit. Equipment used to deposit concrete shall not be wheeled over reinforcement not shall runways be supported on reinforcement.

13.5 PLACING

13.5.1 Special care must be exercised to prevent segregation of the concrete and to prevent splashing the trench or reinforcement with concrete and any such splashes or

accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds.

13.5.2 Concrete shall be handled from mixer or transport vehicle to place of final deposit in a continuous manner and as rapidly a practicable until the given unit of operation,

approved by the Architect is completed. Concrete that has attained its initial set or has contained its water content for more than 1-1/2 hours shall not be used in the work. Reinforcement shall not be splashed with concrete in advance of placing operation.

13.5.3 Concrete shall be deposited in the trenches in uniform layers not exceeding 24" in depth and as nearly as practicable in final position to avoid rehandling. Immediately after depositing, concrete shall be compacted by thoroughly agitating in a manner approved by the Architect, to force out air pockets, work the mixture into corners and around reinforcement and inserts, and prevent formation of voids.

14. DEPOSITING AGAINST OTHER CONCRETE

Before depositing new concrete in the walls on or against concrete that has hardened, the forms shall be retightened, the surface of the hardened concrete shall be roughened, as required, thoroughly cleaned of foreign matter and laitance, and moistened with water. The new concrete placed in contact with hardened or partially hardened concrete shall contain an excess of mortar to insure bond. To insure sufficient mortar at the juncture of the hardened and the newly deposited concrete, a layer of Portland Cement-sand mortar one inch to two inches thick shall be deposited against the hardened concrete into which the regular mix concrete shall be deposited immediately. The cement-sand mortar shall be of the same proportions as the regular concrete mix except that the coarse aggregate is omitted.

15. SEALED CONCRETE FLOOR FINISH

15.1 Interior exposed concrete slabs shall be finished as hereinafter described. The dusting of wearing surfaces with dry materials WILL NOT be permitted. In preparation for finishing, floor slabs shall be struck off true to the required level at or below the elevation or grade of the finished floors as shown on the drawings. Floors shall be left with a tolerance (Class "B") of 1/4" in 10 feet except where drains occur or a definite slope is given in which case the floors shall be finished to the lines and grades shown on the drawings or as directed by the Architect.

a. Provide Sealed Concrete floor Finish
   1. Submit Product Data : Submit Manufacturer's data including recommended procedures for mixing materials and application methods.
   2. Smooth trowel floor slab. Smooth troweling provides the final surface textural surface for the Interior exposed concrete floor slab
   3. Apply 1ST COAT of Densifier/Hardener immediately following smooth trowel.

15.2 <u>MONOLITHIC FINISH</u>

Tamping the concrete with special tools to force the coarse aggregate away from the surface shall finish floors shown on the drawings to receive a monolithic finish. Then screeding and floating with straight edges to bring the surface to require finish level shown on the drawings. While the concrete is still green but sufficiently hardened to bear a man's weight without imprinting, it shall be wood floated to a true even plane with not coarse aggregate visible. Sufficient pressure shall be used on the wood floats to bring moisture to the surface. The concrete shall then be hand-trowelled to produce a surface free from trowel marks.

15.3 WOOD OR CORK FLOAT FINISH

Floors indicated on the drawing to receive wood or cork float or broomed finish shall be finished by tamping the concrete with special tools to force aggregate away from the surface, then screeding with straight edges to bring surface to required line as shown on the drawings. While the concrete is still green but hardened sufficiently to bear the cement finisher's weight, the surface shall be floated with a wood or cork float to a true uniform plane with no coarse aggregate visible.

15.4 POWER MOWER MACHINE FINISHING

In lieu of hand finishing, the contractor may use a power machine for finishing concrete floors in accordance with the direction of the machine manufacturer. The preparation of concrete surfaces for finishing by machine shall in general be as herein before required for hand finishing.

15.5 SEALED CONCRETE FINISH

Clear, high-solids, water based, non-yellowing membrane-forming, inorganic curing, sealing and hardner, material for treatment of uncovered concrete floor surfaces, complying with ASTM C1315-Type 1, Class A, and being classified as “low-odor” and with a VOC content of less than 350 g/L. Comply with the testing and product requirements of the California Department of Public Health’s “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers.

Do not apply to concrete surfaces that will receive subsequent cementious toppings, sealers, hardeners, ceramic tile, resilient flooring, wood flooring, carpeting or resinous flooring systems, unless sealer manufacture certifies that their product conforms to requirements required by the floor finish manufacturer and will not adversely affect floor finish application.

Acceptable Manufacturers: Subject to compliance with requirements, products by the following manufacturers are acceptable:

Master Builders / BSAF Corporation, www.master-builders-solutions.baaf.us
ChemMasters, www.chemmasters.net
Euclid Chemical Company, www.euclidchemical.com
Laticrete International, Inc., www.laticrete.com
SpecChem LLC, www.specchemllc.com

Concrete Sealer Installation : Install a minimum of TWO (2) COATS, in accordance with Manufacturer’s recommendations.

16. PROTECTION AND CURING

16.1 PROTECTION AGAINST MOISTURE LOSS

Immediately after placing or finishing concrete surfaces not covered by forms shall be protected from loss of surface moisture for not less than 7 days where a normal Portland cement has been used or 3 days where a high-early strength Portland cement has been used by covering with Kraft paper mats. Kraft paper shall be sealed. Protect concrete from too rapid drying or freezing for 6 days.

16.2 CURING COMPOUND

Membrane curing compound shall comply with ASTM C-309, Type I, Class A and B and AASHTO M-148, Type 1 and/or Type I-D. Curing compound shall be equal to “Conspec Cureseal” as manufactured by Conspec Marketing and Manufacturing Co., Inc., 636 South 66th Terrace, Kansas City, Kansas (800) 348-7351 or the approved equal. Materials shall be

applied to all newly finished concrete floors and walks. **Special Curing requirements shall be necessary in areas which receive resinous flooring. All curing compounds shall be compatible with the concrete finish specified.**

16.3 PATCHING

Any concrete which is not formed as shown on the plans or for any reason is out of alignment or level or shows a defective surface shall be considered as not conforming with the intent of these specifications and shall be removed from the job by the contractor at his expense unless the Architect grants permission to patch the defective area, which shall be done in accordance with the following procedure: Permission to patch any such area shall not be considered a waiver of the Architect's right to required complete removal of the defective work if the patching does not, in his opinion, satisfactorily restore the quality and appearance of the surface.

16.4 CLEANING

16.4.1 No cleaning operations shall be undertaken until the walls of the building are entirely completed. Cleaning portions of the walls as the work progresses will not be permitted. Mix one part Portland cement and 1-1/2 parts fine sand with sufficient water to produce a grout having the consistency of thick paint. White Portland cement shall be used for all or part of the cement in the grout, as directed by the Architect, to give the color directed. Wet the surface of the concrete and apply the grout, float the surface with a cork float, scouring the wall vigorously. While the grout is still plastic, the surface shall be finished with a sponge rubber float, removing all excess grout. This finishing shall be done at the time when grout will not be pulled from holes or depressions.

16.4.2 Next, allow the surface to dry thoroughly, and then rub it vigorously with dry burlap to completely remove any dried grout. There shall be no visible fill or grout remaining after this rubbing. The entire cleaning operation for any areas must be completed the day it is started. No grout shall be left on the wall overnight. After the surfaces to be treated have been grout clean, if any slightly dark spots or streaks remain, they shall be wiped off lightly with a fine abrasive hone without using water, but the rubbing with the hone shall not be sufficient to change the texture of the concrete.

17. GROUT

Furnish U.S. Grout Corporations' pre-mixed, five star, non-shrink, non-metallic grout or Euo N.S. grout for setting column bases and beam bearing. Grout shall be used in strict accordance with the manufacturer's printed instructions.

18. JOINTS IN CONCRETE

18.1 EXPANSION JOINTS

Provide expansion joints where so indicated on the drawings. Expansion joints shall be continuous of width to extend full thickness of the concrete on plans. In no case shall the reinforcement, corner protection angles, or other fixed metal items embedded in or bonded into concrete, be run continuous through an expansion joint.

18.2 Concrete walks and ramps shall have expansion joints across the width of the walk or ramp, spaced where indicated on the drawings, but shall not exceed 30' o.c.

18.3 All concrete slabs on fill that are not made an integral part of the concrete vertical surface they intersect, such as walls, columns, etc., shall be provided with continuous expansion strips at the intersection.

18.4 CONSTRUCTION JOINTS

The unit of operation shall not exceed 80 feet in any horizontal direction unless otherwise approved by the Architect, concrete shall be placed continuously so that the unit will be monolithic in construction. At least 48 hours shall elapse between casting the adjoining units unless this requirement is waived by the Architect. Construction joints, if required, shall be located near the midpoint of spans for slabs, seams, or girders unless a beam intersects a girder at its center in which case the joints in the girder shall be offset a distance equal to twice the width of the beam and provision for shear shall be made by use of inclined reinforcement. Vertical joints in wall footings shall be reduced to a minimum. Except where indicated on drawings, no jointing shall be made in footings or foundation work without specific approval of the Architect. Placement of concrete shall be at such rate that surfaces of concrete not carried to joint levels will not have attained initial set before additional concrete is place thereto.

18.5 CONTROL JOINTS

Shall be as detailed on the drawings and accurately located to comply with design requirements. Extreme care shall be taken to assure that the break point of reinforcing bars designated to be cut or stopped at control joints coincides exactly with the center line of the joint as shown on the Drawings.

19. SIDEWALKS

19.1 Furnish and install a two (2) inch minimum thickness leveling sand fill for all sidewalks and provide continuous joints adjacent to the building. Expansion joints shall be installed the full width of the walks at approximately thirty (30) foot intervals.

19.2 Sidewalks shall be at least four (4) inches thick and graded to an even slope to building entrances. Finish as per detail on the Drawings.

19.3 All sidewalks shall have reinforcing of 6" x 6" mesh of No. 8 wires. All reinforcing shall terminate at expansion joints. All reinforced sidewalks (4" thick) shall be with 6x6, #8/#8, W2.1 x W2.1 W.W.F. and all concrete parking and drives (6" thick) shall be reinforced with 6x6, #4/#4, W4.0 x W4.0 W.W.F..Unless noted otherwise on the Civil or Structural drawings.

19.4 Finish is to be monolithic with cork or wood floats to provide a reasonable non-slip surface and the surface shall be marked off with tooled joints in approximately five (5) foot squares with a finish to be similar to details of the Plans.

20. TEST AND SAMPLES ON CONCRETE

20.1 Test cylinders - Fieldwork shall be done per "Standard Method of Making and Curing Compression and Flexure Test Specimens in the Field" (ASTM Designation: C31) and as follows:

21.1.1 The General Contractor shall include in the Base Bid, all costs with having technician from a certified testing laboratory to be present at the Job Site for each concrete pour (foundations and floor slab), to sample the concrete mix, to prepare the test cylinders, perform filled slump tests, perform air test on the concrete, note temperature of concrete and temperature of the environment.

20.1.2 Extent of sampling: One set of 3 test cylinders shall be made for each 50 cu. yards of concrete placed. Location of concrete represented shall be recorded and shown on test cylinders and reports.

20.1.3 Procedure requirements for ASTM C-31 are as follows:

Place concrete cylinders in 3 equal layers. Rod each layer by 25 strokes for 6" diameter cylinders or 50 strokes for 8" diameter cylinders. Rod shall penetrate each lower layer by only 1/2". Cure and protect cylinders from freezing and/or too rapid drying. Cover each cylinder with plastic. During first 24 hours, store cylinders at location and temperature equal to concrete being tested. After 24 hours, store cylinders under moist conditions and at about 73 degrees F until test breaks are made.

20.2 LABORATORY TESTING OF CYLINDERS

20.2.1 Test cylinders per ASTM C-39 for compressive strength. Test one cylinder at 7 days and one at 28 days, out of each set of specimens. Test third cylinder, when and if requested by the Architect.

20.2.2 Copies of each test report shall be submitted within 5 days of date test was made; One to concrete supplier, two to Contractor and one to the Architect.

20.2.3 Test Laboratory will be employed by the Contractor.

20.2.4 Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural light weight concrete, one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

20.2.5 Concrete Temperature: ASTM C 1064, one test hourly when air temperature is 40° F and below and when 80° F and above and one test for each composite sample.

20.3 SLUMP TESTS

Fieldwork shall be done per ASTM C-143 and as follows:

20.3.1 Extent of sampling: Make slump test from first truckload of each day's pour and at any other time when mix consistency appears to have changed.

20.3.2 Maximum to Minimum slumps permitted:

Foundation:	4" to 1"
Slab on grade:	4" to 2"
Other reinforced concrete:	4" to 1"

20.3.3 Procedure requirements of ASTM C-143 are as follows:
Obtain metal slump cone of 12" height x 8" diameter bottom and 4" diameter top. Place cone on a smooth, level, moist board. Place concrete in cone in 3 equal layers. Rod each layer by 25 strokes. Rod shall penetrate lower layer by 1/2" and uniformly rod that layer. Strike concrete off top of cone after final rodding. Remove cone so as not to disturb concrete. Measure height difference between top of cone and slumped concrete and compare that measurement with permitted limits specified above. Reject concrete, which exceeds these limits.

20.4 Specimens shall be cured under laboratory conditions except that when in the opinion of the Architect or Engineer, there is a possibility of the surrounding air temperature falling below 40 degrees F., he may require additional specimens to be cured under job conditions.

20.5 The standard age of test shall be 28 days, but 7-day tests may be used provided that the relation between the 2 and 28 days strength of the concrete is established by test for the materials and proportions used.

20.6 If the average strength of the laboratory control cylinders for any portion of the structure falls below the compressive strengths called for on the Plans, the Architect shall have the right to order a change in the proportions or the water content for the remaining portion of the

structure. if the average strength of the job cured cylinders falls below the required strength, the Architect shall have the right to require tests in accordance with the "Standard Methods of Securing, Preparing and Flexure Strengths" (ASTM Designation C42) or order load tests to be made on the portions of the building affected.

20.7 When required, the load test shall be at the Contractor's expense, in accordance with Section 202 of the ACI Building Code (ACI 318). In the event the load test indicate that concrete placed does not conform to the drawings and these specifications, measures as prescribed by the Architect shall be taken to correct the deficiency and the cost of all such remedial measures shall be responsibility of the Contractor.

20.8 If the average strength of laboratory cylinders for any portion of the job falls below the minimum allowable strength of 28 days, the Architect reserves the right to order a change in proportions of water or cement content of concrete, or both, for the remaining portions of the job without extra cost to the Owner.

21. DRAWINGS

21.1 The drawings and schedules show the typical arrangement of reinforcement.

21.2 Before proceeding with the work, the Contractor shall submit complete drawings and working details for approval.

21.3 Bar list, bonding diagrams and erection diagrams of the reinforcement steel shall be prepared by a licensed engineer. The Engineer whose name appears of the structural drawings is recommended by the Architect.

22. AIR CONTENT

All concrete subjected to freezing and thawing after curing and or required to be watertight shall be air entrained. Total air content as determined in accordance with ASTM C173 shall be:

22.1 5 plus/minus (1) percent for coarse aggregate size No. 467 (1-1/2" max.)

22.2 6 plus or minus (1) percent for coarse aggregate size No. 57 (1" max.) or No. 67 (3/4" max.)

22.3 All interior slabs to receive a surface hardener or subject to abrasion shall have a maximum total air content of three percent.

23. CONCRETE CURBS AND GUTTERS

23.1 Form curbs and gutters for areas indicated, to profile detailed. Reinforce as indicated.

23.2 3,500 psi air-entrained concrete and deformed intermediate grade billet steel reinforcement bars.

23.3 Place concrete, reinforcement and cure following requirements of Section 03300 - "Concrete" of this Section.

23.4 Expansion joints shall be constructed by placing 1/2" premolded asphalt expansion joint material at intervals not exceeding 30 feet along the length of the combined curb and gutter, at all radius point locations.

23.5 Finish surface by cross-brushing.

23.6 The cross section of the combined curb and gutter shall be as shown on the Plans.

23.7 Contraction joints shall be constructed by sawing the curb and gutter at right angles to the curb line at no more than fifteen foot (15') intervals. The saw cuts shall be at least two and one-half inches (2 1/2") in depth and one-fourth inch (1/4") in width. All joints shall be sawed as soon

as is practical after the concrete has hardened sufficiently to eliminate tearing and raveling. The maximum allowable time between the placing of the curb and gutter and the sawing of joints shall be twelve (12) hours; however, any procedure which results in premature and uncontrolled crackling shall be revised immediately. The joints shall be filled immediately after sawing with joint sealer meeting the requirements for sealing concrete pavement joints. A nozzle designed so that the joint is filled completely from top to bottom shall be used in filling the joints.

23.8 When combined curb and gutter adjoins concrete base or concrete pavement, it shall be tied to such base or pavement using essential joint and tie bars. The tie bars shall be two (2) feet and zero (0) inches long and spaced on two (2) feet and six (6) inch centers.

End of Section 03300

SECTION 04100 (ALTERNATE 1)

MORTARS

1. GENERAL

All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required to refer especially thereto.

2. WORK INCLUDED

This Contractor shall furnish all labor and materials to complete all masonry mortar work as required by the drawings and/or herein specified.

2.1 Match existing mortar, color, and texture. Masonry contractor shall prepare a mock-up for approval before an order is placed. Final selection to be approved by the Architect.

3. USES OF MORTAR

Type "N" Portland -Cement -lime mortar, as herein specified, shall be used for exterior and interior masonry units of all exterior and interior walls. (ASTM C-270 or BIA M1-72.) Type "M" shall be used for masonry below grade and in contact with the Earth.

4. MATERIALS

4.1 CEMENTITIOUS MATERIALS

Shall conform to the appropriate ASTM Standard Specifications, amended to date for the materials as follows:

4.1.1 Masonry cement shall be Lehigh Masonry Cement from their plant at Iola, Kansas, or Ash Grove Masonry Cement from their plant at Chanute, Kansas or Atlas Masonry Cement from their plant at Independence, Kansas.

4.1.2 This masonry cement shall be an inter-ground mixture of Portland Cement Clinker and Limestone and shall meet the requirements of the ASTM Specifications C91-53, type 11. Expansion shall not be greater than 1% when tested in accordance with ASTM Specifications C0154-49, except that the test bars shall remain in molds for 48 hours prior to test.

4.1.3 This Contractor will be allowed the option of using hydrated lime (High Calcium, type S) or quick lime.

4.1.4 Quicklime: Standard Specifications for Quick Lime for Structural purposes. (ASTM C-5-26).

4.1.5 Hydrated Lime: Tentative Specifications for Hydrated Lime for Masonry purposes (ASTM20).

4.2 AGGREGATES

Standard Specifications for Aggregate for Masonry Mortar (ASTM C-144).

4.3 WATER

Water shall be clean and free of deleterious amounts of acids, alkalis or organic materials.

4.4 ADMIXTURES:

Admixtures not mentioned in these specifications shall not be used in mortar without the approval of the Architect.

4.5 ANTI-FREEZE COMPOUNDS
No Anti-Freeze liquid, salts or other substances shall be used in the mortar to lower the freezing point.

4.6 STORAGE OF MATERIALS
Cementitious materials and aggregates shall be stored in such a manner as to prevent deterioration and intrusion of foreign matter. Any material having become unsuitable for good construction shall not be used.

5. MEASURING AND MIXING

5.1 MEASUREMENT OF MIXING MATERIAL
Method of measuring materials for the mortar shall be such that the specified proportions of the mortar materials can be controlled and accurately maintained during the entire progress of the work. Mortar mixer sized to accommodate full bags of Portland cement and lime. Mixing mortar shall be in compete accord with BIA technical notes 8B.

5.2 MIXING MORTAR
Cementitious materials and aggregate shall be mixed with the maximum amount of water consistent with satisfactory workability for a minimum period of 3 minutes in a drum type batch mixer.

5.3 MIXING GROUT
Grout shall consist of mortar meeting the applicable specification requirements to which sufficient additional water is added to cause the mixture to flow readily.

5.4 MINIMUM AGGREGATE RATIO
The damp loose volume of aggregate in mortar shall be not less than 2-1/4 time nor more than 3-1/2 time the total separate volumes of cementitious materials used.

6. MORTAR PROPORTIONS

Type “M” and “N” Mortar mix shall be designed in accordance with ASTM C-270 thru a testing laboratory.

End of Section 04100

SECTION 04200 (ALTERNATE 1)

MASONRY

1. GENERAL

1.1 All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required to refer especially thereto.

1.2 This Contractor will be held responsible for obtaining a waterproof wall with all mortar joints filled with a full joint of mortar. The masonry foreman shall supervise carefully the work continuously; any work not complying with these specifications shall be torn down and replaced with proper workmanship.

2. WORK INCLUDED

This Contractor shall furnish all labor and materials to complete all masonry work as required by the drawings and/or herein specified, as follows:

2.1 All brick work indicated on the drawings.
2.2 All required anchors and ties.
2.3 Beam blocks, lintels, etc.
2.4 Wall flashing.

3. DELIVERY, STORAGE & HANDLING

3.1 Store masonry units on elevated platforms, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, containment's, corrosion, and other causes. If units become wet, do not install until they are in air-dried condition.

3.2 Store cementitious materials on elevated platforms, under cover, and in a dry location.

3.3 Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.

3.4 Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

4. MATERIALS

4.1 MASONRY TIES

4.1.1 Veneer Anchors

a. Masonry wall reinforcement where gypsum wall board back up walls are noted on the plans shall be equal to Dur-O-Wall Masonry veneers anchors, D/A 213 hot dipped galvanized (4 Ga.) reinforced plate with 3/16" ties screwed to studs with 3/16" ties screwed to studs with (2) 300 series stainless screws (DA 995). Lengths as required to meet manufacturer's standards.

b. Wall ties to be spaced at 16" o/c. vertically and 2'-0" o/c. horizontally.

4.1.2 Control and Expansion Joints

As shown on the drawings. Care should be used to keep these joints free and open. Install water stops.

4.2 FACE BRICK:

4.2.1 Brick shall be approved by the Owner and Architect before an order is placed. All brick shall be free of chips and cracks and in accordance with the specifications. Face brick shall conform to the Standard Specifications for Facing Brick (solid masonry units made from clay or shale). ASTM Designation C216-50, ASA No. A99.1-1953.

4.2.2 Row lock brick used for windowsills shall use solid brick at the ends so no holes are visible.

4.2.3 Outside corners of soldier course at wall coping shall be/use a stack bond to turn corners to ensure quality of structure and appearance.

4.2.4 Brick Selection: Brick shall be modular brick, to match existing brick, to be submitted to the Architect and Owner for review, before an order is placed. Final selection to be approved by the Architect.

4.2.5 Brick Color: Red to match existing brick, samples along with mortar colors, to be submitted to the Architect and Owner for review, before an order is placed. Final selection to be approved by the Architect.

5. INSTALLATION AND WORKMANSHIP

5.1 GENERAL

5.1.1 No masonry shall be erected when the ambient temperature is below 32 degrees F. on a rising temperature or below 40 degrees F. on a falling temperature or when there is a probability of such conditions existing within 48 hours, unless special provisions are made for heating the materials and protecting the work. Such provisions shall be approved by the Architect. Masonry work which has frozen before the mortar has set to the satisfaction of the Architect shall be removed and replaced.

5.1.2 Face brick shall be as shown and shall be tied to back-up with wall reinforcement. Thoroughly fill head and bed joints of face brick.

5.1.3 Slush with mortar thoroughly around all windows and doors frames and all other built-in parts. Point with mortar around all windows and window sills, making this perfectly weathertight. Walls shall be built perfectly true, plumb, and straight so as to work in courses to correspond with heights of all openings as indicated on the drawings. Where reinforced concrete floors or slabs extend into walls, brick work shall be built above such floors or slabs only after the concrete work has been poured. Masonry shall not serve as vertical concrete forms. Pour concrete first and then build masonry.

5.1.4 The built surfaces of all walls and piers shall be protected with boards at all times, when work is not in progress and shall also be covered with canvas during stormy or damp weather or cold weather and in case of delay. Also, properly protect with boards, exposed corners and angles of face and other brick work during construction.

5.1.5 Brick shall be laid so that three bricks plus three joints equal (8") vertically and one brick plus one joint equal (8") horizontally. If the latter does not produce head joints approximately 3/8" wide and appear similar, consult with the Architect for possible adjustments.

5.1.6 Build control joints where shown and as detailed. All such joints shall be completely free of mortar.

5.1.7 No brick or other units having a film of water or frost on their surface shall be laid in the walls. All masonry shall be laid plumb, true to line, with level and accurately spaced courses, and reveals, with corners plumb and true, and with each course breaking joint with the course below. Bond shall be kept plumb throughout.

5.1.8 Work required to be built in with the masonry, including anchors, wall plugs, and accessories, shall be built in as the erection progresses. Unless otherwise shown on the drawings or specified the space around built-in items shall be filled solidly with masonry. Chases and reglets shall be kept clean and free from mortar or other debris.

5.1.9 Masonry units shall be culled so that only perfect faces of the units shall be expressed.

5.1.10 Face Brick – outside corners of soldier course at wall coping shall be/use a stack bond to turn corners to ensure quality of structure and appearance.

5.2 CUTTING AND PATCHING
Cutting and patching of masonry required by the plans shall be performed by masonry mechanic.

5.3 UNFINISHED WORK
Unfinished work shall be stepped back for joining with new work; toothing may be resorted to only when specifically approved by the Architect. Before new work is started, all loose mortar shall be removed.

5.4 PROTECTION
Surfaces of masonry not being worked on shall be properly protected, at all times, during the construction operation. At such times as rain or snow is imminent and the work is discontinued, the tops of exposed masonry walls and similar surfaces shall be covered with a strong waterproof membrane well secured in place.

6. WALL HEIGHTS
This Contractor shall build-up masonry walls to the elevations indicated.

7. WETTING BRICK
7.1 Brick with initial rate of absorption (suction) more than 30g/30sq. inches per minute when tested per ASTM C 67 be wetted and permitted to surface dry prior to laying. Reference BIA Technical Notes on brick construction 7B, revised. Allow units to absorb the water so they are damp but not wet at the time of laying.

7.2 Wetting of the brick and the water content of the mortar shall be such to form a perfect bond without shrinkage cracks.

8. MORTAR JOINTS
All mortar joints shall be completely filled, especially the head joints. Special care shall be taken to ensure head joints are filled completely. Cavities and expansion joints shall be kept clean and free of mortar and/or mortar drippings.

9. TOOLING OF MORTAR JOINTS
The tool shall be slightly larger than the masonry joint and shall be of concave profile struck to a weather tight joint.

Exposed joints inside and outside of the building shall be ironed smooth and concave. Tools for striking joints shall be not less than 3/4" in diameter. Use extreme care to not have wide head and bed joints.

If necessary, to avoid wide head joints, brick shall be cut. Any face brick cutting which is required must be done with a power saw.

10. WALL FLASHING, WEEPS and VENTS

10.1 Wall flashing shall be furnished and installed over all openings in exterior masonry walls at base of masonry walls, shelf angles and where shown on the Drawings. Flashing material shall be 26 Ga. galvanized steel, cut to size.

10.2 Flashing over openings shall be in one (1) piece and shall extend eight (8) inches beyond opening on each side. End dams shall be provided for all such conditions.

10.3 Where material must be spliced, the ends shall form a six (6) inch wide lap joint. Seal joints with butyl caulk.

10.4 Flashing shall be laid in mortar and covered with mortar. Through wall flashing above windows and door shall have the leading edge stand proud of the finished face of masonry 1/8".

10.5 WEEP HOLES AND VENTS
Install weep holes and vents at proper intervals (32" O.C. and 2" long, above bed joints, typical) at courses above grade, above flashing, and at any water stops over windows, doors, and beams. Refer to details on sheet A4.3. Please note this project is using the "rain screen principal" which has vents near the cap flashing.

10.6 FLASHING INSPECTION
Prior to covering up any through wall flashings the installation must be approved and noted by the Architect or the Architect's representative. Installations that are covered up prior to approval will be removed.

11. WALL CAP/COPINGS

Wall caps and copings are specified elsewhere in these specifications. Refer to details on sheet A4.3.

12. CLEANING

12.1 When masonry work is complete, proceed with cleaning and caulking. Remove excess mortar and stains using scrapers and brushes.

12.2 After walls have been completed and allowed to dry out a minimum of twenty-eight (28) days, clean exterior and interior brick surfaces with "Sure Klean" cleaning agent, as manufactured by Process Solvent Co., Inc.

12.3 Product to be determined by consulting cleaner manufacturer and the brick manufacturer.

12.4 Before cleaning agent is applied, thoroughly wet wall down with clear water.

12.5 Apply solution over no area greater than twenty (20) square feet, clean with a stiff fiber brush, then hose down with clean water immediately after cleaning, removing all traces of cleaning agent.

12.6 Protect all trim, windows, or concrete against contact with the solution.

13. POINTING

This contractor shall examine all exterior and interior masonry joints carefully, especially head joints, rake out all defective joints to a minimum depth of 3/4" removing all loose mortar, specified under Section 4100 – Mortar, of these specifications. Re-clean areas to remove excess mortar and streaks.

End of Section 04200

SECTION 05990 (ALTERNATE 2)

MISCELLANEOUS METALS & METAL SPECIALTIES

1. GENERAL

All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required to refer especially thereto.

2. WORK INCLUDED

Furnish all labor and materials to complete all miscellaneous metals and metal specialty work shown on the drawings and/or herein specified, as follows:

2.1 Metal Canopy

3. METAL CANOPY

Provide and install one (1) canopy, per plans and elevation, as detailed on sheet A4.1c.
They shall be pre-fabricated by Uni-Structures, Inc. Shop drawings are to be submitted and approved by the Architect prior to final order or installation. The General Contractor shall coordinate ordering (sizes and quantities), purchase and install.

MANUFACTURERS (or Approved Equal):

Manufacturer: Architectural Fabrication, Inc.
2100 E. Richmond Ave.
Fort Worth, TX 76104
1-800-962-8027 Toll Free
(817) 926-7270 Phone
https://arch-fab.com/

Manufacturer: Haas Metal Engineering, Inc.
2828 NW Button Rd.
Topeka, KS 66618
(785) 235-1524 Phone
https://www.hmeinc.net/

Manufacturer: Uni-structures, Inc.
8540 Cobb Center Dr.
Kennesaw, GA 30152
(770) 499-2000 Phone
info@unistructures.com

End of Section 05990

SECTION 07200

INSULATION

1. GENERAL

1.1 All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required to refer especially thereto.

1.2 All work shall be done strictly as recommended by the manufacturer of the insulation materials.

1.3 In order not to lose the insulating value, the installation shall be protected from dampness and condensation by a vapor barrier.

2. WORK INCLUDED

Furnish all labor and materials to complete all insulation work shown on the drawings and/or herein specified, as follows:

2.1.1 Type A – 6" Fiberglass Batt

2.1.2 Type B – 2" Rigid Board, (Foundation Edge)

3. PRODUCTS

3.1 TYPE A – 6" FIBERGLASS BATT

All exterior metal stud walls (as detailed on the plans) shall be insulated with unfaced fiberglass batt insulation (R-21) as manufactured by Owens-Corning, or the approved equal.

Insulation shall be fiberglass blanket or batt insulation meeting ASTM C665-01e1 and ASTM E84-04 or other insulation form as may be recommended and submitted by the system manufacturer and approved by the Architect during submittals. Roof insulation shall be one (1) layer of 6" insulation.

3.1.1 Sealants: Shall be Syseal Tape (double-sided bonding tape) 3/4" wide by 1/32" thick extruded vapor barrier sealant by Thermal Design.

3.1.2 Insulation Hangers: Shall be Fast-R™ insulation hangers for supporting insulation between wall girt or roof purlins in roof pitches over 4:12.

3.2 TYPE B – 2" RIGID BOARD, (Foundation Edge)

Rigid insulation shall be STYROFOAM brand extruded polystyrene foam insulation, manufactured by The Dow Chemical Company, 2020 Willard H. Dow Center, Midland, Michigan 48674, (800) 258-2436 or the approved equal. The material shall be Styrofoam, square edge (SE) type.

54. QUALITY ASSURANCE

4.1 Provide the materials in original manufacturer's packages together with detailed instructions and project drawings of the installation. Materials shall be inspected for damage, proper sizes and quantities upon delivery and stored in a dry, secure manner. Installation shall proceed with care to assure proper sealing.

4.2 Substitutions: No changes or substitutions will be allowed unless submitted at least ten (10) days prior to bid date and in compliance with Simple Saver System standards as set forth in this specification. Substitutions of systems that do not have a continuous vapor barrier on the inside plane of the purlins or girts will not be allowed.

5. EXECUTION

Receive, inventory and store materials in a secure weatherproof environment. Store materials off the floor or ground if there is any risk of water damage from rain, flood, etc.

End of Section 07200

SECTION 07540

FULLY ADHERED TPO ROOFING SYSTEM

PART 1 – GENERAL

1. SCOPE OF WORK

The project includes the provision of a complete fully adhered TPO Roofing System.

1.2 Furnish and install elastomeric sheet roofing system, including:
- 1.2.1 Roofing manufacturer's requirements for the specified warranty
- 1.2.2 Preparation of roofing substrates
- 1.2.3 Treated Wood nailers for roofing attachment
- 1.2.4 High Density Cover boards
- 1.2.5 Elastomeric membrane roofing
- 1.2.6 Metal roof edging and copings, pre-finished metal
- 1.2.7 Flashings
- 1.2.8 Walkway pads
- 1.2.9 Other roofing-related items specified or indicated on the drawings or otherwise necessary to provide a complete weatherproof roofing system

1.3 Disposal of demolition debris and construction waste is the responsibility of Contractor. Perform disposal in manner complying with all applicable federal, state, and local regulations.

1.4 Comply with the published recommendations and instructions of the roofing membrane manufacturer, at http://manual.fsbp.com.

1.5 Commencement of work by the Contractor shall constitute acknowledgement by the Roofing Contractor that this specification can be satisfactorily executed, under the project conditions and with all necessary prerequisites for warranty acceptance by roofing membrane manufacturer. Any modification of the Contract Sum will be made in accordance with the stipulations of the Contract Documents stated elsewhere.

2. REFERENCES

2.1 BASE BID

Referenced Standards: These standards form part of this specification only to the extent they are referenced as specification requirements.

- 2.1.1 ASTM C177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2010.

- 2.1.2 ASTM C209 – Standard Test Methods for Cellulosic Fiber Insulating Board; 2012.

- 2.1.3 ASTM C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.

- 2.1.4 ASTM C1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2013.

2.1.5 ASTM C1549 – Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer; 2009.

2.1.6 ASTM D638 – Standard Test Method for Tensile Properties of Plastics; 2010.

2.1.7 ASTM D1004 – Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting; 2009.

2.1.8 ASTM D1079 – Standard Terminology Relating to Roofing and Waterproofing; 2013.

2.1.9 ASTM D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2010.

2.1.10 ASTM D1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2008.

2.1.11 ASTM D3273 – Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2012.

2.1.12 ASTM D6878/D6878M – Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing; 2011a.

2.1.13 CAN-ULC-S770 – Standard Test Method Determination of L-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams; 2009.

2.1.14 FM DS 1-28 – Wind Design; Factory Mutual System; 2007.

2.1.15 FM DS 1-29 – Roof Deck Securement and Above-Deck Roof Components; Factory Mutual System; 2006.

2.1.16 PS 1 – Structural Plywood; 2009.

2.1.17 PS 20 – American Softwood Lumber Standard; 2010.

2.1.18 SPRI ES-1 – Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems; 2003. (ANSI/SPRI ES-1)

3. SUBMITTALS

3.1 Provide membrane manufacturer's printed data sufficient to show that all components of roofing system, including insulation and fasteners, comply with the specified requirements and with the membrane manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with roofing membrane.

3.2 Where UL or FM requirements are specified, provide documentation that shows that the roofing system to be installed is UL-Classified or FM-approved, as applicable; include data itemizing the components of the classified or approved system.

3.3 INSTALLATION INSTRUCTIONS
Provide manufacturer's instructions to installer, marked up to show exactly how all components will be installed; where instructions allow installation options, clearly indicate which option will be used.

3.3.1 Shop Drawings
Provide:

A. The roof membrane manufacturer's standard details customized for this project for all relevant conditions, including flashings, base tie-ins, roof edges, terminations, expansion joints, penetrations, and drains.

B. For tapered insulation, provide project-specific layout and dimensions for each board.

3.4 PRE-INSTALLATION NOTICE
Copy to show that manufacturer's required Pre-Installation Notice (PIN) has been accepted and approved by the manufacturer.

3.5 SPECIMEN WARRANTY
Submit prior to starting work.

3.6 SAMPLES
Submit samples of each product to be used.

4. QUALITY ASSURANCE

4.1 APPLICATOR QUALIFICATIONS
Roofing installer shall have the following:

4.1.1 At least five years' experience in installing specified system

4.1.2 Capability to provide payment and performance bond to building owner

4.2 PRE-INSTALLATION CERTIFICATE
Before start of roofing work, Contractor shall hold a meeting to discuss the proper installation of materials and requirements to achieve the warranty.

4.2.1 Require attendance with all parties directly influencing the quality of roofing work or affected by the performance of roofing work

4.2.2 Notify the Project Engineer well in advance of meeting

5. DELIVERY, STORAGE AND HANDLING

Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.

5.1 Store materials clear of ground and moisture with weather protective covering

5.2 Keep combustible materials away from ignition sources

6. WARRANTY

6.1 Comply with all warranty procedures required by manufacturer, including notifications, scheduling, and inspections.

6.2 WARRANTY

Firestone 15-year Red Shield Limited Warranty covering membrane, roof insulation, roof related sheet metal and membrane accessories.

6.2.1 Limit of Liability: No dollar limitation.

6.2.2 Scope of Coverage: Repair leaks in the roofing system caused by:

A. Ordinary wear and tear of the elements
B. Manufacturing defect in Firestone brand materials
C. Defective workmanship used to install these materials
D. Damage due to winds up to 72 mph. 2

6.2.3 Not Covered:

A. Damage due to winds in excess of 72 mp.
B. Damage due to hurricanes or tornadoes
C. Hail
D. Intentional damage
E. Unintentional damage due to normal rooftop inspections, maintenance, or service

PART 2 -- PRODUCTS

7. MANUFACTURERS

7.1 BASIS OF DESIGN – ROOFING SYSTEM

Firestone Building Products Co., Carmel, IN, www.firestonebpco.com

7.1.1 Approved Manufacturers:

A. Firestone Building Products
B. Carlisle Syntex, Sure-weld, TPO
C. or Approved equal

7.2 MANUFACTURER OF INSULATION AND COVER BOARDS

Same manufacturer as roof membrane.

7.3 MANUFACTURER OF METAL ROOF EDGING

Same manufacturer as roof membrane.

7.3.1 Metal roof edging products by other manufacturers are not acceptable.

7.3.2 Field- or shop-fabricated metal roof edgings are not acceptable.

7.3.3 Substitution Procedures:

A. See Instructions to Bidders.
B. Submit evidence that the proposed substitution complies with the specified requirements.

8. ROOFING SYSTEM DESCRIPTION

8.1 ROOFING SYSTEM

8.1.1 Membrane: Thermoplastic Polyolefin (TPO) single-ply membrane.

8.1.2 Thickness: .060

8.1.3 Membrane Attachment: Adhered with Bonding Adhesive

8.1.4 Comply with applicable local building code requirements.

8.1.5 Provide assembly having Underwriters Laboratories, Inc. (UL) Class A Fire Hazard Classification.

8.2 COVER BOARD

8.2.1 Gypsum-based board:

A. Acceptable Product: Dens-Deck Prime gypsum-board by Georgia-Pacific.
B. Thickness: ½"-inch (12.7mm).
C. Attachment: Mechanically attached.

8.2.2 Crickets and Saddles: Tapered insulation of same type as specified for top layer; slope as indicated.

9. TPO MEMBRANE MATERIALS

9.1 ROOFING MEMBRANE

Flexible, heat weldable sheet composed of thermoplastic polyolefin polymer and ethylene propylene rubber; complying with ASTM D6878, with polyester weft inserted reinforcement and the following additional characteristics:

9.1.1 Thickness: 0.060 inch (2.03 mm) plus/minus 10 percent, with coating thickness over reinforcement of 0.030 inch (0.76 mm) plus/minus 10 percent.

9.1.2 Puncture Resistance: 415 lbf (1868 N), minimum, when tested in accordance FTM 101C Method 2031.

9.1.3 Solar Reflectance: 0.79 minimum, when tested in accordance with ASTM C1549.

9.1.4 Color: White.

9.1.5 Acceptable Product: 060 TPO by Firestone, or as approved by owner in accordance with section 2.01D

9.2 INSULATION FASTENERS

Type and size as required by roof membrane manufacturer for roofing system and warranty to be provided; use only fasteners furnished by roof membrane manufacturer.

9.3 CURB AND PARAPET FLASHING

Same material as membrane, with encapsulated edge which eliminates need for seam sealing the flashing-to-roof splice; precut to 18 inches (457 mm) wide.

9.4 FORMABLE FLASHING

Non-reinforced, flexible, heat weldable sheet, composed of thermoplastic polyolefin polymer and ethylene propylene rubber.

9.4.1 Thickness: 0.060 inch (1.52 mm) plus/minus 10 percent.

9.4.2 Tensile Strength: 1550 psi (10.7 MPa), minimum, when tested in accordance with ASTM D638 after heat aging.

9.4.3 Elongation at Break: 650 percent, minimum, when tested in accordance with ASTM D638 after heat aging.

9.4.4 Tearing Strength: 12 lbf (53 N), minimum, when tested in accordance with ASTM D1004 after heat aging.

9.4.5 Color: White.

9.4.6 Acceptable Product: UltraPly TPO Flashing by Firestone.

9.5 POURABLE SEALER
Two-part polyurethane, two-color for reliable mixing; Pourable Sealer by Firestone.

9.6 SEAM PLATES
Steel with barbs and Galvalume coating; corrosion-resistance complying with FM 4470.

9.7 TERMINATION BARS
Aluminum bars with integral caulk ledge; 1.3 inches (33 mm) wide by 0.10 inch (2.5 mm) thick; Firestone Termination Bar by Firestone.

9.8 CUT EDGE SEALANT
Synthetic rubber-based, for use where membrane reinforcement is exposed; UltraPly TPO Cut Edge Sealant by Firestone.

9.9 GENERAL PURPOSE SEALANT
EPDM-based, one-part, white general-purpose sealant; UltraPly TPO General Purpose Sealant by Firestone.

9.10 MOLDED FLASHING ACCESSORIES
Unreinforced TPO membrane pre-molded to suit a variety of flashing details, including pipe boots, inside corners, outside corners, etc.; UltraPly TPO Small and Large Pipe Flashing by Firestone.

9.11 ROOF WALKWAY PADS
Non-reinforced TPO walkway pads, 0.130 inch (3 mm) by 30 inches (760 mm) by 40 feet (12.19 m) long with patterned traffic bearing surface; UltraPly TPO Walkway Pads by Firestone.

10. ROOF INSULATION AND COVER BOARDS

10.1 GYPYSUM-BASED COVER BOARD
Non-combustible, water resistant gypsum core with embedded glass mat facers, complying with ASTM C 1177/C 1177M, and with the following additional characteristics:

10.1.1 Size: 48 inches (1220 mm) by 96 inches (2440 mm), nominal.
Exception: Board to be attached using adhesive or asphalt may be no larger than 48 inches (1220 mm) by 48 inches (1220 mm), nominal.

10.1.2 Thickness: ½" -inch, or as indicated elsewhere.

10.1.3 Surface Water Absorption: 2.5 g, maximum, when tested in accordance with ASTM C 473.

10.1.4 Spanning Capability: Recommended by manufacturer for following minimum flute spans:

10.1.5 Surface Burning Characteristics: Flame spread of 0, smoke developed of 0, when tested in accordance with ASTM E 84.

10.1.6 Combustibility: Non-combustible, when tested in accordance with ASTM E 136.

10.1.7 Factory Mutual approved for use with FM 1-60 and 1-90 rated roofing assemblies.

10.1.8 Mold Growth Resistance: Zero growth, when tested in accordance with ASTM D 3273 for minimum of 4 weeks.

10.1.9 Acceptable Product: ½" **Dens-Deck Prime** gypsum-board by Georgia-Pacific.

10.2 INSULATION MATERIALS

Insulation is to be of the type and minimum thickness as listed here.

10.2.1 Polyisocyanurate:

A. Insulation is to be a closed-cell, Polyisocyanurate foam core with factory laminated facers. Foam core is to have a rated flame spread of 25 or less and comprehensive strength of 20 psi (ASTM D-1621). Insulation is to conform to federal specification HH-I-1972/2. Insulation is to be (2) layers of 1-1/2" thick, for a total of 3.0" thick. Install with staggered seams.

B. Approved Products:
1) E'NRG'Y 2 by N.R.G. Barriers
2) Pyrox by Apache Products
3) AC Foam and AC Foam II by Atlas Energy Products
4) UltraGard by Schuller Roofing Systems Division
5) GAFTEMP Isotherm R by GAF Corporation

11. METAL ACCESSORIES

11.1 METAL ROOF EDGING AND FASCIA

Continuous metal edge member serving as termination of roof membrane and retainer for metal fascia; watertight with no exposed fasteners; mounted to roof edge nailer.

11.1.1 Wind Performance

A. Membrane Pull-Off Resistance: 100 lbs/ft (1460 N/m), minimum, when tested in accordance with ANSI/SPRI ES-1 Test Method RE-1, current edition.

B. Fascia Pull-Off Resistance: At least the minimum required when tested in accordance with ANSI/SPRI ES-1 Test Method RE-2, current edition.

C. Provide product listed in current Factory Mutual Research Corporation Approval Guide with at least FM 1-270 rating.

11.1.2 Description: Two-piece fascia with 1/8" extruded anchor bar and 24-gauge steel fascia cover.

11.1.3 Fascia Face Height: 5.5 inches (127 mm).

11.1.4 Edge Member Height Above Nailer: 1-1/4 inches (31 mm).

11.1.5 Length: 144 inches (3650 mm).

11.1.6 Functional Characteristics: Fascia retainer supports while allowing for free thermal cycling of fascia.

11.1.7 Aluminum Bar: Continuous 6063-T6 alloy aluminum extrusion with pre-punched slotted holes; miters welded; injection molded EPDM splices to allow thermal expansion.

11.1.8 Anchor Bar Cleat: 20-gage, 0.036-inch (0.9 mm) G90 coated commercial type galvanized steel with pre-punched holes.

11.1.9 Fasteners: Factory-provided corrosion resistant fasteners, with drivers; no exposed fasteners permitted.

11.1.10 Scuppers: TPO Coated Metal

11.1.11 Accessories: Provide matching brick wall cap, downspout, extenders, and other special fabrications as shown on the drawings.

12. ACCESSORY MATERIALS

12.1 WOOD NAILERS
PS 20-dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.

12.1.1 Width: 3-1/2 inches (90 mm), nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.

12.1.2 Thickness: 1.5"

PART 3 – INSTALLATION

13. GENERAL

13.1 Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for the specified roofing system. Where manufacturer provides no instructions or recommendations, follow good roofing practices and industry standards. Comply with federal, state, and local regulations.

13.2 Obtain all relevant instructions and maintain copies at project site for duration of installation period.

13.3 Do not start work until Pre-installation Notice has been submitted to manufacturer as notification that this project requires a manufacturer's warranty.

13.4 Perform work using competent and properly equipped personnel.

13.5 Temporary closures, which ensure that moisture does not damage any completed section of the new roofing system, are the responsibility of the applicator. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition.

13.6 Install roofing membrane only when surfaces are clean, dry, smooth and free of snow or ice; do not apply roofing membrane during inclement weather or when ambient conditions will not allow proper application; consult manufacturer for recommended procedures during cold weather. Do not work with sealants and adhesives when material temperature is outside the range of 60 to 80 degrees F (15 to 25 degrees C).

13.7 Protect adjacent construction, property, vehicles, and persons from damage related to roofing work; repair or restore damage caused by roofing work.

13.7.1 Protect from spills and overspray from bitumen, adhesives, sealants and coatings.

13.7.2 Particularly protect metal, glass, plastic, and painted surfaces from bitumen, adhesives, and sealants within the range of wind-borne overspray.

13.7.3 Protect finished areas of the roofing system from roofing related work traffic and traffic by other trades.

13.8 Until ready for use, keep materials in their original containers as labeled by the manufacturer.

13.9 Consult membrane manufacturer's instructions, container labels, and Safety Data Sheets (SDS) for specific safety instructions. Keep all adhesives, sealants, primers and cleaning materials away from all sources of ignition.

14. EXAMINATION

14.1 Examine roof deck to determine that it is sufficiently rigid to support installers and their mechanical equipment, and that deflection will not strain or rupture roof components or deform deck.

14.2 Verify that surfaces and site conditions are ready to receive work. Correct defects in the substrate before commencing with roofing work.

14.3 Examine roof substrate to verify that it is properly sloped to drains.

14.4 Verify that the specifications and drawing details are workable and not in conflict with the roofing manufacturer's recommendations and instructions; start of work constitutes acceptable of project conditions and requirements.

15. PREPARATION

15.1 Remove and dispose of the existing roofing ballast, membrane, insulation, flashings and sheet metal.

15.2 Dispose of all materials in compliance local, state and federal requirements.

15.3 Protect the existing building and grounds from construction related damage.

15.4 Examine the existing roof deck to ensure it is structurally sound and appropriate to receive new roofing.

15.5 Take appropriate measures to ensure that fumes from adhesive solvents are not drawn into the building through air intakes.

15.6 Prior to proceeding, prepare roof surface so that it is clean, dry, and smooth, and free of sharp edges, fins, roughened surfaces, lose or foreign materials, oil, grease and other materials that may damage the membrane.

16. INSULATION AND COVER BOARD INSTALLATION

16.1 Install insulation in configuration and with attachment method(s) specified in PART 2, under Roofing System.

16.2 Install insulation in a manner that will not compromise the vapor retarder integrity.

16.3 Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.

16.4 Lay roof insulation in courses parallel to roof edges.

16.5 Neatly and tightly fit insulation to all penetrations, projections, and nailers, with gaps not greater than 1/4 inch (6 mm). Fill gaps greater than 1/4 inch (6 mm) with acceptable insulation. Do not leave the roofing membrane unsupported over a space greater than 1/4 inch (6 mm).

16.6 Mechanical Fastening: Using specified fasteners and insulation plates engage fasteners through insulation into deck to depth and in pattern required by Factory Mutual for FM Class specified in PART 2 and membrane manufacturer, whichever is more stringent.

17. SINGLE-PLY MEMBRANE INSTALLATION

17.1 Beginning at low point of roof, place membrane without stretching over substrate and allow to relax at least 30 minutes before attachment or splicing; in colder weather allow for longer relax time.

17.2 Lay out the membrane pieces so that field and flashing splices are installed to shed water.

17.3 Install membrane without wrinkles and without gaps or fish-mouths in seams; bond and test seams and laps in accordance with membrane manufacturer’s instructions and details.

17.4 Install membrane fully adhered to the substrate using TPO Bonding Adhesive.

18. FLASHING AND ACCESSORIES INSTALLATION

18.1 Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by membrane manufacturer's recommendations and details.

18.2 Metal Accessories: Install metal edgings, gravel stops, and copings in locations indicated on the drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.

18.2.1 Follow roofing manufacturer's instructions.

18.2.2 Remove protective plastic surface film immediately before installation.

18.2.3 Install water block sealant under the membrane anchorage leg.

18.2.4 Flash with manufacturer's recommended flashing sheet unless otherwise indicated.

18.2.5 Where single application of flashing will not completely cover the metal flange, install additional piece of flashing to cover the metal edge.

18.2.6 If the roof edge includes a gravel stop and sealant is not applied between the laps in the metal edging, install an additional piece of self-adhesive flashing membrane over the metal lap to the top of the gravel stop; apply seam edge treatment at the intersections of the two flashing sections.

18.2.7 When the roof slope is greater than 1:12, apply seam edge treatment along the back edge of the flashing.

18.3 SCUPPERS

Set in sealant and secure to structure; flash as recommended by manufacturer.

18.4 FLASHING AT WALLS, CURBS, AND OTHER VERTICAL AND SLOPED SURFACES

Install weathertight flashing at all walls, curbs, parapets, curbs, skylights, and other vertical and sloped surfaces that the roofing membrane abuts to; extend flashing at least 8 inches (200 mm) high above membrane surface.

18.4.1 Use the longest practical flashing pieces.

18.4.2 Evaluate the substrate and overlay and adjust installation procedure in accordance with membrane manufacturer's recommendations.

18.4.3 Complete the splice between flashing and the main roof sheet with specified splice adhesive before adhering flashing to the vertical surface.

18.4.4 Provide termination directly to the vertical substrate as shown on roof drawings.

18.5 FLASHING AT PENETRATIONS

Flash all penetrations passing through the membrane; make flashing seals directly to the penetration.

18.6 PIPES, ROUND SUPPORTS, AND SIMILAR ITEMS

Flash with specified pre-molded pipe flashings wherever practical; otherwise use specified self-curing elastomeric flashing.

18.7 PIPE CLUSTERS AND UNUSUAL SHAPED PENETRATIONS
Provide penetration pocket at least 2 inches (50 mm) deep, with at least 1-inch (25 mm) clearance from penetration, sloped to shed water.

18.8 STRUCTURAL STEEL TUBING
If corner radii are greater than 1/4 inch (6 mm) and longest side of tube does not exceed 12 inches (305 mm), flash as for pipes; otherwise, provide a standard curb with flashing.

19. FINISHING AND WALKWAY INSTALLATION

19.1 Install walkways at access points to the roof, around rooftop equipment that may require maintenance, and where indicated on the drawings.

19.2 WALKWAY PADS
Adhere to the roofing membrane, spacing each pad at minimum of 1.0 inch (25 mm) and maximum of 3.0 inches (75 mm) from each other to allow for drainage.

19.2.1 If installation of walkway pads over field fabricated splices or within 6 inches (150 mm) of a splice edge cannot be avoided, adhere another layer of flashing over the splice and extending beyond the walkway pad a minimum of 6 inches (150 mm) on either side.

19.2.1 Prime the membrane, remove the release paper on the pad, press in place, and walk on pad to ensure proper adhesion.

20. FIELD QUALITY CONTROL

20.1 INSPECTION BY MANUFACTURER
Provide final inspection of the roofing system by a Technical Representative employed by roofing system manufacturer specifically to inspect installation for warranty purposes (i.e. not a salesperson).

20.2 Perform all corrections necessary for issuance of warranty.

21. CLEANING

21.1 Clean all contaminants generated by roofing work from building and surrounding areas, including bitumen, adhesives, sealants, and coatings.

21.2 Repair or replace building components and finished surfaces damaged or defaced due to the work of this section; comply with recommendations of manufacturers of components and surfaces.

21.3 Remove leftover materials, trash, debris, equipment from project site and surrounding areas.

22. PROTECTION

Protect new roofing from foot and construction traffic.

End of Section 07540

SECTION 08110

HOLLOW METAL DOORS AND FRAMES

PART I – GENERAL

1. RELATED DOCUMENTS

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

2. SUMMARY

2.1 SECTION INCLUDES

2.1.1 Standard and custom hollow metal doors and frames

2.1.2 Steel side-light, borrowed lite and transom frames

2.1.3 Louvers installed in hollow metal doors

2.1.4 Light frames and glazing installed in hollow metal doors

2.2 RELATED SECTIONS

2.2.1 Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction

2.2.2 Division 08 Section "Flush Wood Doors"

2.2.3 Division 08 Section "Glazing" for glass view panels in hollow metal doors

2.2.4 Division 08 Section "Door Hardware"

2.2.5 Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames

2.2.6 Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access control system

2.3 CODES AND REFERENCES

Comply with the version year adopted by the Authority Having Jurisdiction

2.3.1 ANSI/SDI A250.8 – Recommended Specifications for Standard Steel Doors and Frames

2.3.2 ANSI/SDI A250.4 – Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing

2.3.3 ANSI/SDI A250.6 – Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames

2.3.4 ANSI/SDI A250.10 – Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames

2.3.5 ANSI/SDI A250.11 – Recommended Erection Instructions for Steel Frames

2.3.6 ASTM A1008 – Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

2.3.7 ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

2.3.8 ASTM A924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

2.3.9 ASTM C 1363 – Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus

2.3.10 ANSI/BHMA A156.115 – Hardware Preparation in Steel Doors and Frames

2.3.11 ANSI/SDI 122 – Installation and Troubleshooting Guide for Standard Steel Doors and Frames

2.3.12 ANSI/NFPA 80 – Standard for Fire Doors and Fire Windows; National Fire Protection Association

2.4.13 ANSI/NFPA 105 – Standard for the Installation of Smoke Door Assemblies

2.4.14 FEMA P-361 2015 – Design and Construction Guidance for Community Safe Rooms

2.4.15 ICC 500 – 2014 ICC/NSSA Standard for the Design and Construction of Storm Shelters

2.4.16 NFPA 252 – Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association

2.4.17 UL 10C – Positive Pressure Fire Tests of Door Assemblies

2.4.18 UL 1784 – Standard for Air Leakage Tests of Door Assemblies

3. SUBMITTALS

3.1 PRODUCT DATA
For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.

3.2 Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.

3.3 SHOP DRAWINGS
Include the following:

3.3.1 Elevations of each door design

3.3.2 Details of doors, including vertical and horizontal edge details and metal thicknesses

3.3.3 Frame details for each frame type, including dimensioned profiles and metal thicknesses

3.3.4 Locations of reinforcement and preparations for hardware

3.3.5 Details of anchorages, joints, field splices, and connections

3.3.6 Details of accessories

3.3.7 Details of moldings, removable stops, and glazing

3.3.8 Details of conduit and preparations for power, signal, and control systems

3.4 SAMPLES FOR VERIFICATION
Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

4. QUALITY ASSURANCE

4.1 SOURCE LIMITATIONS
Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

4.2 QUALITY STANDARD
In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".

4.3 FIRE-RATED DOOR ASSEMBLIES
Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40" above sill) or UL 10C.

4.3.1 Oversize Fire-Rated Door Assemblies Construction:
For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.

4.3.2 Temperature-Rise Limit:
Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

4.3.3 Smoke Control Door Assemblies:
Comply with NFPA 105.

A. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.

4.4 FIRE-RATED, BORROWED-LIGHT FRAME ASSEMBLIES
Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.

4.5 PRE-SUBMITTAL CONFERENCE
Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

5. DELIVERY, STORAGE, AND HANDLING

5.1 Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

5.2 Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

5.3 Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

6. PROJECT CONDITIONS

6.1 FIELD MEASUREMENTS
Verify actual dimensions of openings by field measurements before fabrication.

7. COORDINATION

7.1 Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

8. WARRANTY

8.1 SPECIAL WARRANTY
Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

8.2 Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

9. MANUFACTURERS

9.1 MANUFACTURERS
Subject to compliance with requirements, provide steel doors and frames from an SDI Certified manufacturer:
1. ELCO Manufacturing Inc.
2. CECO Door Products (C)
3. Curries Company (CU)
4. Pioneer Industries (PI)
5. Steelcraft (S)

10. MATERIALS

10.1 COLD-ROLLED STEEL SHEET
ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications

10.2 METALLIC-COATED STEEL SHEET
ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

10.3 FRAME ANCHORS
ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

11. HOLLOW METAL DOORS

11.1 GENERAL

Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.

11.2 EXTERIOR DOORS

Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

11.2.1 Design: Flush panel

11.2.2 Core Construction: Manufacturer's standard polyurethane. Where indicated, provide doors fabricated as thermal-rated assemblies with a minimum R-value of 3.2 or better

11.2.3 Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053-inch - 1.3-mm) thick steel, Model 2

11.2.4 Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.

11.2.5 Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.

11.2.6 Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

11.3 INTERIOR DOORS

Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

11.3.1 Design: Flush panel

11.3.2 Core Construction: Manufacturer's standard kraft-paper honeycomb, or one-piece polystyrene core, securely bonded to both faces.

A. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

11.3.3 Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2

11.3.4 Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.

11.3.5 Hinge Reinforcement: Minimum 7-gauge (3/16") plate 1-1/4" x 9" or minimum 14-gauge continuous channel with pierced holes, drilled and tapped.

11.3.6 Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

11.4 MANUFACTURERS BASIS OF DESIGN

11.4.1 CECO Door Products (C) Honeycomb Core – Regent Series

11.4.2 CECO Door Products (C) Polyurethane Core – Imperial Series

11.4.3 Curries Company (CU) - Polystyrene Core – 707 Series

11.4.4 Curries Company (CU) - Polyurethane Core – 707 Series

12. HOLLOW METAL FRAMES

12.1 GENERAL

Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

12.2 EXTERIOR FRAMES

Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.

12.2.1 Fabricate frames with mitered or coped corners. Profile as indicated on drawings

12.2.2 Frames: Minimum 14 gauge (0.067-inch -1.7-mm) thick steel sheet

12.2.3 Manufacturers Basis of Design:
A. CECO Door Products (C) – SU SR Series
B. Curries Company (CU) – M CM Series

12.3 INTERIOR FRAMES

Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.

13.3.1 Fabricate frames with mitered or coped corners. Profile as indicated on drawings.

13.3.2 Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.

13.3.3 Manufacturers Basis of Design:
A. CECO Door Products (C) – SU Series
B. Curries Company (CU) – M Series

12.4 FIRE RATED FRAMES

Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.

12.5 HARDWARE REINFORCEMEN:

Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

13. FRAME ANCHORS

13.1 JAMB ANCHORS

13.1.1 Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.

13.1.2 Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.

13.1.3 Compression Type for Drywall Slip-on (Knock-Down) Frames: Adjustable compression anchors.

13.1.4 Windstorm Opening Anchors: Types as tested and required for indicated wall types to meet specified wind load design criteria.

13.1.5 FEMA 361 Storm Shelter Anchors: Masonry T-shaped, wire masonry type, or existing opening type anchors.

13.2 FLOOR ANCHORS
Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.

13.3 MORTAR GUARDS
Formed from same material as frames, not less than 0.016 inches thick.

14. LIGHT OPENINGS AND GLAZING

14.1 STOPS AND MOLDINGS
Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.

14.2. MOLDINGS FOR GLAZED LITES IN DOORS AND LOOSE STOPS FOR GLAZED LITES IN FRAMES
Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.

14.3 FIXED FRAME MOLDINGS
Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.

14.4 PREFORMED METAL FRAMES FOR LIGHT OPENINGS
Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

15. ACCESSORIES

15.1 MULLIONS AND TRANSOM BAR
Join to adjacent members by welding or rigid mechanical anchors.

15.2 GROUT GUARDS
Formed from same material as frames, not less than 0.016 inches thick.

16. FABRICATION

16.1 Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.

16.2 TOLERANCES
Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.

16.3 HOLLOW METAL DOORS

16.3.1 Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.

16.3.2 Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.

16.3.3 Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.

16.3.4 Continuous Hinge Reinforcement: Provide welded continuous 12-gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".

16.4 HOLLOW METAL FRAMES

16.4.1 Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

16.4.2 Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

A. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.

16.4.3 Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

16.4.4 High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.

16.4.5 Continuous Hinge Reinforcement: Provide welded continuous 12-gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".

16.4.6 Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.

16.4.7 Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.

16.4.8 Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

16.4.9 Jamb Anchors: Provide number and spacing of anchors as follows:

A. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Two anchors per jamb up to 60 inches high

2) Three anchors per jamb from 60 to 90 inches high

3) Four anchors per jamb from 90 to 120 inches high

4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high

B. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches high

2) Four anchors per jamb from 60 to 90 inches high

3) Five anchors per jamb from 90 to 96 inches high

4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high

5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions

C. Severe Storm Shelter Openings: Provide jamb, head, and sill anchors in accordance with manufacturer's tested and approved assemblies.

16.4.10 Door Silencers: Except on weather-stripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".

16.4.11 Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.

16.5 HARDWARE PREPARATION

Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

16.5.1 Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8

16.5.2 Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware

16.5.3 Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware

16.5.4 Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections

17. STEEL FINISHES

17.1 PRIME FINISHES

Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.

Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 - EXECUTION

18. EXAMINATION

18.1 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

18.2 General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).

18.3 Proceed with installation only after unsatisfactory conditions have been corrected.

19. PREPARATION

19.1 Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

19.2 Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.

19.3 Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."

19.4. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

20. INSTALLATION

20.1 GENERAL

Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

20.2 HOLLOW METAL FRAMES

Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.

20.2.1 Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.

20.2.2 Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

20.2.3 Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.

20.2.4 Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.

20.3 HOLLOW METAL DOORS

Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

20.3.1 Non-Fire-Rated Standard Steel Doors:

A. Jambs and Head: 1/8 inch plus or minus 1/16 inch

B. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch

C. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch

D. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch

22.3.2 Fire-Rated Doors: Install doors with clearances according to NFPA 80

20.4 FIELD GLAZING

Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

21. ADJUSTING AND CLEANING

21.1 FINAL ADJUSTMENTS

Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

21.2 Remove grout and other bonding material from hollow metal work immediately after installation.

21.3 PRIME-COAT AND PAINTED FINISH TOUCH-UP

Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

End of Section 08110

SECTION 08400

STOREFRONT

1. GENERAL

All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required to refer especially thereto.

2. WORK INCLUDED

2.1 Furnish all necessary materials, labor and equipment for the complete installation of aluminum framing as shown on the drawings and specified herein.

2.2 Structural support of the framing system, interior closures, trim, and metal sub-sills are not included in this section.

2.3 Sealants as required to maintain environmental separation as specified herein.

3. RELATED WORK SPECIFIED ELSEWHERE

3.1 Section 08520 – Aluminum Windows

3.2 Section 08700 – Finish Hardware. Refer for required hardware and templating.

3.3 Section 08800 – Glass and Glazing

4. QUALITY ASSURANCE

4.1 Drawings and specifications of the storefront are based upon the **2450 FS** supplied by the Manko Window Systems, Inc., 800 Hayes Drive, Manhattan, Kansas 66502
Phone: 1-800-642-1488.
Refer to sheet A.3.1

4.2 Whenever substitute products are to be considered, supporting technical literature, samples, drawings and performance data must be submitted five (5) days prior to bid in order to make valid comparison of the products involved. Test reports certified by an independent test a laboratory must be made available upon request.

4.3 APPROVED MANUFACTURERS

EFCO	United States Aluminum Co, Inc.
Manko	Vista Wall
PPG Industries	Kawner

5. SUBMITTALS

5.1 SHOP DRAWINGS
Submit Shop Drawings and Manufacturer's Data for the following items in accordance with Section 01300 – Submittals.

5.2 Provide shop drawings showing sizes and details of installation prior to shipping window units to project. All dimensions and details shall be the responsibility of the installer and the manufacturer.

Entrances and storefronts, including details of all conditions for every member, joint, anchorage and glazing. Prepare anchorage details so that entrance and storefront elements tie into structural system of the building. Prepare coordination details and erection diagrams. Indicate glass and metal thicknesses. Identify materials including metal alloys, glass types, glazing materials,

fasteners. Identify shop and field sealants by product name and type. Indicate relative layout of adjacent walls, beams, columns, slabs, anchors, and other parts of the building structural system intended for support of the storefront design loads. Dimension position of glass edge relative to metal daylight. Indicate provisions for expansion and contraction. Indicate and schedule hardware, including manufacturer's name, catalog numbers and finish.

6. DELIVERY, STORAGE AND HANDLING

6.1 DELIVERY OF MATERIALS

Deliver materials (except bulk materials) in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size, and color.

6.2 STORAGE OF MATERIALS

Store materials in unopened containers. Store off ground and under cover protected from damage.

6.3 HANDLING MATERIALS

Handle glass in accordance with manufacturer's recommendations. Provide cushions at edges to prevent impact damage. Protect faces from scratches and abrasions.

7. PROJECT CONDITIONS

Environmental Requirements: Do not install materials during inclement weather or when the temperature is below the minimum recommended by the manufacturer. Do not install sealants when extreme temperature conditions or heavy winds are predicted during the period of initial cure.

8. SEQUENCING/SCHEDULING

Schedule the installation of sealants during period of mean temperature (nominal joint width indicated) so that subsequent tensile and compressive stresses within the cured sealant will be minimized.

9. ALTERNATES

Refer to Section 01030 - Alternates where scope and description of alternates to the Contract requirements are given.

10. WARRANTY

Warrant entrances and storefronts against leaks or other defects for a period of 2 years.

11. PERFORMANCE REQUIREMENTS

11.1 WINDOW WALL

11.1.1 When tested in accordance with ASTM E 283, air infiltration shall not exceed .06 CFM per square foot (.0003 $m^3/s\text{-}m^2$) of fixed area.

11.1.2 When tested in accordance with ASTM E 331, no water penetration at a test pressure of 6.24 P.S.F. (75 Pa).

11.1.3 Structural performance shall be based on

A. Maximum deflection of 1/175 of the span and

B. Allowable stress with a safety factor of 1.65.

11.1.4 The system shall perform to these criteria under a wind load of 25 PSF as per 1991 U.B.C.

11.2 WINDOWS

11.2.1 Air, Water and structural test unit sizes and configuration shall conform to requirements set forth in ANSI/AAMA 101-88.

11.2.2 Thermal test unit sizes shall be 4'0" x 6'0". Unit shall consist of a single typical vent.

11.2.3 Test procedures and performance:
Windows shall conform to all ANSI/AAMA 101-88 requirements.

11.2.4 Thermal transmittance test: (Conductive U-Value

12. MATERIALS

12.1 STOREFRONT

Aluminum Framing: Equal to the **2450 FS,** supplied by the
Manko Storefront Framing or the approved equal.

12.1.1 Extrusions shall be 6063-T5 alloy and temper (ASTM B 221 alloy G.S. 10A-T5). Fasteners, where exposed, shall be aluminum, stainless steel or zinc plated steel in accordance with ASTM A 164-71. Perimeter anchors shall be aluminum or steel, providing the steel is properly insulated from the aluminum. Vertical Mullions shall be of sufficient strength to meet job requirements.

12.1.2 The interior glazing gasket shall be a resilient elastomer of 70 + or - 5 durometer. All mullions shall have a glazing gasket of elastomeric extrusions and sealant to be structural type silicone as recommended by the sealant manufacturer. Horizontals shall have flexible (PVC) thermal break material located on exterior side of glass plane. Exterior glazing shall be EDPM secured by extended aluminum pressure plates fastened to main horizontal grid members (synthetic polymer tape optional exterior glazing). Provisions shall be made at all sealed horizontals to lead moisture accumulation to exterior.

12.1.3 A cover shall be snapped over pressure plate to show only a sharp radiused, uninterrupted horizontal exterior profile.

12.1.4 Glazing
Vertical members of the curtain wall grid shall permit the application of a structural silicone sealant. The sealant, backer rod and other materials that come in contact with the silicone shall be compatible. The sealant manufacturer's instructions shall be followed.

12.1.5 The storefront is to be supported (vertically and horizontally) by the structural columns and vertical and horizontal mullions designed and detailed on the Drawings.

12.1.6 The manufacturer shall review and approve the system designed providing any and all additional engineering, miscellaneous components and reinforcing, required for a complete installation of the curtain wall system.

12.2 DOORS

12.2.1 Exterior grid framing system for glazed walls shall be 1-3/4" x 4-1/2" flush glazing system with glazing vinyl on both sides of glass; components shall be equal "350" doors (wide style - single acting) as manufactured by Manko or those by Amarlite or those by Howmet or the approved equal.

12.2.2 Aluminum doors shall be equal to medium style tubular section and snap-in stop with bulb-type glazing neoprene. The hardware is specified in Section 08700. For these doors this supplier shall fabricate the doors to accommodate the specified hardware.

12.2.3 The aluminum sections shall be given a caustic etch followed by an anodic treatment to produce a high-density aluminum oxide coating of dark bronze, where noted.

12.2.4 Storefront System Manufacturer will be responsible for detailing and sizing of frame.

12.2.5 Extruded aluminum shall be 6063-T5 alloy and tempered.

12.2.6 Weather-strip shall be Santoprene or equal and closed cell sponge neoprene leaf on the pivot.

12.3 GLASS AND GLAZING
Window manufacturer furnish and factory glaze the units with 1" insulated glazing, tinted grey. Refer to specification section 08800 Glass & Glazing.

12.4 THERMAL BARRIER
Barrier material shall be poured-in-place two-part polyurethane. A non-structural thermal barrier is unacceptable.

12.5 The door manufacturer under Section 08700 shall furnish all hardware.

13. FINISH

13.1 All exposed framing surfaces shall be free of scratches and other blemishes.

13.2 Aluminum mullions, all molding, trim and exposed flashing shall be Architectural Class II anodized AAM12C22A42/44. Color shall be “Dark Bronze”.

14 INSTALLATION

WINDOW WALL

14.1 Framing shall be installed, glazed and adjusted by experienced workmen in accordance with the manufacturer's installation instructions and/or approved shop drawings.

14.2 All items under this heading shall be set in correct locations as shown in the details and shall be level, square and plumb and in alignment with other work in accordance with the manufacturer’s installation instructions and approved shop drawings. All joints between framing and the building structure shall be sealed in order to secure a watertight installation.

14.3 Do not use exposed fasteners.

15 CLEANING AND PROTECTION

15.1 After installation all metal surfaces shall be cleaned to remove mortar, plaster, paint or other contaminants. After cleaning, all work shall be protected against damage until the General Contractor accepts it. Thereafter, it shall be the responsibility of the General Contractor to maintain protection and provide final cleaning.

15.2 After completion of window installation, windows shall be inspected, adjusted, put into working order and left clean, free of labels, dirt, etc. Protection from this point shall be the responsibility of the General Contractor.

16. WARRANTIES

TOTAL WINDOW SYSTEM

16.1 The responsible contractor shall assume full responsibility and warrant for one year the satisfactory performance of the total window installation which includes that of the windows, hardware, glass (including insulated units), glazing, anchorage and setting system, sealing, flashing, etc. as relates to air, water and structural adequacy as called for in the specifications and approved shop drawings.

16.2 Any deficiencies due to such elements not meeting the specifications shall be corrected by the contractor at his expense during the warranty period.

End of Section 08400

SECTION 08710

DOOR HARDWARE

1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 This Section includes commercial door hardware for the following:

A. Swinging doors
B. Other doors to the extent indicated

1.2.2 Door hardware includes, but is not necessarily limited to, the following:

A. Mechanical door hardware
B. Electromechanical door hardware
C. Cylinders specified for doors in other sections

1.2.3 Related Sections:

A. Division 08 Section "Hollow Metal Doors and Frames".
B. Division 08 Section "Aluminum-Framed Entrances and Storefronts".

1.2.4 Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction

A. ANSI A117.1 - Accessible and Usable Buildings and Facilities
B. ICC/IBC - International Building Code
C. NFPA 70 - National Electrical Code
D. NFPA 80 - Fire Doors and Windows
E. NFPA 101 - Life Safety Code
F. NFPA 105 - Installation of Smoke Door Assemblies
G. State Building Codes, Local Amendments

1.2.5 Standards: All hardware specified herein shall comply with the following industry standards:

A. ANSI/BHMA Certified Product Standards – A156 Series
B. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

1.3.1 Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

1.3.2 Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

A. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

B. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

C. Content: Include the following information:
1. Type, style, function, size, label, hand, and finish of each door hardware item.
2. Manufacturer of each item.
3. Fastenings and other pertinent information.
4. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
5. Explanation of abbreviations, symbols, and codes contained in schedule.
6. Mounting locations for door hardware.
7. Door and frame sizes and materials.
8. Warranty information for each product.

D. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

1.3.3 Shop Drawings: Details of electrified access control hardware indicating the following:

A. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
1. Elevation diagram of each unique access-controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.

2. Complete (risers, point-to-point) access control system block wiring diagrams.

3. Wiring instructions for each electronic component scheduled herein.

B. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

1.3.4 Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

1.3.5 Informational Submittals: Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

1.3.6 Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

1.4 QUALITY ASSURANCE

1.4.1 Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

1.4.2 Installer Qualifications: A minimum 5 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1.4.3 Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

1.4.4 Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

A. Electrified modifications or enhancements made to a source manufacturer’s product line by a secondary or third-party source will not be accepted.

B. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

1.4.5 Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

1.4.6 Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

A. Function of building, purpose of each area and degree of security required
B. Plans for existing and future key system expansion
C. Requirements for key control storage and software
D. Installation of permanent keys, cylinder cores and software
E. Address and requirements for delivery of keys

1.4.7 Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

A. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electro-mechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.

B. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.

C. Review sequence of operation narratives for each unique access-controlled opening.

D. Review and finalize construction schedule and verify availability of materials.

E Review the required inspecting, testing, commissioning, and demonstration procedures.

1.4.8 At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

1.5.2 Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

1.5.3 Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software, and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

1.6.1 Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

1.6.2 Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

1.7.1 General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1.7.2 Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

A. Structural failures including excessive deflection, cracking, or breakage

B. Faulty operation of the hardware

C. Deterioration of metals, metal finishes, and other materials beyond normal weathering

D. Electrical component defects and failures within the systems operation

1.7.3 Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

1.7.4 Special Warranty Periods:

A. Ten years for mortise locks and latches

B. Five years for exit hardware

D. Twenty-five years for manual overhead door closer bodies

E. Five years for motorized electric latch retraction exit devices

F. Two years for electromechanical door hardware

1.8 MAINTENANCE SERVICE

Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

2. PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

2.1.1 General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

2.1.2 Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

2.1.3 Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

2.2.1 Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

Manufacturers:
A. Bommer Industries (BO)
B. Hager Companies (HA)
C. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE)

2.3 POWER TRANSFER DEVICES

2.3.1 Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed

wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

Manufacturers:
A. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) – EL-CEPT Series.
B. Securitron (SU) - EL-CEPT Series.

2.3.2 Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
A. Provide one each of the following tools as part of the base bid contract:
1. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – Electrical Connecting Kit: QC-R001

2. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – Connector Hand Tool: QC-R003

B. Manufacturers:
1. Hager Companies (HA) – Quick Connect

2. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – QC-C Series

2.4 CYLINDERS AND KEYING
2.4.1 General: Cylinder manufacturer to have minimum (10) years' experience designing secured master key systems and have on record a published security keying system policy.

2.4.2 Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
A. Manufacturers:
Sargent Manufacturing (SA)

2.4.3 Cylinders: Original manufacturer cylinders complying with the following:
A. Mortise Type: Threaded cylinders with rings and cams to suit hardware application

B. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring

C. Bored-Lock Type: Cylinders with tailpieces to suit locks

D. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes

E. Keyway: Match Facility Standard

2.4.4 Keying System: Each type of lock and cylinders to be factory keyed.

A. Conduct specified "Keying Conference" to define and document keying system instructions and requirements

B. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner

C. Existing System: Field verify and key locks to match Owner's existing system.

2.4.5 Key Quantity: Provide the following minimum number of keys:

A. Change Keys per Cylinder: Two (2)

B. Master Keys (per Master Key Level/Group): Five (5)

2.4.6 Key Registration List (Bitting List):

A. Provide keying transcript list to Owner's representative in the proper format for importing into key control software

B. Provide transcript list in writing or electronic file as directed by the Owner

2.5 MECHANICAL LOCKS AND LATCHING DEVICES

2.5.1 Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

A. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 10 million cycles

B. Manufacturers:

1. Corbin Russwin Hardware (RU) – ML2000 Series
2. Sargent Manufacturing (SA) – 8200 Series

2.6 LOCK AND LATCH STRIKES

2.6.1 Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

A. Flat-Lip Strikes: For locks with three-piece antifriction latch-bolts, as recommended by manufacturer.

B. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

C. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

D. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

2.6.2 Standards: Comply with the following:

A. Strikes for Mortise Locks and Latches: BHMA A156.13

B. Strikes for Bored Locks and Latches: BHMA A156.2

C. Strikes for Auxiliary Deadlocks: BHMA A156.36

D. Dustproof Strikes: BHMA A156.16

2.7 CONVENTIONAL EXIT DEVICES

2.7.1 General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

A. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

B. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.

C. Except on fire rated doors, provide exit devices with hex key dogging device to hold the push-bar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

D. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

E. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.

F. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy-duty escutcheon trim with threaded studs for thru-bolts.
   1. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
   2. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

G. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

H. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.

I. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

J. Extended cycle test: Devices to have been cycle tested in ordinance with ANSI/BHMA 156.3 requirements to 9 million cycles.

K. Rail Sizing: Provide exit device rails factory sized for proper door width application.

L. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

2.7.2 Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

Manufacturers
A. Corbin Russwin Hardware (RU) – ED4000 / ED5000 Series
B. Sargent Manufacturing (SA) – 80 Series

2.8 DOOR CLOSERS

2.8.1 All door closers specified herein shall meet or exceed the following criteria:

A. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.

B. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

C. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.

D. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.

E. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

F. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

G. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

2.8.2 Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

Manufacturers
A. Corbin Russwin Hardware (RU) – DC8000 Series.
B. Norton Door Controls (NO) – 9500 Series
C. Sargent Manufacturing (SA) – 281 Series

2.9 ARCHITECTURAL TRIM

2.9.1 Door Protective Trim:

A. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

B. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

C. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with

NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.

D. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
Stainless Steel: 300 grade, 050-inch thick.

E. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.

F. Manufacturers
1. Burns Manufacturing (BU)
2. Hager Companies (HA)
3. Hiawatha, Inc. (HI)
4. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO)

2.10 DOOR STOPS AND HOLDERS

2.10.1 General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

2.10.2 Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

Manufacturers
A. Burns Manufacturing (BU)
B. Hager Companies (HA)
C. Hiawatha, Inc. (HI)
D. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO)

2.11 ARCHITECTURAL SEALS

2.11.1 General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

2.11.2 Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

2.11.3 Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

2.11.4 Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

2.11.5 Manufacturers:
A. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
B. Reese Enterprises, Inc. (RE)

2.12 ELECTRONIC ACCESSORIES

2.12.1 Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

Manufacturers:
A. Sargent Manufacturing (SA) – 3280 Series
B. Security Door Controls (SD) – DPS Series
C. Securitron (SU) – DPS Series

2.12.2 Linear Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw plus 50% for the specified electrified hardware and access control equipment.

Manufacturers:
A. Alarm Controls (AK) - APS Series
B. Corbin Russwin Hardware (RU) - BPS Series
C. Sargent Manufacturing (SA) - 3500 Series
D. Securitron (SU) - BPS Series

2.13 FABRICATION

Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers' recognized installation standards for application intended.

2.14 FINISHES

2.14.1 Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

2.14.2 Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

2.14.3 Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3. **EXECUTION**

3.1 EXAMINATION

3.1.1 Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

3.1.2 Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

3.2.1 Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series

3.2.2 Wood Doors: Comply with ANSI/DHI A115-W series

3.3 INSTALLATION

3.3.1 Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

3.3.2 Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

A. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

B. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

C. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."

D. Provide blocking in drywall partitions where wall stops, or other wall mounted hardware is located.

3.3.3 Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

3.3.4 Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

3.3.5 Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

3.5 ADJUSTING

Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

3.6.1 Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

3.6.2 Clean adjacent surfaces soiled by door hardware installation.

3.6.3 Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

3.7.1 Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

3.8.1 The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed

hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

A. Quantities listed are for each pair of doors, or for each single door.

B. The supplier is responsible for handing and sizing all products.

C. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate selection for the material and application.

3.8.2 Manufacturer's Abbreviations:

A. PE – Pemko
D. SA – Sargent
E. RO – Rockwood
F. MK – McKinney
H. SU – Securitron

Hardware Sets

Set: 1.0
Doors: 100A
Description: Exterior

1	Continuous Hinge	CFMSLF-HD1 PT or CFMSLI-HD1 PT		PE	
1	Rim Exit Device, Storeroom	16 55 56 8804 PSB GMK	US32D	SA	⚡
1	Door Closer	281 CPS	EN	SA	
1	Drop Plate	281D	EN	SA	
1	Kit	581-2	EN	SA	
1	Door Stop	462	US2C	RO	
1	Threshold	279x292AFGPK x Opening Width		PE	
1	Rain Guard	347A x Door Width		PE	
1	Rain Guard	68AR x Door Width		PE	
1	Sweep	345ANB x Door Width		PE	
1	ElectroLynx Harness	QC-C1500P		MK	⚡
1	ElectroLynx Harness	QC-C Length Required		MK	⚡
1	Electric Power Transfer	EL-CEPT		SU	⚡
1	Position Switch	DPS-M-BK		SU	⚡
1	Power Supply	BPS-24-1		SU	⚡

Notes: Card reader furnished by Owner.
Weatherstripping furnished by Aluminum Door Supplier.

Set: 2.0
Doors: 100B
Description: Waiting

1	Continuous Hinge	CFMHD1 x Door Height		PE	
1	Storeroom/Closet Lock	8204 LNL GMK	US26D	SA	
1	Door Closer	TB 281 CPS	EN	SA	
1	Kick Plate	K1050 10" x 2" LDW CSK	US32D	RO	
1	Position Switch	DPS-M-BK		SU	⚡

Notes: Balance of hardware is existing and will remain.

End of Section 87100

SECTION 09200

METAL STUD PARTITIONS AND GYPSUM WALL BOARD

1. GENERAL

1.1 All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required to refer especially thereto.

1.2 In cold weather and during the period of wallboard application and joint finishing, temperatures within the building shall be maintained uniformly within the range of 55 to 70 degrees F. Adequate ventilation shall also be provided to eliminate excessive moisture within the building during this same period. All materials as specified below, shall be delivered to the job in their original, unopened containers or bundles; stored in a place providing protection from damage and exposure to the elements. Damaged or deteriorated materials shall be removed from the premises.

1.3 The installation and application of all materials shall be in accordance with the latest printed directions or specifications of United States Gypsum Co., or the National Gypsum Company.

1.4 USG "Curtain Wall Systems", systems folder SA-805, current edition shall be included in this specification as if bound herein. Contractor shall consult this document and its referenced documents and become thoroughly familiar with their contents.

1.5 When low humidity, high temperatures and rapid drying exist during gypsum base and veneer finish application, Durabond Joint Compound and Perf-A-Taper Reinforcement shall be used on all joints and internal corners and allowed to set and dry thoroughly before plaster application.

2. WORK INCLUDED

This contractor shall include all labor and materials required to complete all gypsum wall board partitions, curtain walls, and furred walls as shown on the drawings and/or herein specified, as follows:

2.1 Metal studs, floor, bridging ceiling track and accessories.

2.2 All furring channels, runners, hanging wires, etc.

2.3 DensGlass Gold, Gypsum wallboard, sheathing, and 15# asphalt felt. (Alternate 1)

2.4 Corner beads, casing beads, plaster stops and expansion joints.

2.5 Screws and miscellaneous attachments.

2.6 Wall furring.

2.7 Interior gypsum wallboard shall be Fire-Rated, and Abuse-Resistant

2.8 Galvanized Structural Metal Studs

3. WORK EXCLUDED

Suspended exposed grid acoustical ceilings.

4. MATERIALS

4.1 Metal stud partition system shall be complete with upper and lower runners, stud stiffeners, foundation clips, flat strap diagonal bracing at each wall, slide clips, anchors, screws, and other accessories required by the Plans or necessary to complete the wall system. All framing members shall be formed from corrosion-resistant steel corresponding to the requirements of ASTM A 446, with a minimum yield strength of 40 KSI for SJ style studs, 33 KSI for CR runners.

4.2 All component and framing system shall be as manufactured by United States Gypsum Company, Dietrich, Superior, Inland/Milcor, or the approved equal and shall be complete accord with suggestions and requirements of United States Gypsum Company "USG Steel Framing Systems" systems folder. SA-510.

4.3 STUDS AND RUNNERS

4.3.1 Exterior Curtain Walls

A. Dietrich 6-0" CSW Studs and runners-under 13'-0" AFF 18 GA, 16" o/c. or as governed by manufacturer's recommendation

B. Bridging: Rigid Bridging at maximum of 3'-4" o/c.

C. Clips: Vertical slide clips, or deep track, (See Structural).

4.3.2 Interior Studs and Runners

A. All interior partitions

1. 4-0" CWN Studs and CR runners-under 12'-0" AFF 20 GA, 16" o/c. or as governed by manufacturer's recommendation

2. 6-0" CWN Studs and CR runners-above 12'-0" AFF 20 GA, 16" o/c. or as governed by manufacturer's recommendation

B. 7/8" Furring channels.

4.4 SHEATHING BOARD

5/8" (5/8" thick x 4' x 8', 9' or 10') DensGlass Gold Fireguard Exterior Sheeting.

4.4.1 Composition

A. Gypsum sheathing manufactured in accordance with ASTM C 1177 with glass mats both sides and long edges, water-resistant treated core.

4.4.2 Fire resistance

A. Noncombustible when tested in accordance with ASTM E 136.

B. 1/2" DensGlass Gold Exterior Sheathing: Flam spread 10, smoke developed 0, when tested in accordance with ASTM E 84.

C. 1/2" DensGlass Gold Exterior Sheathing is rated Type X as defined in ASTM C 1396 and can be used in generic assemblies utilizing a 1/2" Type X gypsum board.

D. **1/2" DensGlass Gold Fireguard exterior sheathing** is UL classified, Type DGG, in UL designs N501, N502, U301, U302, U305, U309, U337, U342, U354, U355, U365, U411, U425, U467, U473, U475, U617, V417, V419, X508,

X516. 5/8" DensGlass Bold Fireguard exterior sheathing can be used in UL assemblies where the gypsum board is listed as "Gypsum Board" for thicknesses up to 5/8".

E. 1/2" DensGlass Gold Fireguard Exterior Sheathing ULC classified, Type DGG in ULC designs U301, U302, W301, W404, W415.

4.5 INSULATION
(Exterior Walls): 6" Batt insulation is specified under Section 07200 - Insulation.
(Interior Walls): 6-mil visqueen as specified under Section 07200 - Insulation.

4.6 GYPSUM PANELS

4.6.1 Exterior Curtain Walls
Face Board - gypsum board, Firecode Type "X", 5/8" thick, 48" wide, lengths as required.

4.6.2 Interior Walls
Face Board - Both sides studs, gypsum board, Firecode, Type "X", 5/8" thick x 48" wide, length as required.

4.7 RUNNER FASTENERS
5/32" dia. power driven type with 1-1/2" penetration into 3,000 psi concrete at 12" o/c. maximum.

4.8 ASPHALT FELT
15# asphalt felt.

4.9 SEALANTS
Butyl tape - 1/16" thick, 100% solid polymeric, non-staining, butyl-based sealant tape. Other sealants are specified under Section 07000, "Moisture Protection".

4.10 FASTENERS
Fasteners for all applications shall comply with wallboard manufacturers printed recommendations.

4.11 EXTERNAL CORNERS, WALL
U.S.G. dur-a-bead reinforcement or equal.

4.12 METAL TRIM AT EDGES ABUTTING OTHER MATERIALS
USG 200-A of size required.

4.13 JOINT REINFORCEMENTS
USG part-a-tape reinforcing tape or equal.

4.14 EMBEDDING AND FILLING COMPOUND
USG durabond joint compound-taping, or equal.

4.15 FINISHING COMPOUND
USG durabond joint compound topping or equal.

4.16 GYPSUM BOARD CONTROL JOINT
USG 093 or equal.

5. FRAMING:

5.1 Floor and ceiling tracks shall be accurately aligned to assure plumb partition. Secure track to the slab with power-driven fasteners at a minimum of 16" o/c. by position studs into the track at 16" o/c.(maximum) rotating studs into place for a friction fit. Secure located adjacent to door and window openings, partition intersections and corners by self-drilling sheet metal screws through both flanges of studs and tracks. Secure solid bridging to studs in exterior walls.

5.2 Position studs in runners and space no greater than 16" o/c.(maximum) for exterior walls and 16" o/c. on interior walls. Securely anchor each stud to runner with four (4) 5/8" Type S-12 low-profile Head Screws, two at top and two at bottom, with one screw in each flange. (See details where field welding is required).

5.3 Double the studs at door jambs, ends of walls or partitions, and at areas where cabinets or equipment is to be attached and supported by the wall. Studs shall be fastened together with truss type clips or fasteners (Contractor to provide and install 2 x 6 wood blocking between studs to support cabinets, etc. and where indicated on the drawings).

5.4 Double plate the exterior wall.

6. EXECUTION

6.1 Place panels parallel to framing. Position all ends over framing members in parallel application. Use maximum practical lengths to minimize end joints. Fit ends and edges closely, but not forced together. Stagger end joints in successive courses. Place end joints on opposite sides of partitions on different studs. When necessary, cut ends, edges and cutouts within field of panel in workmanlike manner.

Drive fasteners in field of panel first, working toward ends and edges. Hold panel in firm contact with framing while driving fasteners. Space perimeter fasteners at least 3/8" from ends and edges. Drive fasteners home with heads slightly below surface of panels to provide a uniform dimple 1/32" deep. Do not use a nail set; avoid breaking face paper.

6.2 Make doorframe opening of such size that when the wallboard is secured to the studs, it will fit snugly into the steel frames.

6.3 Extend gypsum wallboard to roof deck above ceiling on corridor walls and partitions between classrooms.

6.4 Provide all additional framing and 2 x 6, 2 x 8 blocking as required to support built-in anchorage and attachment devices for other work.

6.5 <u>EXTERIOR SHEATHING</u>

6.5.1 Provide DensGlass Gold Exterior Sheathing where indicated on drawings. Install sheathing in accordance with manufacturer's instructions and applicable instructions in GA-253 and ASTM C 1280.

6.5.2 Install DensGlass Gold Exterior Sheathing with gold side out.

6.5.3 Use maximum lengths possible to minimize number of joints.

6.5.4 Attach DensGlass Gold Exterior Sheathing to wood framing with nails spaced 4" o.c. at perimeter for racking shear resistance; 8" o.c. at perimeter where there are framing

supports and where racking shear resistance is not required; and 8" o.c. along intermediate framing in field for both conditions.

6.5.5 Attach DensGlass Gold Exterior Sheathing to metal framing with screws spaced 8" o.c. at perimeter where there are framing supports; and 8" o.c. along intermediate framing in field A greater number of fasteners may be specified to obtain specific values and is allowed up to 4" o.c. spacing.

6.5.6 Drive fasteners to bear tight against and flush with surface of sheathing. Do not counter sink.

6.5.7 Locate fasteners minimum 3/8" from edges and ends of sheathing panels, tight against and flush with surface of sheathing.

6.5.8 Weather Resistant Barrier: If a weather barrier is required by the local building code, design professional, owner or cladding manufacturer over DensGlass Gold Exterior Sheathing, one of the following procedures may be used. Consult building code or design authority for proper application selection. Follow manufacturer's installation recommendations.

A. Entire exterior face of gypsum sheathing covered with an asphalt impregnated felt or synthetic fiber wrap such as Tyvek Commercial Wrap, or equal.

B. Liquid applied barriers such as Sto Guard as manufactured by Sto Corp., Dryvit's Backstop NT or equal.

C. Self adhering membranes.

6.6 PAINTED CEILING SOFFITTS

6.6.1 Soffits must be dried in and protected from the elements during and after installation.

A. Apply fiberglass mesh joint tape over joints and embed in setting-type joint compound specified.

B. Skim coat surface with setting-type joint compound for smooth finish.

C. Prime and paint with exterior grade, high quality paint.

6.6.2 Apply EIFS with or without insulation, install as recommended by manufacturer.

6.6 MASONRY MATERIALS

6.6.1 Erect per specifications Section 04100 and 04200.

6.6.2 Anchor brick with approved brick ties, screw-attached to each steel stud using two 1-1/4" Type S-12 Pancake Head Cadmium-Plated Screws. Anchor other masonry units to each stud in a similar manner, 16" o/c. maximum or as recommended by the Brick Institute of America.

6.7 INSULATION

Apply two (2) foot wide extruded polystyrene insulation horizontally with tongue edge up over gypsum sheathing. Fasten 1" panels to studs with 2" Type S-12 Wafer Head Insulation Screws spaced 12" o/c. Cover sheathing with panels and fit joints tightly. Insert friction-fit Contractor CW-40 Thermafiber Insulation between steel studs.

6.8 DRYWALL INTERIOR

6.8.1 Position Sheetrock Brand Firecode Gypsum Panels vertically or horizontally and attach to studs with 1" Type S-12 Screws spaced 8" o/c. Install gypsum panel to interior immediately following gypsum-sheathing application to properly resist design wind loads.

6.8.2 Install drywall accessories, finish joints accessories and screw heads per Folder SA-927.

6.8.3 Embed tape, fill and finish joints.

6.8.4 Embed, fill and finish corner protections, except 400 Series Trim.

6.8.5 3-coat fill and finish nail and screw head depressions.

6.8.6 Sand between coats and sand finish coat to a smooth, leveled plane that will not show joints or attachment locations after 2-coat paint application.

6.9 FIRE-RATED, ABUSE-RESISTANT, MOLD-RESISTANT GYPSUM BOARD

6.9.1 A gypsum core wall panel with additives to enhance fire resistance, mold resistance, surface indentation resistance, and impact resistance of the core and surfaced with abrasion, moisture/mold/mildew resistant paper on front, back and long edges; and complying with ASTM C 1396, Type X (Hi-Abuse Brand XP Fire-Shield Wallboard). Refer to drawings for locations.

6.9.2 Details

A. Thickness: 5/8"

B. Width: 4 ft.

C. Length: 8 ft. through 12 ft.

D. Edges: Tapered

E. Surface Abrasion Resistance: Not greater than 0.009" depth when tested at 50 cycles in accordance with ASTM D 4977, Modified.

F. Indentation Resistance: Not greater than 0.132" depth when tested at an impact load of 72 in.-lbs. in accordance with ASTM D5420.

G. Impact/Penetration Resistance: Not less than 210 ft.-lbs. when tested in accordance with ASTM E 695, Modified.

E. Mold and Mildew Resistance: Panel score of 10, when tested in accordance with ASTM D 3273.

End of Section 09200

SECTION 09500

ACOUSTICAL CEILINGS

1. GENERAL

1.1 All work included under this heading shall be subject to the General Conditions of the entire operations. The Contractor for this portion of the work is required to refer especially thereto.

1.2 The installation shall be made by an Acoustical Contractor approved by the manufacturer of the acoustical materials as thoroughly experienced in this work. Work required includes all labor, materials, acoustical materials on ceilings areas as indicated on the Drawings and/or the schedule of room finishes.

1.3 The acoustical contractor shall be responsible for the examination and acceptance of all surfaces and conditions affecting the proper installation of his materials and shall not proceed until all satisfactory conditions have been corrected. Before delivering any materials to the job site, the acoustical contractor shall obtain written approval of all material samples and methods of installation.

1.4 DELIVERY AND STORAGE OF MATERIALS

1.4.1 All materials shall be delivered in their original unopened packages and stored in an enclosed shelter providing protection from damage and exposure to the elements.

1.4.2 Storage time of materials at the jobsite should be as short as possible, and environmental conditions should be as near as possible to those specified for occupancy. Excess humidity during storage can cause expansion of material and possible warp, sag, or poor fit after installation. Chemical changes in the mat and/or coatings can be aggravated by excess humidity and cause discoloration during storage, even in unopened cartons. Cartons should be removed from pallets and stringers to prevent distortion of material. Long-term (6-12 months) storage under uncontrolled environmental conditions should be avoided.

1.4.3 Damaged or deteriorated materials should be removed from the premises. Immediately before installation, to stabilize tile and panels, store them at a location where temperature and humidity conditions duplicate those ambient during installation and anticipated for occupancy.

2. WORK INCLUDED

This contractor shall furnish all labor and materials to complete all acoustical ceilings as shown on the Drawings and/or herein specified, including the following:

2.1 Furnish and install one-hour fire rated lay-in acoustic tile on an exposed suspension system in all rooms designated to receive suspended acoustic tile ceilings by the room finish schedule or the reflected ceiling plans.

3. MATERIALS

3.1 ACOUSTICAL CEILING TILES

Armstrong 769A
Cortega – Square Lay-in
Size: 24" x 48"
Refer to Finish schedule sheet A3.1
No product substitution shall be made without written approval of the Architect.

3.2 HANGERS
Hanger wires shall be pre-straightened galvanized soft annealed #12 wire spaced at 4'-0" centers.

3.3 PERIMITER TRIM
S.A.C. Perimeter trim shall be equal to Axiom - Classic as manufactured by Armstrong. Armstrong.com/axiom for details. Item number AX6STR (straight) and item number AX6CUR (curved). Shall have a 6" trim channel. All perimeter trim is to be white (WH). Radius must be by manufacturer - no field radiusing.

4. INSTALLATION

4.1 All work shall be in strict accordance with the manufacturer's recommendations and this Contractor shall guarantee the systems structurally for failures and that the acoustical materials shall not sag, warp or buckle.

4.2 Acoustical materials shall be installed under temperature and humidity conditions closely approximating those that will exist when the building is occupied. They shall not be installed when the building is damp and cold or dry and hot. Plastering, concreting, and tile work should be completed and allowed to dry before the installation of acoustic tile. All windows and doors shall be in place and glazed. The heating system shall be installed and operating where necessary to maintain proper conditions before, during, and after the acoustical work is in progress.

4.3 SUSPENDED CEILINGS

4.3.1 Provide white angle molding or color as required at perimeter at proper level for finished ceiling heights.

4.3.2 Suspend Main T or runners by means of #12-gauge hanger wire at 4'-0" o/c. Accurately level and space main beams at 4'-0" o/c. Tie around bottom joist chord and through holes in tees and give each wire and a minimum of 3 twists around self.

4.3.3 Install cross-tees of proper length at right angles to main beam to create a 24" x 48" grid on the exposed grid system. Where recess light fixture, diffusers or other openings require same, place a cross tee.

5. CLEANING UP

The entire installation shall be thoroughly clean. At the completion, this Contractor shall remove all dirt, rubbish and debris caused by his work from this site.

End of Section 09500

SECTION 09650

RUBBER BASE

1. GENERAL

1.1 All work included under this heading shall be subject to the General Conditions of the entire operation. The Subcontractor for this portion of the work is required to refer especially thereto.

1.2 The Contractor shall refer to "Proposal" and familiarize himself with requirements regarding alternates in order to determine extent to which work of this section may be affected.

2. WORK INCLUDED

This Contractor shall furnish all labor and materials to complete all work in connection with all floor finishes required by the drawings and/or herein specified as follows:

2.1 Rubber base for entire project.

3. WORK NOT INCLUDED

3.1 The General Contractor shall maintain spaces to receive work of this section at 70 degrees F. minimum at the floor level for at least 48 hours before, during, and for 10 days after installation of work of this section.

4. **MATERIALS**

4.1 Rubber Base

A. General Contractor shall provide and install base on walls where new flooring is indicated, and where new walls are constructed.

B. Provide and Install rubber base on walls where called for by the Room Finish Schedule for the entire project. Material shall be from roll stock in lieu of pre-cut 4' lengths. No pieces less than 24" shall be installed.

C. Molded rubber cove base shall be ruffed back, vulcanized, 4" high cove as noted, complete with external and internal molded rubber cove base corners, and shall be as manufactured by Roppe, or the approved equal.

D. Rubber base shall be as manufactured by Roppe, 1602 North Union Street, Box 1158, Fostoria, OH 44830-1158. Telephone: 1-800-537-9527, Fax: 419-435-1056. www.roppe.com. Local Rep is Bob Jones. Voicemail is 1-800-537-9527 ext 4817.

E. **Style:** Pinnacle Rubber Base, SBR Rubber.

F. **Colors: As selected by Architect.**

G. **Size:** 4" high. 120' coils, standard cove toe.

End of Section 09650

SECTION 09900

PAINTING

1. GENERAL

1.1 All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required to refer especially thereto.

1.2 Title IV of the Lead Based Paint Poisoning Prevention Act:
(12 U.S.C. 1701u) and the implementing regulations in 24 CFR Part 35; Which prohibits the use of lead-based paint in structures constructed or rehabilitated with federal assistance.

2. WORK INCLUDED

This Contractor shall furnish all labor and materials as indicated on the room finish schedule, and as shown on the drawings and/or herein specified as follows:

2.1 All interior metal that is not copper, aluminum, stainless steel, brass, bronze, chromium plated, or factory finished.

2.2 All gypsum board including, but not limited to those walls noted on the room finish schedule and drawings to receive paint.

2.3 Paint interior wood.

2.4 All exterior metal, that is not prefinished or copper.

2.5 Mechanical and Electrical work not in equipment room.

2.7 Furnish extra paint materials from the same production run as the materials applied, and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.

3. WORK NOT INCLUDED

The following items are supplied pre-finished and will require no finishing.

3.1 Acoustical ceilings

3.2 Ceramic Tile

3.3 Finished mechanical and electrical equipment

3.4 Light fixtures

3.5 Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

4. CONDITIONS OF THE SURFACES

4.1 On all work, this Contractor is to receive the surface to be painted or otherwise treated by him, free from foreign matter such as concrete, plaster, grease, dust etc., caused by other crafts, and shall be required to do a nominal amount of sanding and cleaning before proceeding with his work.

4.2 Foreign matter shall be removed by the craft responsible for its presence, and the surface made acceptable to the Painting Contractor and the Architect. If surface is unacceptable the Painting Contractor shall not commence work and shall notify the Architect in writing.

4.3 Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50- and 90-degrees F (10 and 32 degrees C).

4.4 Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45- and 95-degrees F (7 and 35 degrees C).

4.5 Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 degrees F (3 degrees C) above the dew point; or to damp or wet surfaces. (Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.)

5. MATERIALS - GENERAL

5.1 All materials to be used under this section of the specifications shall be delivered at the building in the original containers, with labels intact and seals unbroken.

5.2 No materials are to be reduced or changed except as specified by manufacturer of said materials.

5.3 All materials, except as otherwise specified, shall be of the "Best Grade" or "First Line" paint manufactured, approved by the Architect.

5.4 COLORS: As selected by Architect from manufacturer's full range.

6. WORKMANSHIP

6.1 All work shall be done by skilled mechanics in a workmanlike manner. All paints must be smoothly and evenly spread on or flowed on, and shall be free from runs, sags, crawling or other defects. All painting shall be done under favorable weather conditions.

6.2 Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application. Comply with procedures specified in PDCA P4.

6.2.1 Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

6.2.2 Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

7. PREPARATION

7.1 All greasy and oily metal surfaces to be painted shall be cleaned with benzine or mineral spirits before any paint is applied. All galvanized metal surfaces shall be treated with a solution made by adding eight (8) oz. of copper acetate or copper sulfate to one (1) gallon of warm water in an earthenware or glass vessel, or with a proprietary etching liquid, or surfaces may be washed with benzine or mineral spirits, and a coat of zinc oxide, or other standard galvanized primer, red lead.

7.2 Do not apply exterior paint in damp, rainy weather or until the surface has dried thoroughly from the effect of such weather. Do not apply varnish or paint when temperature is below 50^{O}F.

7.3 Surface to be stained or painted shall be clean, dry, smooth and adequately protected from dampness. Each coat of paint shall be applied smoothly, worked out evenly and allowed to dry completely before the subsequent coat is applied.

7.4 Finished work shall be uniform and of the approved color. It shall completely cover, be smooth and free from runs, sags, clogging or excessive flooding. Make edges of paint adjoining other materials or colors sharp and clean without overlapping. Where high gloss, enamel is used, lightly sand undercoats to obtain finish coat.

7.5 At completion, touch up and restore finish where damaged and leave in good condition.

7.6 SURFACE PREPARATION
Concrete: Allow new concrete to cure for 28 days, Brush-off blast.

Repair all necessary nail holes, dents, cracks, open joints, and other defects shall be done after the priming or first coat is dry, and before second coat is applied. Sand to a smooth finish. Putty shall be pure linseed oil-white lead whiting, put in color to match the finish coat. At least 24 hours shall be allowed between coats under most favorable conditions. All coats shall be of the proper consistency and well-brushed out.

7.7 WOOD
Sandpaper to smooth and even surface and then dust off. After priming or stain coat has been applied thoroughly fill all nail holes and other surface imperfections with spackle, tinted with primer or stained to match wood color.

7.8 STEEL AND IRON
Remove grease, dirt, mud, rust and scale as necessary to receive paint. Touch up any chipped or abraded places on items that have been shop coated. Where steel and iron have a heavy coating of scale, it shall be removed by descaling or wire brushing as necessary to produce satisfactory surface for painting.

7.9 GALVANIZED METAL
Thoroughly clean by wiping surfaces with prefix surface conditioner and primer with cook permagrip galvanized primer.

7.10 TINTING
Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat but provide sufficient differences in shade of undercoats to distinguish each separate coat.

8. RESPONSIBILITY

8.1 The Painting Contractor shall be held responsible for the finishing of his work in the manner and form prescribed by the Architect.

8.2 The final coat shall not be applied until all other crafts are finished with their work, their material and debris removed, and the premises turned over to the painting Contractor in broom-clean condition.

9. COLOR SAMPLES

The finished work shall match samples of colors and finishes, which will be prepared by the Contractor for the Architect's approval. Contractor shall provide 5' squared samples at site upon request from

Architect. No work of any kind shall be performed until such samples have been approved. Bids shall be based on the use of the specific brands and quality as specified. No substitution shall be made without written approval of the Architect.

10. STORING

A room on the premises shall be assigned to the painting Contractor for the storage of his tools and materials. This Contractor shall properly protect the floor with drop cloths or building paper. All paint shall be mixed in suitable containers. Necessary precautions shall be taken to prevent fire.

11. PROTECTION

This Contractor shall protect the work of all other trades against damage or injury by his employees, or by his materials, tools or utensils used in connection with this work. Any damage done by him shall be repaired at his own expense.

12. COLORS

Colors shall be pure, nonfading pigments, finely ground. Colors that are to be used on plaster or cement shall be lime-proof.

13. INTERIOR MATERIALS

13.1 INTERIOR METAL

First Coat: Metal primer (Not required if factory primed)

Second Coat: Enamel under-coater

Third Coat: Semi-gloss enamel

13.2 WOODWORK

All new woodwork shall be finished as follows:
First Coat – Wood Primer
Second Coat – Enamel Under-coater (tinted)
Third Coat – Flat Enamel

13.3 GYPSUM BOARD

Interior concrete, masonry, and gypsum board primer: Factory-formulated latex interior primer with silicone additive: 1) ICI Dulux Paints; "Dev-Flex" 4208, latex paint system. 2) Porter Paints; "Silicone Touch," latex paint system.

13.4.1 First Coat - Porter 767 Latex Primer Sealer

13.4.2 Interior Flat Latex-Emulsion Size for all Ceiling Locations and Materials: Factory-formulated flat latex-based interior paint, with silicone additive.

A. ICI Dulux Paints; "Dev-Flex" 4208, latex with silicone additive.

B. Porter Paints; "Silicone Touch," latex with silicone additive.

13.4.3 Interior Low-Luster Enamel for all Wall Locations and Materials: Factory-formulated eggshell latex interior enamel, with silicone additive.

A. ICI Dulux Paints; "Dev-Flex" 4208, latex with silicone additive.

B. Porter Paints; "Silicone Touch," latex with silicone additive.

14. FERROUS – METAL PRIMER

First Coat: Benjamin Moore Ironclad Quick Dry Industrial enamel; bronze tone: 07164

Second Coat: Factory formulated quick-drying rust-inhibitive alkyd-based metal primer.

Third Coat: Interior Zinc-Coated Metal Primer: Factory-formulated galvanized metal primer.

15. CONCRETE FLOOR

SEALED CONCRETE: 20 years.

First: Prep concrete according to manufacturer's recommendations.

Second: Apply Sure Seal, 24/7 masonry plus, per manufacturer's recommendations.

Third: Allow to Cure for 24 hours prior to using treated area.

Special note to protect walls from splatters: The wall base adhesive will not secure base properly in the event the walls are not protected.

Contact Manufacturer: SureSeal Sealants: Phone 1-800-636-6677;
Fax 1-770-507-9021. Sales Rep is Bruce Humphry at 1-770-375-9503.

16. GALVANIZED METAL

First Coat: Factory-formulated galvanized metal primer for exterior application.

Second Coat: Factory-formulated full gloss alkyd enamel for exterior application.

Third Coat: Factory-formulated full gloss alkyd enamel for exterior application.

17. CLEANING AND REMOVAL OF RUBBISH

17.1 At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

17.2 After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

17.3 Upon completion of all work under this Contract, the Contractor shall clean the entire area thoroughly, removing all paint splatters, droppings, etc. and touch up all damaged work to the satisfaction of the Architects.

17.4 Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces. The entire installation shall be thoroughly clean.

End of Section 09900

SECTION 10260

WALL PROTECTION (CHAIR RAIL)

1. GENERAL

All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required to refer especially thereto.

2. WORK INCLUDED

Furnish all labor and materials to complete all wall guard (chair rail) work around the perimeter of the new waiting room.

3. PRODUCT SPECIFICATIONS

No product substitution shall be made without written approval of the Architect.

3.1 PRODUCT

WG-3 Wall Guard
Pro-Tek Wall Protection Systems, manufactured by Pawling Corporation
Dimensions: 1" deep x 2 15/16" tall

3.1.1 Product features:

- A. Class A fire rating
- B. Molded end caps
- C. Molded outside corners
- D. Stock length: 12'-0'
- E. High impact textured vinyl cover
- F. Fasteners: 1/32" (813) on center

3.1.2 Continuous aluminum retainer:

- A. Mill finish
- B. alloy 6063-T52
- C. 0.062" thick

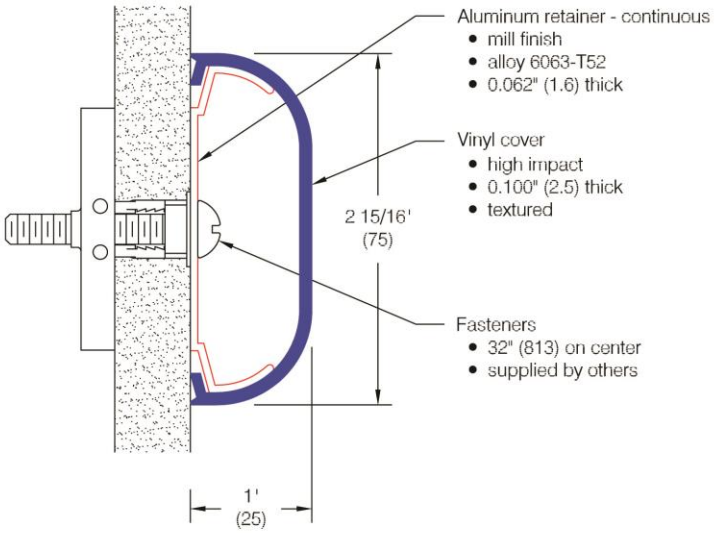
3.1.3 Color:

As selected by Architect from manufacturer's full range.

4. INSTALLATION

Provide and install wall guards as indicated on sheet A4.2. Shop drawings are to be submitted and approved by the Architect prior to final order or installation. The G.C. shall coordinate ordering (sizes, end caps, and related parts), purchase and install.

WG-3 Wall Guard



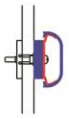
Features:

- Class A fire rating
- Molded end caps
- Molded outside corners
- Stock length 12'-0" (3658)

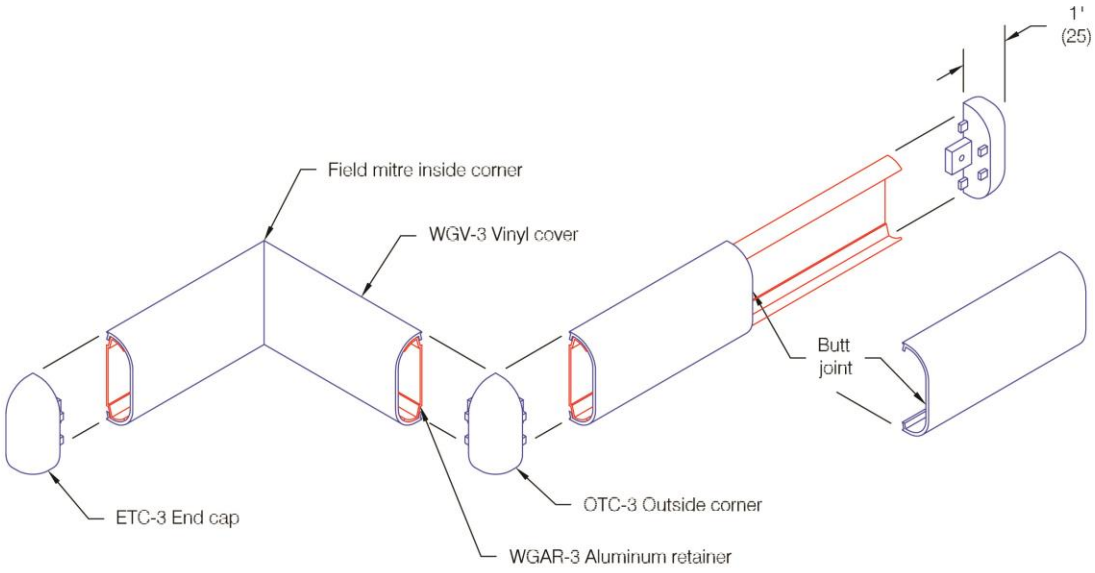
Finishes:

- Manufacturer's standard colors
- Custom colors available
- Grooved (see WD.21.0)

Optional mounting:



WD.20.0



End of Section 10260

SECTION 10500

SPECIALITES

1. GENERAL
All work included under this heading shall be subject to the General Conditions of the entire operation. This Contractor is required to refer especially thereto.

2. WORK INCLUDED
This section of the specifications shall include the furnishing of all labor and materials as required with the installation of the following:
1. Fire Extinguisher with Cabinet
2. Door Hardware

3. QUALITY OF MATERIALS
All materials of every kind which enter into the construction of this work shall be of the best obtainable in the market for use in the best grade of construction.

4. QUALITY OF WORKMANSHIP
All work that is to be performed under these specifications shall be done by the mechanics and artisans skilled in their respective trades, in order to produce first-class installation of the work.

5. SUBMITTALS
SHOP DRAWINGS AND PRODUCT DATA: Submit Shop Drawings and Product Data.
Show in detail the methods of installation, fastening and supports, location and sizes of specialty items, anchoring, hangers, and other pertinent data and information. Submit details drawn to scale at not less than 1/4 inch per foot.

6. FIRE EXTINGUISHER WITH CABINET
The Contractor shall furnish all labor and materials necessary to complete the installation of the specified fire extinguisher. Refer to the Floor plans of the Drawings for the fire extinguisher's location.

6.1 Provide and install (1) one fire extinguishers which is housed inside a cabinet, where indicated on the Drawings fully recessed, SS-O-2409, cabinets as manufactured by Larsen's Manufacturing Company, Minneapolis, MN, or the approved equal.

6.2 The cabinets shall be from the "Occult Series". The box shall be 20 GA cold rolled. The door shall be the vertical duo, panel door, and stainless steel with the standard DSA glass.

6.3 The cabinets shall be sized to house the specified extinguisher.

6.4 The words "Fire Extinguisher" in vinyl cut letters shall be applied onto the door.

6.5 All equipment shall apply with the requirements of Underwriter's Laboratories and local ordinances.

End of Section 10500

SECTION 10520

FIRE EXTINGUISHER

1. **GENERAL**
   All work included under this heading shall be subject to the General Conditions of the entire operation. The Contractor for this portion of the work is required to refer especially thereto.

2. **WORK INCLUDED**
   The Contractor shall furnish all labor and materials necessary to complete the installation of the specified fire extinguisher.
   2.1 Refer to the Floor plans of the Drawings for fire extinguisher's location.

   2.2 The General Contractor shall provide wall/stud thickness as required to properly receive the cabinet.

   2.3 Spacing of the cabinet shall not exceed 150'-0", refer to the code plan which illustrates a 75'-0" radius centered on the fire extinguisher.

3. **FIRE EXTINGUISHER**
   3.1 Provide and install where indicated on the drawings and/or specified herein extinguisher as manufactured by Larsen's Manufacturing Company, Minneapolis, MN, or the approved equal.

   3.2 Furnish and install one (1), Class "A", MP10 fire extinguisher, which shall be installed inside a cabinet.

4. **FIRE EXTINGUISHER CABINET**
   4.1 Provide and install where indicated on the Drawings one (1) fully recessed, SS-O-2409, cabinet as manufactured by Larsen's Manufacturing Company, Minneapolis, MN, or the approved equal.

   4.2 The cabinet shall be from the "Occult Series". The box shall be 20 GA cold rolled. The door shall be the vertical duo, panel door, stainless steel with the standard DSA glass.

   4.3 The cabinet shall be sized to house the specified extinguisher.

   4.4 The words "Fire Extinguisher" in vinyl cut letters shall be applied onto the door.

   4.5 The color of the vinyl letters shall be selected by the Architect.

5. All equipment shall comply with the requirements of Underwriter's Laboratories and local ordinances.

End of Section 10520

SECTION 230000

GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All Products shall be made in America or comply with the Buy American Act.

B. Provisions of the General Conditions, Supplementary Conditions and Division 01 - General Requirements, and applicable provisions elsewhere in the Contract Documents apply to work of Division 23.

C. In case of disagreement between Drawings and Specifications, or within either document itself, obtain a written clarification from the Mechanical Engineer through the Architect. Failure to obtain clarification prior to bid will result in the better quality and greater quantity being required during the construction phase without additional reimbursement.

1.2 DESCRIPTION OF WORK

A. Work Included: Unless specified otherwise, provide all supervision, labor, materials, transportation, equipment, hauling, and services necessary for a complete and operational mechanical system. Provide all incidental items such as offsets, fittings, etc. required as part of the work even though not specifically shown on Contract Drawings or in Specifications.

B. Inspection: Inspect work proceeding or interfacing with work of Division 23 sections prior to submitting bid and report any known or observed defects that affect the Mechanical Design to the General Contractor. Do not proceed with the construction work until defects are corrected.

C. The mechanical contractor shall provide temporary heating and cooling as directed and scheduled by general contractor/construction manager. If permanent heating and cooling systems are chosen to be utilized, extended warranties on all equipment shall be in place prior to use. In addition to extended warranties, contractor shall provide weekly temporary filter changes at all permanent air distribution equipment being used to ensure ductwork remains clean for owner acceptance.

1.3 REFERENCES

A. General:

1. For products or workmanship by Association, Trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
2. The date of the standard is that which is in effect as of the date of the Contract Documents, except when a specific date is specified.

1.4 QUALITY CONTROL

A. Materials and apparatus required for the work shall be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces.

B. Unless otherwise specifically indicated, equipment and materials shall be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

1.5 EXAMINATION OF CONTRACT DRAWINGS AND SPECIFICATIONS

A. The Mechanical Drawings show the general arrangement of piping, ductwork, mechanical equipment, and appurtenances, and shall be followed as closely as actual building construction and the work of other trades will permit.

B. The Architectural and Structural Drawings shall be considered part of the mechanical work insofar as the Drawings furnish this Division with information relating to design and construction of the building.

C. Field verify building dimensions governing mechanical work. Do not scale the Mechanical Drawings for dimensions. If field dimensions are not available take dimensions, measurements, locations, levels, etc. from the Architectural Drawings and the approved Shop Drawings submitted on the actual equipment to be furnished.

D. The Mechanical Contractor shall request the Test and Balance (TAB) Contractor perform an early review of the Contract Documents for the purpose of becoming familiar with project requirements & identifying areas where proper balancing cannot be achieved. The report requirements are referred to in Division 23, Testing, Adjusting and Balancing section, "Submittals." Forward a copy of the report to the mechanical engineer for review. The Mechanical Contractor shall modify the system as recommended by the TAB Contractor or refer unresolved issues to the Mechanical Engineer for resolution prior to ordering of ductwork and equipment. Unresolved balancing issues from untimely or incomplete application of these requirements will be the responsibility of the Mechanical Contractor to correct.

E. No extra compensation shall be claimed or allowed due to differences between the actual dimensions and those indicated on the Drawings.

F. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the General Contractor and obtain written instructions for any changes necessary. Report any inconsistencies between the drawings and specifications and the installation requirements of equipment manufacturers.

G. Order of Precedence: The precedence of Mechanical Construction Documents is as follows:

1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.
2. Should there be a conflict within the Specifications or within Drawings of the same scale, the more stringent or higher quality requirements shall apply.
3. In the Drawings, the precedence shall be figured dimensions over scaled dimensions and noted materials over graphic indications.
4. Should a conflict arise between the Drawings and the Specifications the most stringent shall have precedence.
5. Should there be a conflict in dimensions or locations between Mechanical Drawings and/or Architectural/Structural Drawings, the Architectural/Structural Drawings shall have precedence.

1.6 EXAMINATION OF PROJECT SITE

A. Examine site carefully to determine conditions to be encountered, work to be performed, equipment, materials to be transported, stored, furnished, and other features applicable to completion of work.

B. Study Drawings and specifications, report inconsistencies, errors, omissions, or conflicts with codes and ordinances.

C. Submittal of bid will indicate satisfactory examination of the Documents have been made, and applicable allowances included in the bid.

1.7 REGULATORY REQUIREMENTS

A. Refer to Architectural Drawings and Division 01 specifications for a list of applicable codes.

B. Execute work per Underwriters, Public Utility, Local and State Codes, Ordinances and applicable regulations. Obtain and pay for required permits, inspections, and certificates. Notify Architect of items not meeting said requirements.

C. Comply with latest editions of all applicable codes, standards, ordinances and regulations in effect as of the date of the Contract Documents.

D. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.

E. Where hourly fire and smoke ratings are indicated and required, whether or not shown, provide components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

1.8 COORDINATION

A. The Contractor shall plan all of his work in advance, and shall inform the General Contractor of the proposed construction schedule and anticipated completion date upon request. Contractor shall complete the entire installation as soon as the condition of the remaining building construction will permit.

B. Before purchase, fabrication, or installation of items, determine if the installation will properly fit and can be installed as contemplated without interference with structural elements or the work of other trades.

C. Locations of pipes, ducts, switches, panels, equipment, and fixtures, shall be adjusted to accommodate the work or interferences anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.

D. Right of Way: Lines which pitch shall have the right-of-way over those which to not pitch. Lines whose elevations cannot be changed shall have right-of-way over lines whose elevations can be changed.

E. Offsets, transitions, and changes in direction of pipes and ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the Drawings.

F. Where major conflicts occur, contractor shall rely upon the Architect/Engineer to make final decision regarding priority of right-of-way. Contractor shall requires written clarification from the Architect/Engineer prior to conflict reaching critical stage requiring removal of previously installed equipment or system components either by himself or by other trades involved.

G. When directed by the Architect/Engineer, submit Shop Drawings showing interrelationship of various portions of work and work of other trades. Failure to properly coordinate may result in removal and relocation at expense to the Contractor.

H. Coordination Drawings:

1. The HVAC contractor shall prepare reproducible Coordination Layout and Installation Drawings (at least ¼" scale) for coordination of systems interferences and conflicts with other trades.
2. The Plumbing, Fire Protection, and Electrical Contractors, as well as acoustical and drywall ceiling contractors, are required to superimpose their Shop Drawings on the HVAC Drawings and verify layout and elevations to eliminate conflicts. Any conflicts shall be highlighted and these Drawings shall be forwarded to the Architect for resolution. Priority shall be given to "gravity"

systems above the ceiling. Each trade shall initial acknowledgement that the proceeding has been completed. No fabrication of ductwork, fire protection, or other prefabricated systems shall begin until these Coordination Drawings have been completed and review by the General Contractor and Architect/Engineers. Any Subcontractor that fabricates and installs items above the ceiling before the Coordinated Drawings are reviewed and conflicts resolved shall do so at their own risk, and be responsible to relocate said equipment in the event conflicts arise, at no cost to the Owner.

3. Duct layout on coordination drawings shall include duct size, length, fittings, and pressure class of each duct.
4. Additionally, all trades shall show the proposed location of access panels (for maintenance) in "hard" ceilings for access to HVAC boxes, control valves, damper motors, plumbing valves, fire protection drains, valves, light fixture remote ballasts, ceiling hung equipment, etc., for coordination with the reflected ceiling plans. Indicate on same Drawings the location of access panels in walls as well as location of plumbing cleanouts.
5. Upon Architect/Engineer completion of the review of the Coordination Drawings, the Design Team, General Contractor and Subcontractors shall conduct a pre-installation coordination meeting for all "fit-up" above ceilings. No ceiling shall be lowered without the expressed approval of the Owner and the Architect.

I. Coordinate all electrical work with Electrical Contractor. Read the Electrical Specification and report any inconsistencies. See "Electrical Wiring and Safety Device Work and Material Responsibilities" in this section.

J. Coordinate all cutting & patching with General Contractor.

K. Utility Interruptions: Coordinate mechanical utility interruptions with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

L. Where CAD files or Revit models are deemed beneficial by contactor for contractors use in coordination, a service charge will be assessed for file preparation.

M. Request for electronic files shall be submitted to Architect/Engineer with signed Data Release form including listed sheet numbers requested.

N. A service charge of $100 per sheet for preparation of electronic drawing files or Revit files will be charged for requested construction document sheets.

1.9 PROJECT CONDITIONS

A. Accessibility:

1. Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of work. Coordinate these requirements with the General Contractor. Such spaces and clearances shall be kept to the minimum size required.
2. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide better accessibility. Any changes shall be approved by the Architect prior to making the change.
3. Provide the General Contractor with the exact locations of access doors. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.
4. Demonstration of access will be required prior to project completion. The contractor is responsible for providing reasonable and safe access for all system components. Contractor to arrange with an Owner's Representative a time for the demonstration prior to the final punchlist.

B. Fabrication: Before installing and/or fabricating any lines of piping or ductwork the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural work.

C. Freeze Protection: Do not run pipes in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

D. Scaffolding, Rigging and Hoisting: Provide scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.10 SUBMITTALS

A. Within thirty (30) days after award of the Contract, submit to Architect complete catalog data and/or Shop Drawings for each item of material and for every manufactured item of equipment to be used in the work. Such data shall include specific performance data, material description, rating, capacity, dimensions, and type for each item of material, each manufactured item, and all component parts utilized in final operating mechanical system. Applicable data shall be underline in each applicable item identified in each catalog by the same identification acronyms used on the Drawings.

B. Seismic Restraint Plan

1. The contractor shall provide a vibration and seismic restraint plan for project designated in a Seismic Design Category C (with a seismic importance factor greater than 1.0), D, E, or F as found on the structural drawings. The plan shall include stamped and signed drawings for the state in which the project is located, details, equipment cutsheets, and analysis from one of the acceptable equipment manufacturers listed below for the entire project scope. The Contractor will provide the selected equipment manufacturer with a copy of the drawings, specifications, soils reports and any other pertinent information necessary to perform the vibration and seismic restraint analysis per pertinent codes.
2. Acceptable Manufacturers:

    a. Mason Industries, Inc.
    b. Kinetics Noise Control, Inc.
    c. M.W. Sausse & Co., Inc.
    d. Amber/Booth, a VMC Company.

C. This Contractor shall submit to the Architect the number of copies required by the General and Special Conditions of Division 01, but in no case less than four (4) copies.

D. Each item submitted shall bear the Contractor's stamp, be dated and signed certifying that he has reviewed and approved the Submittal.

E. For each item scheduled on the Drawings, submit a replication of that schedule indicating actual data of the submitted equipment in the schedule.

F. The review comments of the Architect and/or Engineer do not in any case supersede the Drawings and Specifications, and shall not relieve the Contractor from responsibility for deviations from the Drawings or Specifications unless the Contractor has called to the attention of the Architect and/or Engineer, in writing, such deviations at the time of submission, nor shall it relieve the Contractor from responsibility for errors of any sort in the items submitted.

G. Test Reports: Submit certified test reports as required by various Section of Division 23 showing compliance in accordance with the General Conditions of the Contract.

H. Deviations: It is the Contractor's responsibility to indicate deviations from the Plans and Specifications. Approval shall not be considered acceptance of the deviation unless it has been explicitly indicated.

1.11 SITE OBSERVATION REPORTS

A. During the construction period the Engineer may issue periodic site observation reports. The contractor shall immediately address the issues and provide a written response identifying the "Responsible Contractor," "Date," "Corrective Action Take," and "Recommendations."

B. The written response must be returned to the Architect no later than five (5) working days after receipt of the site observation report.

1.12 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions: Comply with Division 01 & Instructions to Bidders.

B. Contractors desiring to use alternate equipment or materials and manufacturers or suppliers desiring to furnish alternate materials or equipment in lieu of those specified, shall submit requests for approval to the Engineer not less than seven (7) calendar days prior to scheduled closing date for receipt of proposals.

C. Materials and equipment are specified by manufacturer and catalog numbers. The manufacturers and catalog numbers are used to establish a degree of quality and style for such equipment and material.

D. When alternate or substitute materials and equipment are used, Contractor will be responsible for space requirement, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Contractor shall provide drawings for alternate/substitute equipment in detail equal to the construction documents.

1.13 PROJECT RECORD DOCUMENTS

A. General: Comply with Division 01.

B. Job Site Documents: Maintain at the job site, one record copy of the following:

1. Drawings.
2. Specifications.
3. Addenda.
4. Reviewed Shop Drawings.
5. Field Test Records.

C. Do not use record documents for construction purposes. Maintain documents in clean, dry legible condition, apart from documents used for construction.

D. Record Information: Label each document "Record Document." Mark information with contrasting color using ink. Keep each record current. Do not permanently conceal any work until required information is recorded. Record the following information on drawings:

1. Horizontal and vertical location of underground utilities.
2. Location of internal utilities and appurtenances concealed in construction.
3. Field changes of dimension and detail.
4. Changes by change order or field order.

5. Details not on original Contract Drawings.

E. Contractor shall transfer all as-built information on to CAD files. Electronic copy will be provided upon request.

F. Record the following information on Specifications:

1. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed.
2. Changes by change order or field order.
3. Other matters not originally specified.

G. Shop Drawings: Maintain Shop Drawings as record documents recording changes made after review as specified for drawings above.

1.14 DELIVERY, STORAGE AND HANDLING

A. Deliver and store materials and equipment in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size, and color.

B. Protection: Make provisions for coordination with Owner and other Contractors for safe storage of materials and equipment. Store materials and equipment off the ground and under cover, protected from damage.

C. All items subject to moisture damage, such as controls, shall be store in a dry, heated space.

D. Large Items: Make arrangements with other Contractors on the job for introduction into the building of equipment too large to pass though finished openings. Schedule deliver of large equipment required special openings as required for installation without delaying the work of other project trades.

E. Acceptance: Check and sign for materials to be furnished by Division 23 and other trades for installation under Division 23 upon delivery. Assume responsibility for the storage and safekeeping of such materials from time of deliver until final acceptance.

F. Inspection: Stored material shall be readily accessible for inspection by the Architect until installed.

1.15 WARRANTIES

A. Warranty: In accordance with Division 01, provide a written warranty to the Owner covering the entire mechanical work to be free from defective materials, equipment and workmanship. If the warranty period is not defined in Division 01, the minimum warranty period will be for a period of one year after Date of Acceptance. Purchase of manufacturer's extended warranty may be required to comply with the warranty period requirement. During this period provide labor and materials as required to repair or replace defects at no additional cost to the Owner. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the General Contractor.

B. This warranty will be in addition to the terms of any specific equipment warranties or warranty modifications resulting from use of equipment for temporary heat or ventilation.

1.16 SCHEDULE OF TESTING

A. Provide testing in accordance with the General Conditions of the Contract. Make all specified tests on piping, ductwork and related system as necessary. Demonstrate the proper operation of equipment installed under this project.

B. Equipment shall not be tested, or operated for any purpose until fully lubricated in accordance with manufacturer's instructions and until connections to fully operative systems have been accomplished.

C. A schedule of testing shall be drawn up by the Division 23 Contractor in such a manner that it will shower areas tested, test pressure, length of test, date, time and signature of testing personnel. All testing must be performed in the presence of the General Contractor's Representative; his signature for verification of the test must appear on the schedule. At completion of testing, the schedule shall then be submitted in triplicate to the Architect.

D. Make sure operation and performance tests are made on seasonal equipment.

E. Complete all tests required by Code Authorities, such as smoke detection, life safety, fire protection and health codes.

1.17 DEMONSTRATION OF ACCESS

A. The Contractor shall demonstrate to the Owner's designated representative the access to all switches, valves, actuators, dampers, motors, lubrication lines, sensors and panels. Contractor shall correct deficiencies note by the Owner. Refer outstanding issues to the Architect/Engineer for resolution. Contractor to be responsible for arranging the demonstration prior to final inspection.

1.18 CERTIFICATES AND KEYS

A. Certificates: Upon completion of the work, deliver to the General Contractor one copy of Certificate of Final Inspection.

B. Keys: Upon completion of the work, submit keys for mechanical equipment, panels, etc. to the General Contractor.

1.19 OPERATING AND MAINTENANCE DATA

A. Include the following information in addition to operation and maintenance information required by Division 01 standards and other Division 23 standards.

B. Submit three (3) typed and bound copies of the maintenance manual, 8-1/2" x 11" in size, to the Architect, for review and approval. These approved copies shall then be transmitted to the Owner.

C. The manual shall be enclosed in a stiff-back, three-ring binder and shall have:

1. Table of Contents, Equipment List with identification used in contract documents.
2. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
3. Operating instructions for complete system, including procedures for fire or failure of major equipment and procedures for normal staring/operating/shutdown and long-term shutdown.
4. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
5. Manufacturer's data on each piece of equipment, including:

    a. Installation instructions.
    b. Drawings and Specifications (approved Shop Drawings).
    c. Part lists.
    d. Complete wiring and temperature control diagrams (approved Shop Drawings).
    e. Completed and approved TAB report.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

End of Section 230000

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 MOTOR CONNECTED AND CONTROLLED BY VARIABLE FREQUENCY DRIVES

A. Motors shall be NEMA Design "B", and U.L. Listed inverter duty rated motors for "PWM" drives with motor winding heater overload.

B. Motors shall comply with NEMA MG1, Part 31and can withstand the stress of 1600V peak with a 0.1 m second rise time.

C. Connect cooling fans as required via the variable frequency drive. Provide controls, contactor, and wiring as required.

D. Motors shall be provided with a shaft grounding ring.

1. A maintenance free, circumferential, conductive micro fiber shaft grounding (SGR) to discharge shaft currents to ground. The conductive microfibers shall redirect shaft currents and provide a reliable, very low impedance path from shaft to motor frame by-passing motor bearings entirely.
2. Vertical turbine pump motor, the upper shaft shall be provided with a coating to isolate the shaft from the bearings. The shaft grounding ring shall be installed within the motor casing. This information shall be provided with the shop drawings submittal for verification of method of installation and to ensure they are to be supplied.
3. Each motor shall be provided with SGR by the motor manufacturer or equipment manufacturer and shall not be field installed.
4. All motors sizes up to 100 h.p. (75kW) shall be guaranteed not to fail due to electrical bearing fluting damage, for the life of the motor.
5. Each motor equipped with his device shall be provided with an externally mounted tag stating that a SGR is installed.
6. Method of installation shall be as recommended by manufacturer however, epoxy mounted SGR's shall not be used.
7. Device shall have the following features:

    1) Protect motor and attached equipment.
    2) Provide long term effectiveness.
    3) Easy to install.
    4) Contamination proof.
    5) Effective at any R.P.M.

8. After each motor is installed, the contractor shall have a 3rd party test the installation to ensure no VFD induced shaft voltages are present and provide written documentation of the successful test results. If the testing is not successful, the installation shall be corrected prior to putting the motor into service. The testing must be performed with a Fluke 199C Scope Meter and the appropriate accessories for testing while the motor is in operation.

PART 3 - EXECUTION (Not Applicable)

End of Section 230513

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

1.2 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. 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.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 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. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. 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 or stainless 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 U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or 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 552, Type II cellular glass with 100-psig (688-kPa) or 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.

2.4 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, 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.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 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. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. 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.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. 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.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. 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.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. 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.

L. 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 weight-distribution 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 weight-distribution 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-silicate-insulation inserts of length at least as long as protective shield.
6. 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 1-1/2 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.

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 and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. 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. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
6. 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.
7. 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 carbon-steel plate, and with U-bolt to retain pipe.
8. 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.
9. 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.

K. 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.

L. 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.

M. 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. 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).

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. 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.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. 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.

P. Comply with MSS SP-69 for trapeze pipe-hanger 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 230548

VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Freestanding and restrained spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Restraining braces and cables.

1.2 ACTION SUBMITTALS

A. Product Data: For each product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Welding certificates.

C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.

H. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

I. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside 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. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside 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. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 VIBRATION-CONTROL DEVICE INSTALLATION

A. Coordinate with other trades and install roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
3. Brace a change of direction longer than 12 feet (3.7 m).

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

G. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

End of Section 230548

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.

1.2 ACTION SUBMITTAL

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Valve Tags:

1. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Tag Size: 1-1/2 round.
3. 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-fourths the size of principal lettering.
4. Fasteners: Brass wire bead chain.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. 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).
6. 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-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: Yellow.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. 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).

F. 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-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 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, 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 1-1/2 inches (38 mm) high.

2.4 PIPE MARKERS

A. Underground Pipe Marker Tape: Bright colored plastic ribbon tape, minimum 6 inches wide by 4 mil thick, continuously imprinted to indicate piping service, manufactured for direct burial service.

B. Underground Metallic Detection Tape: Bright colored plastic ribbon tape, minimum 6 inches wide by 4 mil thick, metallic film bonded to tape, continuously imprinted to indicate piping service, manufactured for direct burial service.

2.5 UTILITY MARKERS

A. Cast Aluminum, 4x7 inch top with integrally cast name of piping system; integrally cast spike, minimum 10 inches long. As manufactured by Lake Shore Markers, Erie PA; or approved equal.

B. Heading: "CAUTION"; In yellow letters on black background.

2.6 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. 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).

F. 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-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

PART 3 - EXECUTION

3.1 PREPARATION

A. Mechanical Contractor shall 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 prior to identification marking placement.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: ASME/ANSI A13.1 Marker Color Chart.

B. 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.

C. Pipe Label Color Schedule:

1. Chilled-Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

2. Condenser-Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

3. Heating Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

4. Refrigerant Piping:

   a. Background Color: Green.
   b. Letter Color: White.

5. Low-Pressure Steam Piping:

   a. Background Color: Green.
   b. Letter Color: White.

6. High-Pressure Steam Piping:

   a. Background Color: Green.
   b. Letter Color: White.

7. Steam Condensate Piping:

   a. Background Color: Green.
   b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 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 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.

1.2 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.

1.3 ACTION SUBMITTALS

A. LEED Submittals:

1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.4 INFORMATIONAL SUBMITTALS

A. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

B. Certified TAB reports.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC pr NEBB 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.

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."

PART 2 - PRODUCTS (Not Applicable)

2.1 TEST AND BALANCE CONTRACTORS

A. Subject to compliance with requirements, provide services for one of the Independent Test and Balance Contractors:

1. Allied Laboratories
   Wichita, Kansas
   (316) 262-2691

2. Quality Test and Balance
   Wichita, Kansas
   (316) 796-0030

3. Energy Management and Control Corporation
   Topeka, Kansas
   (785) 233-0289

4. Pro Balance
   Blue Springs, Missouri
   (816) 228-7800

5. Precisionaire
   Grain Valley, Missouri
   (816) 847-1380

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 ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. 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.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. 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.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. 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" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

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," 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. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. 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, heat-recovery 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 for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in 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, full-heating, 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 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7 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.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

    a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and comply with requirements in Section 232123 "Hydronic Pumps."

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

    a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. 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.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. 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.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 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.

3.11 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.

3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.12 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser-water flow rate recirculating through the cooling tower.
6. Measure cooling-tower spray pump discharge pressure.
7. Adjust water level and feed rate of makeup water system.
8. Measure flow through bypass.

3.13 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.14 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.15 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 electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.

5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. 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.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.16 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

4. Balance each air outlet.

3.17 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 5 percent.
4. Cooling-Water Flow Rate: Plus or minus 5 percent.

3.18 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.19 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

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.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

End of Section 230593

SECTION 230713

DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, exposed supply and return.

B. Related Section:

1. Section 233113 "Metal Ducts" for duct liner.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products 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. Shop Drawings: Include completed plates from the National Commercial & Industrial Insulation Standards Manual (Volume 6 or later edition) for the following applications:

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.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. 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.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. See metal duct specification for duct liner requirements.

B. 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.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. 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.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. 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.

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

    a. CertainTeed Corp.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap.

H. 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.

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

    a. CertainTeed Corp.; Commercial Board.
    b. Fibrex Insulations Inc.; FBX.
    c. Johns Manville; 800 Series Spin-Glas.
    d. Knauf Insulation; Insulation Board.
    e. Manson Insulation Inc.; AK Board.
    f. Owens Corning; Fiberglas 700 Series.

2.2 FIRE-RATED INSULATION SYSTEMS

A. 1 and 2 Hour; zero clearance Applied Fire Protection for Commercial Kitchen Grease Ducts when tested in accordance with ASTM E 2336 – Passes all 5 Acceptance Criteria in Sections 16.1 to 16.5 – Reference ICC-ES Building Code Report ESR 2213 or ESR 2832, also reference UL Listing HNKT G-18.

B. 1 and 2 Hour Applied Fire Protection when tested in accordance with UL 1978; Compliant per Intertek Listing TC/BI 120-01.

C. 1 and 2 Hour F- and T-Rated Through Penetration Firestop when tested in accordance with ASTM E 814 (UL 1479): UL Through Penetration listings; C-AJ-1562; C-AJ-7004; C-AJ-7012; C-AJ-7014; C-AJ-7019; C-AJ-7021; C-AJ-7047; C-AJ-7095; C-AJ-7098; C-AJ-7119; F-A-1093; F-A-1094; F-A-3048; F-C-7036; FC-7037; W-L-7041; W-L-7099; W-L-7121; W-L-7145; W-J-7086.

D. 1 and 2 Hour Applied Fire Protection for Ventilation Air Duct when tested in accordance with ISO 6944-1985 - Reference UL Listings HNLJ V19; HNLJ V29;

E. Manufacturers: Subject to compliance with requirements, provide one of the following:

1. Products:

a. CertainTeed Corp.; FlameChek.
b. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
c. Thermal Ceramics; FireMaster XL.
d. 3M; Fire Barrier Wrap Products.
e. Unifrax Corporation; FyreWrap.

F. Access Doors (Fire Rated): Thermal Ceramics FastDoor XL (or equal) for duct access to Type 1 commercial kitchen hood exhaust ductwork: Install access openings at each change in direction and at intervals as required by code. Insulation cover system shall be tested and listed by UL (HNKT G18) to provide zero clearance to combustible construction and [1] [2]-hour fire rating per ASTM E 2336. Duct access cover panel shall be tested and listed by UL (YYXS.MH47995) with integral neoprene gasket to provide liquid tight seal and shall have a high temperature gasket and signage "Access Door – Do not Obstruct" compliant to code and NFPA 96. Installation shall be performed by an experienced contractor per manufacturer instructions and applicable UL Listings. Sheet metal and insulation contractors shall coordinate installation of the FastDoor XL and the duct enclosure system.

G. Refer to Specification Section 23 51 00 Breechings, Chimneys and stacks for pre-engineered Listed grease duct systems. Listed grease duct systems shall be used in areas where duct is exposed to view.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.

d. Mon-Eco Industries, Inc.; 22-25.

2. 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).
3. 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. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. 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).
3. 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. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. 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).
3. 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."

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

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. 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.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. 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. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: White.
6. 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).
7. 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. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts.

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

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

D. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

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

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

2. Sheet and roll stock ready for shop or field sizing.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
5. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.

E. 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 or stucco-embossed aluminum-foil facing.

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

   a. Polyguard Products, Inc.; Alumaguard 60.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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

   a. ABI, Ideal Tape Division; 491 AWF FSK.

b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

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

a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.

2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.

2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick3/4 inch (19 mm) wide with wing seal or closed seal.

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

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

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

        1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
        2) GEMCO; Perforated Base.
        3) Midwest Fasteners, Inc.; Spindle.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    c. Spindle: Copper or zinc-coated, low-carbon steel, Aluminum, or Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened 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. Products: Subject to compliance with requirements, provide one of the following:

        1) GEMCO; Nylon Hangers.
        2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

    b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
    c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-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. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
        2) GEMCO; Peel & Press.
        3) Midwest Fasteners, Inc.; Self Stick.

    b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    c. Spindle: Copper or zinc-coated, low-carbon steel, Aluminum, or Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    d. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel aluminum stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

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

        1) AGM Industries, Inc.; RC-150.
        2) GEMCO; R-150.
        3) Midwest Fasteners, Inc.; WA-150.
        4) Nelson Stud Welding; Speed Clips.

    b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) GEMCO.
        2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. C & F Wire.

2.11 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.

B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Installation shall conform to the National Commercial & Industrial Standards Manual published by the Midwest Insulation Contractors Association (MICA). www.micainsulation.org

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

C. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

D. 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.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

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.

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). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 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 duct flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation. Do not compress more than 25 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.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Roofing Contractor shall seal penetrations with flashing sealant. Duct penetrations must be completed and insulated before roof is sealed.
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.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. General Contractor shall 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).

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).

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).

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.

1. Install capacitor-discharge-weld pins and speed washers, or stick pins with speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (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.

2. 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) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F (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).

3. 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.
4. 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.
5. 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 insulation pins.

1. Install capacitor-discharge-weld pins and speed washers, or stick pins with speed washers, or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches (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.

2. 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) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F (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).

3. 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.
4. 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.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. 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.

C. 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 stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies.

D. Grease wrap installation:

1. Install 2 layers of FireMaster FastWrap XL or equal for a 1 and 2 hour commercial kitchen grease duct applications per ASTM E 2336.

2. General Installation Instructions for Double Layer Installations: The inside layer of FireMaster FastWrap XL blankets are cut to a length that will fit around the duct and meet with a tight butt joint. Adjacent blankets on the inside layer are tightly butted against each other. The outside

layer is cut to a length that will fit around the duct and overlap itself no less than 3 inches (152 mm). Adjacent blankets on the outside layer overlap each other a minimum of 3", or they can be fitted together with a tight butt joint and covered with a 6 inches (305 mm) wide collar centered over the butt joint. Cut edges of the blanket shall be taped with aluminum foil tape to prevent exposed edges of the insulation from wicking of condensation moisture in air ventilation ducts or grease from a leaking grease duct joint. During installation the blankets are temporarily held in place with filament tape until the wrap is mechanically attached with steel bands or steel insulation pins.

3. Mechanical Fastening of Enclosure Material to Ductwork: Banding - Carbon steel or stainless steel banding is used to hold the outer layer of the blanket enclosure in place. Banding is minimum 1/2 inch (12.7 mm) wide, and is placed around the entire perimeter of the duct on maximum 10-1/2 inches (267 mm) centers and 1-1/2 inches (38 mm) from each blanket or collar edge.

4. Pinning - To prevent blanket sag on duct spans 24 inch wide (610 mm) or larger, minimum 12-gauge steel insulation pins are welded to the duct along bottom horizontal and outside vertical runs in columns spaced 12 inches (305 mm) apart, 6 to 12 inch (152 to 305 mm) from each edge, and on 10-1/2 inches (267 mm) centers. Pins are also required 1 inch (25 mm) from the end of a duct and 1 inch (25 mm) from any edge near a 90° bend spaced 6 inch (152 mm) apart. Pins are locked in place with 1-1/2 inch (38 mm) diameter or 1-1/2 inch (38 mm) square galvanized steel speed clips or cup head pins. Pins are turned down or the excess cut off to eliminate sharp edges.

5. Grease Duct Access Door Installation: Provide UL Listed liquid tight Thermal Ceramics FastDoor XL access doors where required by code. Sheet metal and insulation contractors shall coordinate installation of FastDoor XL.

3.7 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Painting Contractor shall paint jacket with paint system identified below where required by architect or engineer:

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.8 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 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.

3.9 DUCT INSULATION SCHEDULE, GENERAL

(All supply and return ductwork shall have duct liner unless specified to have no duct liner. See Metal Ducts Section 23 31 13 for requirements.)

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

(All supply and return ductwork shall have duct liner unless specified to have no duct liner. See Metal Ducts Section 23 31 13 for requirements.)

A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

D. Concealed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density. Apply insulation from fan discharge at exterior to 20'-0" along duct towards exhaust discharge.

E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating. Two layers, 1-1/2 inches each per manufacturers installation guidelines.

F. Exposed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

G. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating. Two layers, 1-1/2 inches each per manufacturers installation guidelines.

H. Exposed ductwork in mechanical room shall be insulated with 2 inch thick 3-lb/cu. ft. ductboard with FSK.

I. Exposed round duct in mechanical room shall be insulated with 2.5-lb/cu.ft. microflex with FSK.

3.11 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option. Exterior ducts shall have aluminum jacket.

B. Supply-Air Duct and Plenum Insulation: Mineral-fiber board, 2 inches (50 mmthick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

C. Return-Air Duct and Plenum Insulation: Mineral-fiber board, 2 inches (50 mm) thick 3-lb/cu. ft. (48-kg/cu. m) nominal density.

D. Outdoor-Air Duct and Plenum Insulation: Mineral-fiber board, 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket (where noted on plans).

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. Aluminum, Stucco Embossed: 0.020 inch (0.41 mm) thick.

D. Ducts and Plenums, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. Aluminum, Stucco Embossed with 0.032 inch (0.81 mm) thick.

End of Section 230713

SECTION 230900

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. See Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each control device indicated.

B. Shop Drawings:

1. Schematic flow diagrams.
2. Power, signal, and control wiring diagrams.
3. Details of control panel faces.
4. Damper schedule.
5. Valve schedule.
6. DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
7. Control System Software: Schematic diagrams, written descriptions, and points list.

C. Where CAD files or Revit models are deemed beneficial by contactor for contractors use in coordination, a service charge will be assessed for file preparation.

D. Request for electronic files shall be submitted to Architect/Engineer with signed Data Release form including listed sheet numbers requested.

E. A service charge of $100 per sheet for preparation of electronic drawing files or Revit files will be charged for requested construction document sheets.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

B. Software and firmware operational documentation.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

A. Manufacturers:
1. Sandifer Engineering and Controls - TAC.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.3 DDC EQUIPMENT

A. Operator Workstation: PC-based microcomputer with minimum configuration as follows:

1. Motherboard: With 8 integrated USB 3.0 ports, integrated Intel Pro 10/100/1000 (Ethernet), integrated audio, bios, and hardware monitoring.
2. Processor: Intel Pentium I5-2320 Processor.
3. Random-Access Memory: 8.00 GB DDR3 memory, 1333 MHz.
4. Radeon HD 6450, 1 GB DDR3
5. Monitor: 24 inches wide screen LED monitor color.
6. Keyboard: Logitech K850 wireless keyboard QWERTY, 105 keys in ergonomic shape with unifying receiver.
7. Hard-Disk Drives: QTY 2, 1 TB Hard Drives, SATA-6, Setup as RAID 1.
8. CD/DVD Writer/Reader
9. Mouse: Logitech MX Master 2S wireless unifying receiver.
10. Standard Tower Case.
11. 2 TB backup portable hard drive, USB 3.0 interface.
12. Uninterruptible Power Supply: 2 kVa.
13. Operating System: Microsoft Windows 10 Premium 64 bit. Professional with high-speed Internet access.
14. Printer: Color, ink-jet type as follows:

a. Print Head: 4800 x 1200 dpi optimized color resolution.
b. Paper Handling: Minimum of 100 sheets.
c. Print Speed: Minimum of 17 ppm in black and 12 ppm in color.
d. Application Software.

B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.
    d. Software applications, scheduling, and alarm processing.
    e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation.

D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).

2.5 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.6 TIME CLOCKS

A. Manufacturers:

1. ATC-Diversified Electronics.
2. Grasslin Controls Corporation.
3. Paragon Electric Co., Inc.
4. Precision Multiple Controls, Inc.
5. SSAC Inc.; ABB USA.
6. TCS/Basys Controls.
7. Theben AG - Lumilite Control Technology, Inc.
8. Time Mark Corporation.

B. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers;

minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

C. Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.7 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Manufacturers:

   a. BEC Controls Corporation.
   b. Ebtron, Inc.
   c. Heat-Timer Corporation.
   d. I.T.M. Instruments Inc.
   e. MAMAC Systems, Inc.
   f. RDF Corporation.

2. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

   a. Set-Point Adjustment: Exposed.
   b. Set-Point Indication: Exposed.
   c. Thermometer: Exposed.
   d. Color: As selected by Architect from manufacturer's standard color selection.
   e. Orientation: Vertical.

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Manufacturers:

   a. BEC Controls Corporation.
   b. MAMAC Systems, Inc.
   c. RDF Corporation.

2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.

4. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 18 inches (460 mm) long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Exposed.
    d. Color: As selected by Architect from manufacturer's standard color selection.
    e. Orientation: Vertical.

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Humidity Sensors: Bulk polymer sensor element.

1. Manufacturers:

    a. BEC Controls Corporation.
    b. General Eastern Instruments.
    c. MAMAC Systems, Inc.
    d. ROTRONIC Instrument Corp.
    e. TCS/Basys Controls.
    f. Vaisala.

2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Exposed.
    d. Color: As selected by Architect from manufacturer's standard color selection.
    e. Orientation: Vertical.

5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F (0 to 50 deg C).
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Manufacturers:

    a. BEC Controls Corporation.
    b. General Eastern Instruments.
    c. MAMAC Systems, Inc.
    d. ROTRONIC Instrument Corp.
    e. TCS/Basys Controls.

f. Vaisala.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
   d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas or liquid service; range suitable for system; linear output 4 to 20 mA.

F. Room Sensor Cover Construction: Manufacturer's standard locking covers.

1. Set-Point Adjustment: Exposed.
2. Set-Point Indication: Exposed.
3. Thermometer: Exposed.
4. Color: As selected by Architect from manufacturer's standard color selection.
5. Orientation: Vertical.

G. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking, solid metal, ventilated.
3. Adjusting Key: As required for calibration and cover screws.

2.8 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

1. Manufacturers:

a. BEC Controls Corporation.
b. I.T.M. Instruments Inc.

2.9 GAS DETECTION EQUIPMENT

A. Manufacturers:

1. B. W. Technologies.
2. CEA Instruments, Inc.
3. Ebtron, Inc.
4. Gems Sensors Inc.
5. Greystone Energy Systems Inc.
6. Honeywell International Inc.; Home & Building Control.
7. INTEC Controls, Inc.
8. I.T.M. Instruments Inc.
9. MSA Canada Inc.
10. QEL/Quatrosense Environmental Limited.
11. Sauter Controls Corporation.
12. Sensidyne, Inc.
13. TSI Incorporated.
14. Vaisala.
15. Vulcain Inc.

B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 35 and 200 ppm.

C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.

D. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.10 THERMOSTATS

A. Manufacturers:

1. Erie Controls.
2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
3. Heat-Timer Corporation.
4. Sauter Controls Corporation.
5. tekmar Control Systems, Inc.

6. Theben AG - Lumilite Control Technology, Inc.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:

a. Time of day.
b. Actual room temperature.
c. Programmed temperature.
d. Programmed time.
e. Duration of timed override.
f. Day of week.
g. System mode indications include “heating,” “off,” “fan auto,” and “fan on.”

C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

E. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

F. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, and the following:

1. Reset: Manual.
2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.

G. Room Thermostat Cover Construction: Manufacturer's standard locking covers.

1. Set-Point Adjustment: Exposed.
2. Set-Point Indication: Exposed.
3. Thermometer: Exposed.
4. Color: As selected by Architect from manufacturer's standard color selection.
5. Orientation: Vertical.

H. Room thermostat accessories include the following:

1. Insulating Bases: For thermostats located on exterior walls.
2. Thermostat Guards: Locking, solid metal, ventilated.
3. Adjusting Key: As required for calibration and cover screws.
4. Set-Point Adjustment: ½-inch- (13-mm-) diameter, adjustment knob.

I. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

J. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

K. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet (6 m).
2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

L. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet (6 m).
2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

M. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

2.11 HUMIDISTATS

A. Manufacturers:

1. MAMAC Systems, Inc.
2. ROTRONIC Instrument Corp.

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.12 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

   a. Belimo Aircontrols (USA), Inc.
   b. IA Seriec T.A.C.
   c. Professional Series.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
   e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
12. Run Time: 30 seconds.

2.13 CONTROL VALVES

A. Manufacturers:

1. Danfoss Inc.; Air Conditioning & Refrigeration Div.
2. Hayward Industrial Products, Inc.
3. Magnatrol Valve Corporation.
4. Neles-Jamesbury.
5. Parker Hannifin Corporation; Skinner Valve Division.
6. Pneuline Controls.
7. Sauter Controls Corporation.

B. Control Valves: Valves must be selected so that the minimum stabilized control calve authority is greater than or equal to 0.25. Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: 250-psig; DZR Brass (Ametal®) or bronze body, bronze trim, rising stem, DZR Brass (Ametal®) disc with EPDM seat or renewable composition disc, and screwed ends with backseating capacity repackable under pressure. Basis of Design: Victaulic Series 786.
2. NPS 2-1/2 (DN 65) and Larger: 250-psig ductile iron body, DZR brass or bronze trim, rising stem, plug-type disc, flanged or grooved ends, and renewable seat and disc. Basis of Design: Victaulic Series 788 and 789.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
4. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate or the following:
    a. Two Position: Line size.
    b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly Valves: 300-psig (2065-kPa), maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable pressure-responsive EPDM or Buna N seat, sleeve and stem seals. Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.

1. Body Style: Grooved.
2. Disc Type: Electroless nickel-plated ductile iron, Aluminum bronze, Elastomer-coated ductile iron or Epoxy-coated ductile iron.

3. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.
4. Basis of Design: Vicatulic Vic 300 Master Seal.

E. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

F. Terminal Balancing Valve for Modulating Control:NPT female threaded ends, non-ferrous Ametal® DZR brass copper alloy body, PPS (polyphenylsulfide) plug, EPDM o-ring seat and spindle seal, stainless steel return spring, Nedox® coated Ametal® spindle, and 10-position setting dial. Suitable for working temperatures to +250°F (+120°C). Normally closed actuators shall be available factory installed. Victaulic Series TCM.

2.14 DAMPERS

A. Manufacturers:

1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.
6. Greenheck.
7. Ruskin.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).

1. Secure blades to ½-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

C. Temperature Control Contractor shall provide all control dampers and actuators unless damper is provided by unit manufacturer.

2.15 CONTROL CABLE

A. All DDC control wires shall be a minimum of two pairs, plenum rated, shielded, and with a drain wire. The LAN wire must be a 22-gauge wire conforming to the above standard as a minimum. All other wire must be eighteen- (18) or twenty- (20) gauge conforming to the above standard as a minimum. The wire cover shall be a bone or ivory color with orange or purple stripe. DDC wire must be installed in its own raceway and must be located 12" away from network and intercom wiring supported by D-rings, J-hooks, or in a cable tray.

B. All conduit and wiring for low voltage HVAC controls shall be by Temperature Controls Contractor.

C. All line voltage conduit and wiring for HVAC controls shall be by Electrical Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

B. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

C. Install automatic dampers according to Section 233300 "Air Duct Accessories."

D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

E. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

F. Install hydronic instrument wells, valves, and other accessories according to Section 232113 "Hydronic Piping."

G. Install refrigerant instrument wells, valves, and other accessories according to Section 232300 "Refrigerant Piping."

H. Install duct volume-control dampers according to Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."

I. Install electronic and fiber-optic cables according to Section 271500 "Communications Horizontal Cabling."

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Electrical Specifications "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Electrical Specifications "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Electrical Specifications "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.

8. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
9. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

B. Operational and Maintenance Training:
1. On-Site building engineer.
2. Minimum of three additional maintenance personnel.

Note: Manufacturer shall provide services for (4) four hour training sessions to instruct Owner's personnel in operation and maintenance. Schedule training with owner. Provide minimum 14-day notice.

End of Section 230900

SECTION 231123

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
2. Service Regulators: 65 psig (450 kPa) minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Steel Support 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.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

5. Viega MegaPress G Natural Gas System (Exterior Above grade Applications): Fittings: Cold Press Mechanical Joint Fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria ANSI/CSA LC4. Sealing elements for press fittings shall be HNBR. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect™) feature design (leakage path). MegaPress fittings with Smart Connect Feature assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation. Note: Verify pipe and fittings with applicable codes. Piping and fittings shall comply with CSA LC-4 and the latest edition of NFPA-54.

B. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet shall be threaded or suitable for welded connection.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    b. Outlet shall be threaded or suitable for welded connection.
    c. Bridging sleeve over mechanical coupling.
    d. Factory-connected anode.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.

4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches (1830 mm.)

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig (862 kPa).
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BrassCraft Manufacturing Company; a Masco company.

b. Conbraco Industries, Inc.; Apollo Div.
c. Lyall, R. W. & Company, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BrassCraft Manufacturing Company; a Masco company.
b. Conbraco Industries, Inc.; Apollo Div.
c. Lyall, R. W. & Company, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Lee Brass Company.
b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.

6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. PE Ball Valves: Comply with ASME B16.40.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Kerotest Manufacturing Corp.
   b. Lyall, R. W. & Company, Inc.
   c. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig (552 kPa).
8. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

G. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ASCO Power Technologies, LP; Division of Emerson.
   b. Dungs, Karl, Inc.
   c. Eclipse Combustion, Inc.
   d. Goyen Valve Corp.; Tyco Environmental Systems.
   e. Magnatrol Valve Corporation.
   f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
   g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.

6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

B. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Pacific Seismic Products, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 0.5 psig (3.45 kPa) 7 psig (48 kPa) 60 psig (414 kPa).
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS 2 (DN 50) and smaller.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Actaris.
    b. American Meter Company.
    c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    d. Invensys.
    e. Maxitrol Company.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Canadian Meter Company Inc.
   b. Eaton Corporation; Controls Div.
   c. Harper Wyman Co.
   d. Maxitrol Company.
   e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.7 DIELECTRIC UNIONS

A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International Ltd.
   e. Matco-Norca, Inc.
   f. McDonald, A. Y. Mfg. Co.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.

2. Description:

   a. Standard: ASSE 1079.
   b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

F. Install fittings for changes in direction and branch connections.

G. Install pressure gage upstream and downstream from each service regulator.

3.2 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. 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.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
    a. Exception: Tubing passing through partitions or walls does not require striker barriers.
5. Prohibited Locations:
    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gauge upstream and downstream from each line regulator.

W. Install sleeves for piping penetrations of walls, ceilings, and floors.

X. Install sleeve seals for piping penetrations of concrete walls and slabs.

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.4 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports.

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).

3.6 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

A. Comply with requirements for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.8 PAINTING

A. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MP1 EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel.
d. Color: Per architects direction.

B. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MP1 INT 5.1Q.

    a. Prime Coat: Alkyd anticorrosive metal primer.
    b. Intermediate Coat: Interior latex matching topcoat.
    c. Topcoat: Interior latex gloss.
    d. Color: Per architects direction.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.9 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:

1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.

B. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints (up to and including 2” NPS).
2. Steel pipe with wrought-steel fittings and welded joints (2 1/2” NPS and larger).

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.11 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints (up to and including 2” NPS).
2. Steel pipe with wrought-steel fittings and welded joints (2 1/2” NPS and larger).

C. Underground, below building, piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints (up to and including 2” NPS).
2. Steel pipe with wrought-steel fittings and welded joints (2 1/2” NPS and larger).

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping. Vent shall be extended to exterior.

F. Gas piping in return air plenums shall be encased in containment conduit. Vent encasement pipe to exterior or inside boiler room.

3.12 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground: PE valves.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

C. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

End of Section 231123

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 and flat-oval ducts and fittings - spiral duct.
3. Double-wall round and flat-oval ducts and fittings - spiral duct.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.
8. Seismic-restraint devices.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Duct product data.
2. Liners and adhesives.
3. Sealants and gaskets.
4. Hangers and supports.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
6. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products 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. 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, seismic restraints, and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to ¼" 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.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. 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, 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 2-2, "Rectangular 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. 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." NOTE: Adjustable elbows will be allowed. All joints must be sealed. NOTE: Adjustable elbows will be allowed. All joints must be sealed.

E. Exposed ductwork shall be free of defects and constructed of paint lock sheet metal.

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS - SPIRAL DUCT

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.

1. Manufacturers: Subject to compliance with requirements, provide spiral duct products by one of the following:

    a. Lindab Inc.
    b. McGill AirFlow LLC.
    c. SEMCO Incorporated.
    d. Sheet Metal Connectors, Inc.
    e. Spiral Manufacturing Co., Inc.
    f. Wichita Sheet Metal.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. 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."

1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.

D. 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."

1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

E. 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."

F. Exposed ductwork shall be free of defects and constructed of paint lock sheet metal.

2.3 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS - SPIRAL DUCT

A. Manufacturers: Subject to compliance with requirements, provide spiral duct products by one of the following:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.
5. Wichita Sheet Metal.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. 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."

    a. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.

2. 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."

    a. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

3. 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."

D. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.

E. Interstitial Insulation: Minimum 1.0-inch (or greater if noted on plans) fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with film that meet flame and smoke spread requirements. Locate against perforated face - no fibers in air stream - complying with UL 181, Class 1.

F. Exposed ductwork shall be free of defects and constructed of paint lock sheet metal.

2.4 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: G60 (Z180).
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 (Z180).
2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil (0.025 mm) thick on opposite surface.
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. 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.

F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: Black.
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

H. 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.

I. 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).

2.5 DUCT LINER

A. Rectangular duct sizes called out on plans are clear inside dimensions. Increase duct size as required to accommodate liner. See below for specific ducts requiring liner and those with wrap.

1. Supply ductwork: 1" duct liner. Applied entire length.
2. Return ductwork: 1" duct liner. Applied entire length.
3. Exhaust ductwork: 1" duct liner. Apply insulation from fan back down the duct for a distance of 20'– 0" in all directions. Apply in all branches if multiple branches occur near the fan.
4. DOAS Supply ductwork: 1½" duct wrap. Applied Entire length. See Duct Insulation Specification Section 23 07 13 for requirements.
5. DOAS Exhaust/Return ductwork: 1½" duct wrap. Apply insulation from fan discharge to exterior discharge at louver or roof hood. See Duct Insulation Specification Section 23 07 13 for requirements.
6. VAV primary air supply ductwork: 1½" duct wrap. Applied entire length. See Duct Insulation Specification Section 23 07 13 for requirements.
7. Outdoor air ductwork: 1½" duct wrap. Applied entire length. See Duct Insulation Specification Section 23 07 13 for requirements.

B. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. CertainTeed Corporation; Insulation Group.
   b. Johns Manville.
   c. Knauf Insulation.
   d. Owens Corning.

2. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Solvent or Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

a. 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).
b. 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. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA Inc.
b. Armacell LLC.
c. Rubatex International, LLC

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

a. 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).
b. 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. Natural-Fiber Duct Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor and complying with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bonded Logic, Inc.
b. Reflectix Inc.

2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at75 deg F (24 deg C) mean temperature when tested according to ASTM C 518.
3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to ASTM E 84; certified by an NRTL.

4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

    a. 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).
    b. 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."

E. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

F. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).
7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 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: 4 inches (102 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. 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."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. 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.

2.7 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 and flat-oval 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 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 12 feet (3.7 m) in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches (38 mm) from bottom of duct.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 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.

3.5 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.

3.6 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.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Painting shall be performed by Painting Contractor. Mechanical Contractor shall coordinate requirements with other trades.

B. Paint exposed ductwork as directed by Architect.

3.8 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. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    b. Supply Ducts with a Pressure Class of 4-Inch wg (1000 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    c. Return Ducts with a Pressure Class of 4-Inch wg (1000 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    d. Exhaust Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    e. Outdoor Air Ducts with a Pressure Class of 4-Inch wg (1000 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 50 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 seven days' 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.

3.9 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

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.

3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive 1-inch wg (250 Pa.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Constant-Volume Air-Handling Units:

a. Pressure Class: Positive 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units:

a. Pressure Class: Positive 4-inch wg (1000 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 3.
d. SMACNA Leakage Class for Round and Flat Oval: 3.

4. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 1-inch wg (250 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: A.

c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 1-inch wg (250 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 Air-Handling Units:

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.

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
c. Welded seams and joints.
d. Pressure Class: Positive or negative 3-inch wg (750 Pa).
e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
f. SMACNA Leakage Class: 3.

4. Ducts Connected to Dishwasher Hoods:

a. Type 304, stainless-steel sheet.
b. Exposed to View: No. 4 finish.
c. Concealed: No. 2D finish.
d. Welded seams and flanged joints with watertight EPDM gaskets.
e. Pressure Class: Positive or negative 2-inch wg (500 Pa).
f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
g. SMACNA Leakage Class: 3.

5. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:

a. Type 316, stainless-steel sheet.

1) Exposed to View: No. 4 finish.
2) Concealed: No. 2B finish.

b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.

c. Pressure Class: Positive or negative 4-inch wg (1000 Pa).
d. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
e. SMACNA Leakage Class: 3.

6. 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.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 1-inch wg (250 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum.

G. Liner:
Note: Refer to drawings. Specific areas/locations may require additional thicknesses. These thicknesses are noted on plans where different from this specification.

1. Supply Air Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.
2. Return Air Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.
3. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.
4. Supply Fan Plenums: Fibrous glass, Type II, 2 inch (50 mm) thick.
5. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II , 2 inches (50 mm) thick.
6. Transfer Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.

H. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts: 1” inch (25 mm) thick.
2. Return Air Ducts: 1 inch (25 mm) thick.
3. Exhaust Air Ducts: 1 inch (25 mm) thick.

I. 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 3-1, "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 or Welded.

J. 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 1500 fpm (5 to 7.6 m/s) or Lower: Conical tap.
b. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

End of Section 233113

SECTION 233300

AIR DUCT ACCESSORIES

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. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling radiation dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Flange connectors.
10. Duct silencers.
11. Turning vanes.
12. Remote damper operators.
13. Duct-mounted access doors.
14. Flexible connectors.
15. Flexible ducts.
16. Duct accessory hardware.
17. Acoustic Panels and Enclosures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

C. 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.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 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: G60 (Z180).
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. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. 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 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. Pottorff.
7. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 1000 fpm (5.1 m/s).

D. Maximum System Pressure: 1-inch wg (0.25 kPa).

E. Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.

F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch (150-mm) width, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:

1. Material: Nonferrous metal.
2. Diameter: 0.20 inch (5 mm).

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
    a. Sleeve Thickness: 20 gage (1.0 mm) minimum.
    b. Sleeve Length: 6 inches (152 mm) minimum.
6. Screen Mounting: Rear mounted.

7. Screen Material: Galvanized steel.
8. Screen Type: Bird.
9. 90-degree stops.

2.4 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. Pottorff.
7. Ruskin Company.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 1000 fpm (5.1 m/s).

D. Maximum System Pressure: 2-inch wg (0.5 kPa).

E. Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.

F. Blades:

1. Multiple, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum.
2. Maximum Width: 6 inches (150 mm).
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

G. Blade Seals: Neoprene.

H. Blade Axles: Galvanized steel.

I. Tie Bars and Brackets:

1. Material: Aluminum.
2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Synthetic or Stainless steel or Bronze.

L. Accessories:

1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.5 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. McGill AirFlow LLC.
    d. Nailor Industries Inc.
    e. Pottorff.
    f. Ruskin Company.
    g. Greenheck.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. 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.

5. 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.

6. Blade Axles: Galvanized steel.
7. 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.

8. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. McGill AirFlow LLC.
    d. Nailor Industries Inc.
    e. Pottorff.
    f. Ruskin Company.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
e. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

6. Blade Axles: Galvanized steel.
7. 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.

8. Tie Bars and Brackets: Aluminum.

C. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. McGill AirFlow LLC.
d. Nailor Industries Inc.
e. Pottorff.
f. Ruskin Company.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:

a. Hat shaped.
b. 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized, roll-formed steel, 0.064 inch (1.62 mm) thick.

7. Blade Axles: Galvanized steel.
8. 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.

9. Blade Seals: Neoprene.

10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

D. Low-Leakage, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. McGill AirFlow LLC.
    d. Nailor Industries Inc.
    e. Pottorff.
    f. Ruskin Company.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
    d. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

7. Blade Axles: Galvanized steel.
8. 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.

9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

E. 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.

F. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated 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.

2.6 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. McGill AirFlow LLC.
6. Nailor Industries Inc.
7. Pottorff.
8. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage. Unit shall leak less than 3cfm/sq. ft. at 1" of static pressure.

C. Frames:

1. Hat shaped.
2. 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of 6 inches (152 mm).
2. Parallel- and opposed-blade design.
3. Galvanized-steel.
4. 0.064 inch (1.62 mm) thick single skin or 0.0747-inch- (1.9-mm-) thick dual skin.
5. Blade Edging: Closed-cell neoprene.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- (13-mm-) diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

F. Bearings:

1. Oil-impregnated bronze.
2. 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.
3. Thrust bearings at each end of every blade.

2.7 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. NCA Manufacturing, Inc.
7. Pottorff.
8. Prefco; Perfect Air Control, Inc.
9. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm (10-m/s) velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory-installed, galvanized sheet steel.

1. Minimum Thickness: 0.05 (1.3 mm) thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.024-inch- (0.61-mm) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

2.8 CEILING RADIATION DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Nailor Industries Inc.
4. Pottorff.
5. Prefco; Perfect Air Control, Inc.
6. Ruskin Company.

B. General Requirements:

1. Labeled according to UL 555C by an NRTL.
2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

F. Fire Rating: 1 or 2 or 3 hours. Refer to Code Plan requirements.

2.9 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with welded corners and mounting flange.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.039-inch- (1.0-mm-) thick, galvanized sheet steel; length to suit wall or floor application[with factory-furnished silicone calking.

I. Damper Motors: Two-position action.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).

6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
7. Electrical Connection: 115 V, single phase, 60 Hz.

K. Accessories:

1. Auxiliary switches for signaling, fan control or position indication.
2. Test and reset switches, remote mounted.

2.10 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm (10-m/s) velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with welded corners and mounting flange.

F. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.

G. Smoke Detector: Integral, factory wired for single-point connection.

H. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- (1.6-mm-) thick, galvanized sheet steel.

I. Leakage: Class I.

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 0.039-inch- (1.0-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

L. Master control panel for use in dynamic smoke-management systems.

M. Damper Motors: Two-position action.

N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
7. Electrical Connection: 115 V, single phase, 60 Hz.

O. Accessories:

1. Auxiliary switches for signaling fan control or position indication.
2. Test and reset switches, remote mounted.

2.11 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gauge and Shape: Match connecting ductwork.

2.12 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dynasonics.
2. Vibro-Acoustics.
3. Industrial Acoustics Company.
4. Price.
5. Ruskin.
6. Aerosonics.

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Shape:

1. Rectangular straight with splitters or baffles.

2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90 (Z275), galvanized sheet steel, 0.040 inch (1.02 mm) thick.

E. Round Silencer Outer Casing: ASTM A 653/A 653M, G90 (Z275), galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches (600 mm) in Diameter: 0.034 inch (0.85 mm) thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches (660 through 1000 mm) in Diameter: 0.040 inch (1.02 mm) thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches (1060 through 1300 mm) in Diameter: 0.05 inch (1.3 mm) thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches (1370 through 1500 mm) in Diameter: 0.064 inch (1.62 mm) thick.

F. Inner Casing and Baffles: ASTM A 653/A 653M, G90 (Z275) galvanized sheet metal, 0.034 inch (0.85 mm) thick, and with 1/8-inch- (3-mm-) diameter perforations.

G. Special Construction:

1. Suitable for outdoor use.
2. High transmission loss casings where scheduled on plans.

H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:

1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Dissipative type with fill material.

a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression, Moisture-proof nonfibrous material.
b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

3. Lining: Glass Fiber Insulation.

J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints: Continuously welded or flanged connections.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Accessories:

1. Factory-installed end caps to prevent contamination during shipping.

L. Source Quality Control: Test according to latest ASTM E 477.

1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm (10-m/s) face velocity.
2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg (1500-Pa) static pressure, whichever is greater.

M. Capacities and Characteristics:

1. Refer to Duct Silencer Schedule for additional information.

2.13 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO Incorporated.

B. 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.

C. 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.

D. 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."

E. Vane Construction: Double wall.

2.14 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pottorff.
2. Ventfabrics, Inc.
3. Young Regulator Company.
4. Metropolitan Air Technology.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass or Copper or Aluminum.

D. Cable: Stainless steel.

E. Wall/Ceiling-Box Mounting: Recessed.

F. Wall/Ceiling-Box Cover-Plate: 1 inch diameter, nylon - paintable..

2.15 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Elgen Manufacturing.
5. Flexmaster U.S.A., Inc.
6. Greenheck Fan Corporation.
7. McGill AirFlow LLC.
8. Nailor Industries Inc.
9. Pottorff.

B. 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 Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
   b. Access Doors up to [18 Inches (460 mm)] Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Continuous and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0- to 8.0-inch wg (800 to 2000 Pa).
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

2.16 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Flame Gard, Inc.

3. 3M.
4. Firemaster.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).

F. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative.

2.17 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. 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.

E. 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).

F. 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).

G. 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).

H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).

2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

I. 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.

2.18 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements,provide products by one of the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.

B. Noninsulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.

1. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20 m/s).
3. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).

C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20 m/s).
3. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

D. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

2.19 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.

2.20 ACOUSTIC PANELS AND ENCLOSURES

A. Furnish and install Discharge Plenums Acoustic Panels and Enclosures of the sizes, configuration, and performance as described on plans and/or schedules. Enclosures will include, as required, acoustical panels, trims and mounting channels, sealant, hardware, doors and assembly drawings supplied by manufacturer for on site assembly by others.

B. Panel performance characteristics, including transmission loss and absorption coefficient, shall be attained through testing in accordance with the ASTM E90 and ASTM C423 test standards.

C. Manufacturer's performance data for dynamic insertion loss, generated noise and pressure drop shall be provided and shall be obtained in accordance with ASTM E90 and ASTM C423 test standards. Submittals shall include dimensions, openings, access door details, construction materials, material finishes, assembly instructions, and installation details.

D. Panels shall be tongue and groove construction and shall consist of 18 gauge solid steel skin, 22 gauge perforated steel liner, 18 gauge full depth splitters spaced maximum of 16" apart, and absorptive acoustic fiberglass media.

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 backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. 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.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct security bars. Construct duct security bars from 0.164-inch (4.18-mm)steel sleeve, continuously welded at all joints and 1/2-inch- (13-mm-) diameter steel bars, 6 inches (150 mm) o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch (63-by-63-by-6-mm) steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch (300-by-300-mm) hinged access panel with cam lock in duct in each side of sleeve.

I. Connect ducts to duct silencers rigidly.

J. 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. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot (15-m) spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. 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).

M. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

P. Connect terminal units to supply ducts directly. Do not use flexible ducts to change directions.

Q. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.

R. Connect flexible ducts to metal ducts with draw bands. Seal duct connection.

S. Install duct test holes where required for testing and balancing purposes.

T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

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. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

End of Section 233300

SECTION 233713

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Perforated diffusers.
4. Louver face diffusers.
5. Linear bar diffusers.
6. Linear slot diffusers.
7. Adjustable bar registers and grilles.
8. Concentric diffusers.

1.2 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.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Round Ceiling Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Carnes.
   b. METALAIRE, Inc.
   c. Nailor Industries Inc.
   d. Price Industries.
   e. Titus.
   f. Tuttle & Bailey.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel or Aluminum as per GRD schedule on drawings.
4. Finish: as per GRD schedule on drawings.
5. Pattern: see plans.

B. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carnes.
b. Krueger.
c. METALAIRE, Inc.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel or Aluminum as per GRD schedule on drawings.
4. Finish: as per GRD schedule on drawings.
5. Pattern: see plans.

C. Perforated Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carnes.
b. Krueger.
c. METALAIRE, Inc.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel backpan and pattern controllers, with steel or aluminum face as per GRD schedule on drawings.
4. Finish: as per GRD schedule on drawings.
5. Face Size: as per GRD schedule on drawings.

D. Louver Face Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carnes.
b. METALAIRE, Inc.
c. Nailor Industries Inc.
d. Price Industries.
e. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel or Aluminum.
4. Finish: as per GRD schedule on drawings.
5. Face Size: as per GRD schedule on drawings.
6. Mounting: as per GRD schedule on drawings.
7. Pattern: as per GRD schedule on drawings.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Bar Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carnes.
b. Krueger.
c. METALAIRE, Inc.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel or Aluminum or Stainless steel as per GRD schedule on drawings.
4. Finish: as per GRD schedule on drawings.

B. Linear Slot Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carnes.
b. Krueger.
c. METALAIRE, Inc.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material - Shell: Steel or Aluminum; fully insulated (front, back, end caps) as per GRD schedule on drawings.
4. Material - Pattern Controller and Tees: Aluminum.
5. Finish - Face and Shell: as per GRD schedule on drawings.
6. Finish - Pattern Controller: as per GRD schedule on drawings.
7. Finish - Tees: as per GRD schedule on drawings.
8. Slot Width: as per GRD schedule on drawings.
9. Number of Slots: One Two Three Four Insert number.

2.3 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carnes.
b. Krueger.
c. METALAIRE, Inc.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.

2. Material: Steel or Aluminum or Stainless steel as per GRD schedule on drawings.
3. Finish: as per GRD schedule on drawings.

2.4 CONCENTRIC DIFFUSERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Price Industries.
b. Krueger.
c. Titus.
d. Nailor Industries Inc.

2. Specified roof top A.C. units will utilize a concentric supply/return diffuser assembly complete with fixed blade extruded concentric diffuser and plenum. The diffusers shall be compatible with 2½ to 25 ton unitary package equipment as shown in the plans. Assembly shall include peripheral supply and control return with an internal one piece low pressure drop distribution plenum to ensure even, four-way air distribution and low noise. Plenum distribution assembly must be internally sealed to prevent short circuiting and all internal walls of the plenum shall be insulated. Internal insulation must comply with UL 181 and NFPA 90A. All exposed insulation edges shall be coated with NFPA approved sealant to prevent erosion.

3. Entire plenum assembly to be supported via hanger brackets. Hanger brackets to be provided by TITUS as an integral part of the plenum assembly. The assembly shall be capable of being installed in a T-bar ceiling, plaster ceiling or duct mounted in an open area. No exposed fasteners, wood or sheet metal adapters will be acceptable.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as 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.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

End of Section 233713

SECTION 237413

PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Electric-heating coils.
3. Gas furnace.
4. Economizer outdoor- and return-air damper section.
5. Ultra Violet Germicidal Irradiation (UV) System.
6. Airflow measuring stations.
7. Integral, space temperature controls.
8. Roof curbs.
9. Energy Recovery.
10. Wind/Seismic Restraint Brackets.

1.2 DEFINITIONS

A. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

B. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

D. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

F. VVT: Variable-air volume and temperature.

1.3 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Third party wind restraint calculations sealed by engineer. Calculations shall be provided from an independent design firm for each unit ensuring equipment is anchored to curb and designed for loads at project site. Factors that determine the number of brackets required include unit surface area, uplift, unit weight, restraint bracket design, shear strength of screws and unit location.

C. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigerant system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors & Heat Wheel: 5 year non-prorated.
2. Warranty Period for Gas Furnace Heat Exchangers: 10 year non-prorated for aluminized steel & 10 year non-prorated for stainless steel.
3. Warranty Period for Solid-State Ignition Modules: 3 year non-prorated.
4. Warranty Period for Control Boards: 3 year non-prorated.

5. Defective parts shall be repaired or replaced at no charge during warranty period.
6. If HVAC units are used during construction, cover all return air openings with MERV-8 filters and replace all filters regularly and immediately prior to occupancy. Contractor shall provide additional extended warranty for length of time used during construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON, Inc.
2. Daikin.
3. Engineered Air.
4. Trane - Horizon.
5. York – Addison Mfg.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.052 inch (1.3 mm) thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.034 inch (0.86 mm) thick.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1 inch (25 mm) thick; with thermal break.
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1.

1. Drain Connections: Threaded nipple both sides of drain pan.
2. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Condensate Trap: Provide condensate trap at depth recommended by manufacturer for installed application.

G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, forward curved or backward inclined, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Relief-Air Fan: Forward curved or Backward inclined, shaft mounted on permanently lubricated motor.

E. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

F. Motor Connected and Controlled by Variable Frequency Drives.

1. Motors shall be NEMA Design "B", and U.L. Listed inverter duty rated motors for "PWM" drives with motor winding heater overload.
2. Motors shall comply with NEMA MG1, Part 31and can withstand the stress of 1600V peak with a 0.1 m second rise time.
3. Connect cooling fans as required via the variable frequency drive. Provide controls, contactor, and wring as required.
4. Motors shall be provided with a shaft grounding ring.
   a. A maintenance free, circumferential, conductive micro fiber shaft grounding (SGR) to discharge shaft currents to ground. The conductive microfibers shall redirect shaft currents and provide a reliable, very low impedance path from shaft to motor frame by-passing motor bearings entirely.
   b. Each motor shall be provided with SGR by the motor manufacturer or equipment manufacturer and shall not be field installed.
   c. All motors sizes up to 100 h.p. (75kW) shall be guaranteed not to fail due to electrical bearing fluting damage, for the life of the motor.
   d. Each motor equipped with his device shall be provided with an externally mounted tag stating that a SGR is installed.
   e. Method of installation shall be as recommended by manufacturer however, epoxy mounted SGR's shall not be used.
   f. Device shall have the following features:
      1) Protect motor and attached equipment.
      2) Provide long term effectiveness.
      3) Easy to install.
      4) Contamination proof.
      5) Effective at any R.P.M.
   g. After each motor is installed, the contractor shall have a 3rd party test the installation to ensure no VFD induced shaft voltages are present and provide written documentation of the successful test results. If the testing is not successful, the installation shall be corrected prior to putting the motor into service. The testing must be performed with a Fluke 199C Scope Meter and the appropriate accessories for testing while the motor is in operation.

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections complying with ASHRAE 62.1.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

C. Electric-Resistance Heating:

1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:

    a. Magnetic contactors.
    b. Step Controller: Pilot lights and override toggle switch for each step.
    c. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
    d. Time-delay relay.
    e. Airflow proving switch.

D. Hot Gas Reheat Coil:

1. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: One or Two as scheduled on drawings.

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater. Digital or variable speed inverter driven.

C. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.

6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: Minimum 90 percent arrestance, and MERV 7.

2.7 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
3. High-Altitude Kit: For Project elevations more than 2000 feet (610 m) above sea level.

C. Heat-Exchanger and Drain Pan: Stainless steel, or Aluminized steel (refer to schedule for staged or modulating).

D. Venting: Gravity vented with vertical extension.

E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension.

F. Safety Controls:

1. Gas Control Valve: Multistage or Modulating as scheduled.
2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with motorized damper filter.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ULTRAVIOLET LIGHT GERMICIDAL IRRADIATION (UV) SYSTEM

A. General Requirements for UV Section:

1. The UV surface irradiation system shall consist of heavy duty, factory assembled; installed and tested light fixtures that emit short wave UVC light (200 nm – 270 nm).

2. Constructed and tested for HVAC environments: UL listed at 55°F to 135°F with airflow velocities up to 1000 FPM. Independently tested to verify output and performance. UV system shall have UL Approval per Category Code ABQK (Accessories, Air Duct Mounted) UL Standards: UL153, UL1598 & UL1995.
3. Assembly shall consist of double ended UVC florescent lamp and housing, power source and sockets shall be UL Drip proof construction.
4. The enclosure shall be made of drip-proof construction from galvanized steel. The ballast shall be a self-contained electronic type. The enclosure shall include safety mechanical interlocks which do not allow the UV assembly to light unless installed on its track. The multiple UV assemblies shall connect via interlock.
5. UVC Lamp shall be a standard output hot cathode, low pressure T8, double ended UVC lamp. Lamps shall be constructed with a thick wall glass of soda barium UV transparent glass with a base of metal. Lamps shall have 5.5 milligrams or less of mercury.
6. Lamps shall produce adequate UV output and operate in environments of temperatures between 55°F to 135°F. Lamps shall produce a minimum of 80% of initial UV output at end of life (9000 hours minimum).
7. Power source shall be 120 VAC 60hz. Power connections shall be via a provided j-box or line cord from one end of the UV fixture. UV fixtures shall electrically connect via interlocks.
8. Installation shall be such that the cumulative sum length of UV fixtures end-to-end shall equal the coil width +/- three (3) inches. Modular coil system shall be installed and wired so that the entire surface of the coil and drain pan is bathed by UVC. System shall be installed using "tracks" to allow UV fixture to slide into place, for ease of access during installation and annual maintenance. System shall be installed 8"-20" (14" ideal) from coil surface. System shall incorporate safety "cut-off" switches on access doors.
9. Approved manufacturers: UV Resources or UltraViolet Devices, Inc. (UVDI).

2.10 ENERGY RECOVERY:

A. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.

B. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.

C. Wheel shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.

D. Wheel shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.

E. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.

F. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized

Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.

G. Energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory. The 5 year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts.

H. Hinged service access doors shall allow access to the wheel.

I. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

J. Wheel may be variable speed or provided with integral pre-heat coil for frost protection.

2.11 AIRFLOW MEASURING STATIONS

A. Airflow measuring stations shall be provided and located in the outside and/or return air paths as indicated on the schedule and plans to measure airflow. Airflow measuring stations shall be tested per AMCA Standard 611 and licensed to bear the AMCA Ratings Seal for airflow measurement performance. Integral control damper blades shall be provided as galvanized steel and housed in a galvanized steel frame. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage.

1. The airflow measurement station shall measure up to 100 percent of the total outside air and/or return air. The airflow measurement station shall be capable of measuring down to 300 fpm. the airflow measuring device shall adjust for temperature variations. Output shall be provided from the station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/- 5 percent. Airflow measuring stations shall be mounted on the AHU interior.

2.12 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.13 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC." Unless noted otherwise, manufacturer shall provide equipment with BMS Gateway – Bacnet for integration into facility Building Management System. Factory installed and factory provided controllers. Unit shall be provided from manufacturer with DDC components such as return air sensors, co_2 sensors, supply air sensors, damper actuators, etc. As shown on unit control schematics. Refer to mechanical drawings. Unit shall be capable of stand alone operation in the event of communication loss. Provide Bacnet points list and I/O address list.

B. Basic Unit Controls:

1. Control-voltage transformer.
2. Where DDC Controls and Building Management System are not utilized or part of project scope of work provide wall-mounted 7-day programmable thermostat and/or sensor with the following features:

    a. Heat-cool-off switch.
    b. Fan on-auto switch.
    c. Fan-speed switch.
    d. Automatic changeover.
    e. Adjustable deadband.
    f. Exposed set point.
    g. Exposed indication.
    h. Degree F indication.
    i. Unoccupied-period-override push button.
    j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.
    k. Humidistat (where hot-gas reheat is required for dehumidification cycle).

2.14 ACCESSORIES

A. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature in gas burner compartment.

B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

D. Coil guards of painted, galvanized-steel wire.

E. Hail guards of galvanized steel, painted to match casing.

F. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

2.15 ROOF CURBS

A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

    a. Materials: ASTM C 1071, Type I or II.
    b. Thickness: 2 inches (50 mm).

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

    a. Liner Adhesive: Comply with ASTM C 916, Type I.

b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
d. Liner Adhesive: Comply with ASTM C 916, Type I.
e. Vibration Isolation Rail: Where noted on plans.
f. Transition Roof Curb: Where scheduled, curb is designed to adapt from existing roof curb to new equipment with no field modifications required.
g. Contractor shall coordinate roof construction type ie…metal building, bar joist, etc. prior to shop drawing submittals.

C. Curb Height: 14 inches (355 mm) minimum. Coordinate roof slope with curb for level equipment installation.

2.16 WIND/SEISMIC RESTRAINT BRACKETS FOR ATTACHMENT OF ROOF MOUNTED EQUIPMENT TO CURB.

A. Brackets shall be AES Industries, Inc. or pre-approved equal.

B. Calculations shall be made from third party independent design firm for each unit ensuring equipment is anchored to curb and designed for loads at project site. Factors that determine the number of brackets required include unit surface area, uplift, unit weight, bracket design, shear strength of screws and unit location.

C. Bracket: Minimum 10 gauge

D. Screws/Fasteners: Intercorp #12 TEK Screws or as required by design firm calculations.

2.17 CAPACITIES AND CHARACTERISTICS

A. See plans for additional information.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting: Install RTUs on concrete base using elastomeric mounts.

1. Minimum Deflection: 1/4 inch (6 mm).

B. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

C. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

D. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

E. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Section 231126 "Facility Liquefied-Petroleum Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

F. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. Install limp mass barrier (Kinetics KNM-200AL or equal) inside roof curb.
6. Coordinate access to smoke detector locations with electrical contractor. See electrical drawings and specifications.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.3 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

End of Section 237413

SECTION 260000

BASIC ELECTRICAL REQUIREMENTS

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 all Sections of Division 26, 27, and 28. All of the electrical related work required for this project (unless noted otherwise) is a part of the electrical contract price and is not necessarily specified under Division 26, 27, 28 or shown on the electrical drawings. Therefore, all divisions of this specification and all drawings shall be consulted. The more stringent requirement of this specification (or drawings) shall be followed; regardless of what division or section the more stringent requirement resides.

1.2 SUMMARY

A. This Section includes the following:

a. Related Documents.
b. Summary.
c. References.
d. General.
e. Submittal Information.
f. Quality Assurance, Regulations, and Codes.
g. Coordination.
h. Permits and Fees.
i. Electrical demolition.
j. Renovation and Remodel.
k. Cutting and patching for electrical construction.
l. Painting.
m. Aligning, Adjusting and Testing.
n. Substitution of Equipment.
o. Materials Approved as Equal.
p. As-built Drawings.
q. Operating Instructions, Brochures, and Manuals.
r. Punch-list and Final Inspection.
s. Guarantee.

1.3 REFERENCES

A. The latest edition of the following standards and codes, standard publications of professional organizations, and the local authorities having jurisdiction are the minimum requirements for this work.

a. American National Standards Institute (ANSI).
b. American Society for Testing and Materials (ASTM).
c. Association of Edison Illuminating Companies (AEIC).
d. Code of Federal Regulations (CFR).
e. Insulated Cable Engineer's Association (ICEA).
f. Institute of Electrical and Electronic Engineers (IEEE).
g. National Electrical Manufacturer's Association (NEMA).
h. National Fire Protection Association (NFPA).
i. NFPA 70, the National Electrical Code (NEC).
j. Underwriters' Laboratories, Inc. (UL).
k. State, City, and Local Authorities.

1.4 GENERAL

A. The Electrical Contractor shall furnish all labor; materials, tools, transportation, equipment, services and facilities, required for the complete and proper installation of all electrical work specified within the contract documents. The electrical installation shall include all materials, devices, apparatus, and equipment as specified herein, as shown on the drawings, AND as required for a complete and operational system.

B. Experienced, qualified, licensed electricians shall install the entire electrical system in a first class, workmanlike manner. The electrical system shall be left completely connected and ready to give continuous, trouble-free service.

a. TO ENSURE THAT ONLY QUALIFIED AND RESPONSIBLE BIDS ARE CONSIDERED, SUBMIT THE FOLLOWING INFORMATION ATTACHED TO THE BID FORM:
b. List the date of your company's incorporation, and the state of which the company is incorporated. List the number of years in business under current corporate name.
c. List your company's President, Vice-President(s), Treasurer's, and Secretary's names.
d. List jurisdictions and trade categories in which your organization is legally qualified to do business, and indicate registration or license numbers of company and all personnel who plan to work on this project.
e. List the category of work your organization normally performs with its own forces.
f. Claims & Suits: List any judgments, claims, arbitration proceedings, suits, or disputes (previous or ongoing) against your organization or its officers. List any arbitration proceedings or suits (previous or ongoing) that your organization has filed with regard to construction contracts within the last five years.
g. List, within the last five years, any officers of your organization that were officers of another organization that failed to complete a construction contract.
h. List the name of the job foreman that will be assigned to this project and include his/her work history with the company and with any previous companies. List this persons construction experience and present commitments of other projects. List any other key individuals of your organization who will be assigned to this project.
i. List a minimum of Five (5) previous projects of similar size and characteristics to this project, which were completed by your organization and the foreman listed above. Provide the name of each project, owner, architect, contract amount, project location, and the date project was completed.
j. List all major construction projects that your organization has in progress, giving the name of project, owner, architect, contract amount, percent complete and scheduled completion date.
k. State the total amount of work in progress and under contract by your company at time of submitting bid for this project.
l. State average annual amount of construction work performed during the past five years.
m. References: Provide a minimum of Three (3) Trade References.

C. The electrical drawings are shown in a schematic form (unless specifically dimensioned) and are intended to show only the approximate locations of devices, and equipment. This does not grant the contractor permission to locate devices and equipment as he sees fit.

a. Exact equipment locations, device placement, and conduit routings are not specified on the drawings (unless dimensioned) and shall be governed by structural conditions, ceiling/wall panel spacing, base cabinets, permanent furniture and other obstructions.

b. Full coordination of all work and consultation of all drawings shall be required to avoid possible interference with other trades. The architectural plans shall be consulted to determine space availability for electrical equipment prior to rough in.

c. The Architect reserves the right to make any reasonable change in the location of apparatus, outlets and equipment up to the time of rough in, without any additional expense to the Owner. *Relocating a receptacle outlet 6ft. in any direction is considered a reasonable change.*

D. Any damage to the building or elements of the building including other trades work (accidental or intentional) caused by or originating from the Contractor shall be repaired at the cost of the Contractor.

E. All electrical components shall be installed per the respective manufacturer's installation instructions.

1.5 SUBMITTAL INFORMATION

A. The Electrical Contractor shall submit electronic submittals in PDF format which shall include the following information:

a. On front cover provide the name and address of the Project, the Architect, the Engineer, and the Contractor. List the name and telephone number for the Electrical Contractor assigned to the project.

b. Adequate description(s) of product submitted – Manufacturer's name, catalog number, technical data, shop drawings, pictures, etc. Include wiring diagrams, photometries, and test reports as required.

c. Instructions for the operation and maintenance of the equipment prepared by the manufacturer.

d. Complete parts list for each equipment item.

e. Clearly marked catalog logic indicating mounting, finishes, capacities, sizes, options, etc.

f. Identification mark or nomenclature relating each submitted item to the drawings (when applicable). For example, Panel "A", Light Fixture Type "B", or Special Outlet No. 1.

B. The submittal review performed by the Architect-Engineer shall not include verification or approval of quantities indicated on the submittal. All submittal approvals relate to the product's conformance with the contract documents only.

C. All submittals must be reviewed, verified, and approved by the ELECTRICAL contractor before the Architect or Engineer will review same. Submittals reviewed and stamped by the General Contractor only, will be returned. The ELECTRICAL contractor's stamp and signature on each submittal shall indicate the Contractors review. The Contractor shall return all submittals, which do not meet the specifications, to the supplier for correction before submitting to the Engineer or Architect. Only those materials specified, approved, or otherwise indicated by the contract documents will be permitted on this project.

D. The Architect-Engineer's submittal approval will not relieve the Contractor from his responsibilities to full-fill the contract documents. All deviations from the contract documents associated with submittals must be called to the Engineer's attention at time of submission and must also be approved by the Owner or his representative.

E. Shop drawings shall be submitted on wiring devices, conduit, boxes, wire, light fixtures (includes LED drivers, ballasts & lamps), light poles, switchgear (includes distribution and branch circuit panelboards, starters and disconnects), and all special systems (fire alarm, intercom, clocks, sound, security, telephone, data, etc.). Refer to each respective division 26 section for additional submittal requirements.

F. Electronic Autocad files (.dwg) may be made available to the successful contractor for the sole purpose of creating submittal drawings related to this project. The Contractor shall execute a Cad Release agreement and submit a fee equal to $100 per drawing sheet, prior to receiving the files.

1.6 QUALITY ASSURANCE, REGULATIONS, & CODES

A. All Electrical Components, Devices, Equipment, and Accessories installed under this contract shall be listed and labeled by Underwriters Laboratories, Inc. (UL). Materials, which are not covered by UL shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. The Architect/Engineer must specifically approve materials that do not carry the UL label.

B. All Electrical Components, Devices, Equipment, and Accessories installed under this contract shall be of the brand(s) specified herein, or approved as an equal by the Architect/Engineer within the contract documents. All materials and equipment furnished shall be new, free from defects, and of current production. Materials and equipment, which are no longer being produced, will not be acceptable.

C. Each class of materials or equipment shall be of a single manufacturer. Do not intermix manufacturers of the same class of equipment. Manufacturers of all equipment shall have a permanent service organization, which will respond with service via telephone within 2 hours of request and in person (if necessary) within 24 hours of request.

D. All electrical equipment and materials shall be received and stored by the Electrical Contractor in a manner which will protect the equipment and materials against physical damage, dirt, moisture, grease, etc. Conduit shall be kept closed and free of foreign objects.

E. All electrical work shall comply with the latest rules and regulations of the National Electrical Code (NFPA 70), the Americans with Disabilities Act (ADA), the local ordinances (City, County, and State), the local utility companies and all other Boards, Codes, and Departments having jurisdiction. The electrical installation shall be performed in accordance with the latest Rules and Regulations of the Occupational Safety and Health Act (OSHA).

F. All electrical work and material shown on the drawings or specified herein, which is determined to be in direct conflict with a code requirement or local ordinance, shall be provided and installed to meet the code or local ordinance. However, all electrical work indicated in the contract documents, which is determined to be in excess of code requirements or local ordinances, shall be performed as specified in the contract documents. Any deviations made from the plans and specifications in order to conform to codes, ordinances, laws, rules, or regulations shall be approved by the Architect and be made with no cost increase to the Owner. In cases where two or more codes have different levels of requirements (regarding the same topic), the more stringent code shall apply.

1.7 COORDINATION

A. The electrical contractor shall visit the site and examine all existing conditions, which may affect work under his contract prior to bidding. Failure to visit the site and determine existing conditions is not a basis for additional compensation.

B. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

   a. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

C. Sequence, coordinate, and integrate the installation of electrical materials and equipment for efficient flow of work among all other trades. Perform work in such an order that there will be no unnecessary

delays or interference with other trade installations. Coordinate the installation of large electrical equipment requiring positioning before closing in the building. Coordinate closely with the Mechanical Contractor to allow for a clean and neat installation of conduit, cable tray, light fixtures, devices, plumbing, mechanical equipment, mechanical duct work, etc. above ceilings and in other concealed locations.

D. Coordinate service connections to components and systems furnished by utility companies.

a. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components with the utility company.
b. All electrical service entrance equipment and work shall comply with requirements of authorities having jurisdiction and of utility company providing electrical power.
c. The electrical contractor shall bear all expenses for the installation of the temporary and permanent electrical service to the building. These expenses include concrete filled guard posts around transformers and the installation of pedestals (when required by local utility company). The Electrical Contractor shall also pay for all deposits and reimbursements required for the service to the building.
d. The electrical contractor shall coordinate and bear all expenses involved in the complete telephone, internet, cable TV service conduit installations (include pull wire) per respective utility company requirements.

E. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."

F. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

G. Where acoustical ceilings and similar finishes will conceal electrical identification markings and devices, coordinate installation of these items before ceiling installation.

1.8 PERMITS AND FEES

A. The Electrical Contractor shall pull all permits required for this project. He shall pay for all fees related to the certificates, permits, licenses, and inspections.

a. These items must be submitted to the Architect before final acceptance of the project is granted.

1.9 ELECTRICAL DEMOLITION

A. Demolish (disconnect and remove) all electrical items as noted or shown on the drawings back to source. Sequence work with other trade demolition.

B. The Electrical Contractor shall be responsible for all electrical demolition associated with architectural, structural, and mechanical demolition of this project. Refer to the architectural, structural and mechanical plans and specifications for areas/items required to be demolished. Verify all questionable electrical items with the General Contractor prior to demolition.

a. Remove all existing electrical equipment, devices, conduit, conductors, etc. associated with areas/items of demolition back to source.
b. Cut and cap abandoned raceways, which can not be entirely removed due to concrete encasement or other inaccessibility. Provide blank plates as required and/or patch to match existing adjacent surface(s).

C. Remove all demolished electrical material from the site periodically to prevent damage to new equipment or injury to personnel.

D. The Owner shall reserve the right to salvage any and all electrical components, which are removed by the Electrical Contractor during the demolition phase (unless specifically noted otherwise).

a. Coordinate with the Owner or his authorized representative prior to commencing with the demolition phase and verify which items are to be salvaged and returned to the Owner.

1.10 RENOVATION AND REMODEL

A. The Electrical Contractor shall fully familiarize himself with the existing systems (electrical, fire alarm, intercom, security, telephone, computer networking, sound, clocks, bells, etc.) of the building to be renovated or remodeled.

a. Consult existing system manufacturers for ALL interconnection requirements between new devices and existing systems. Verify all required parts, prior to bidding the job and notify the Architect/Engineer of all conflicts such as capacity, availability, or obsolescence.
b. The Electrical Contractor shall be responsible for providing and installing ALL components necessary to interconnect new devices to existing systems even though not specifically shown on the drawings or called out in the specifications.

B. The Electrical Contractor shall be responsible for properly supporting (per N.E.C.) ALL existing conduit and cable encountered during the renovation process.

C. Relocate all existing electrical items as shown on the drawings or as required by the Architect to facilitate work by other trades.

a. Relocate switches, fixtures, outlets, boxes, conduit, panelboards, and all other electrical components in order to meet the intent of the architectural plans (for example, relocate items where new doors are installed in existing walls).
b. Consult system manufacturers for specific requirements when applicable.
c. Provide and install all components required for the relocation of all electrical items (wire, cable, conduit, boxes, coverplates, fasteners, etc.).
d. Relocate all "special systems" components as required. For example, if a reception or office area is being relocated, all of the special systems associated with that area shall be relocated to the new reception or office.

1.11 CUTTING & PATCHING

A. The Contractor shall be responsible for cutting and/or patching any building material necessary to complete the installation of the electrical system.

a. Use a "Concrete Termite" drill or "core" drill when drilling through concrete. Do not use a "hammer drill", "air hammer" or "star drill".
b. Use "link-seal" products by Thunderline Corporation after drilling through exterior basement or foundation walls.

B. Qualified workmen of the trade involved shall do all cutting and patching.

C. The Electrical Contractor shall pay for cutting and patching due to Electrical Contractors failure to coordinate at the time of rough in.

1.12 PAINTING

A. All electrical raceways and equipment installed in finished areas (defined by the Architect) shall be painted in accordance with division 9 "painting" section (unless directed otherwise by the Architect).

B. All electrical equipment requiring touch-up painting due to shipping and handling abuse or any other reason shall be painted to match the adjacent surface (color and quality).

1.13 ADJUSTING, ALIGNING AND TESTING

A. The Electrical Contractor shall keep a calibrated voltmeter, ammeter, ground test meter, infrared scanner, and megohm meter on site and available at all times during construction hours. Provide test readings as required by these specifications and as requested by the Engineer.

   a. The electrical load shall be distributed equally across all phases from the service entrance equipment down to the smallest branch circuit panelboard. Keep a record of all adjustments and submit final voltage and amperage readings (each phase) to the Architect.
   b. After the project is substantially completed, perform dielectric testing in accordance with the requirements of the National Electrical Code. The entire system shall test out to be free from short circuits and open circuits.

B. Check, align, and adjust all components of the electrical system for optimum performance. Perform all tests required by these specifications – refer to each division 26 section for specific test requirements

C. The Owner reserves the right to conduct independent Acceptance Tests on the electrical system as he sees fit. These tests, if performed, will be used to determine compliance of these specifications and will be conducted in the presence of the Architect/Engineer and Contractor. Notification of these independent tests will be given a minimum of five (5) working days prior to execution. The contractor shall correct all deficiencies in materials and workmanship revealed by the Acceptance Tests.

1.14 SUBSTITUTION OF EQUIPMENT

A. After execution of the contract, substitutions of equipment manufacturers and/or material manufacturers shall be permitted only when the equipment and/or material specified cannot be delivered to the job in time to complete the work in proper sequence.

   a. Any delay must originate beyond the control of the contractor; otherwise the substitution will not be approved.
   b. The Electrical Contractor must make substitution requests in writing. Written requests shall be accompanied with documentation from the specified manufacturer and from the proposed manufacturer indicating equality, differences in price, and differences in delivery dates.
   c. The Owner shall receive all credits associated with the approved substitution via change order.

1.15 MATERIALS APPROVED AS EQUAL

A. All materials used for this project shall be provided as specified (manufacturer's name and model number) unless changes to the contract documents are formally made by written addendum prior to the opening of bids.

1.16 AS-BUILT DRAWINGS

A. Prepare two (2) sets of blue-line or black-line electrical drawings showing in red ink ALL changes or deviations made from the original plan design. These changes marked in red ink shall also include all addendum items, change orders, etc.

a. These drawings shall be clean, neat and without tears or stains. Do not use the field set of drawings as these required As-Built drawings.
b. These drawings are to be submitted to the Engineer for review and will be forwarded to the Owner for his future reference.

1.17 OPERATING INSTRUCTIONS, BROCHURES, AND MANUALS

A. The Electrical Contractor shall submit ALL operating instructions, brochures, instruction sheets, and manuals, which are provided with (or available with) new equipment to the Architect for transmittal to the Owner. Provide this information in a neat, organized format and present the information in a 3-ring binder. Label the front cover with the follow information:

a. "Electrical Operating Instructions, Brochures, and Manuals for Facility Systems"
b. Project Name and Address
c. Name and Address of Architect
d. Name and Address of Engineer
e. Name and Address of Contractor
f. Contractor's Telephone Number (including emergency number).

B. Save all adjusting tools, wrenches, keys, etc. which may be provided with new equipment, and submit to the Architect for transmittal to the Owner.

C. The Electrical Contractor and/or special systems sub-contractor shall also provide full explanation (as well as any written material) to the Owner regarding the operation, maintenance, and care of each special system. Special systems include Fire Alarm, Intercom, Clock, Sound, Intrusion Detection, Cable TV, and Voice/Data.

1.18 PUNCH-LIST AND FINAL INSPECTION

A. An initial inspection will be performed upon written notification from the Contractor indicating that the job is complete. The Engineer will generate a punch-list after the initial inspection. This punch list will be transmitted to the contractor for execution.

a. The Electrical Contractor shall be present for the initial inspection and shall provide all tools, ladders, meters, instruments, etc. required for a complete and thorough inspection (removal of coverplates, panelboard covers, ceiling tiles, etc.).

B. A Final Inspection by the Engineer will be performed after the contractor has executed all punch-list items.

a. The intent of the Final Inspection is for the Contractor and Architect-Engineer to verify that the completed project is in conformance with the contract documents.
b. The Electrical Contractor shall be present for the Final Inspection and shall again provide all tools, ladders, meters, instruments, etc. required for a complete and thorough inspection (removal of coverplates, panelboard covers, ceiling tiles, etc.).
c. Additional inspections by the Architect-Engineer due to incomplete or incorrect work will be charged to the Contractor at an hourly rate of $120.00 per man-hour.

1.19 GUARANTEE

A. This Contractor shall guarantee the entire electrical installation for a period of one (1) year. The one-year period will start on the date of final completion and acceptance (by the Architect).

a. Should defective or faulty parts, components, equipment, etc. become evident within this one-year period, the Electrical Contractor shall correct and/or replace the defective component without cost to the Owner.

b. In addition to defective components, the Electrical Contractor shall also guarantee the installation of the electrical system. The electrical work associated with this project is guaranteed by the Electrical Contractor to be first-class, executed by experienced workmen, and installed to comply with the contract documents. The Electrical Contractor shall correct all areas of the building showing poor workmanship or incomplete installations (such as loose joints & connections involving the raceways & conductors).

PART 2 - PRODUCTS (not applicable)

PART 3 - EXECUTION (not applicable)

End of Section 260000

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Southwire Company
2. General Cable Technologies Corporation
3. Cerrowire LLC
4. Encore Wire Corporation
5. AFC Cable Systems

B. Use Copper Conductors Only: UL-Listed, comply with NEMA WC 70. All conductor sizes are based on the use of copper materials and are code required minimum sizes. Conductor sizes exceeding ampacity requirements of the circuit are sized for voltage drop and shall be installed as indicated.

C. Conductor Insulation: Comply with NEMA WC 70 for TypesTHHN-THWN-2.

D. Minimum Size: Wire smaller than No. 12 AWG shall not be used unless specifically indicated herein or on the drawings

1. No. 14 AWG (or larger) copper, solid or stranded, 90° C. wire shall be permitted for control wiring applications. Where stranded conductors are used, provide with spade type insulated copper terminals.

E. MC cable - Equal to AFC Cable Systems MC-TUFF:

1. Steel armor, #12awg copper, with green ground conductor.
2. Phase conductors color-coded per specifications.
3. Lock-nut method of connection when terminating mc cable to a junction box (do not use snap-in connectors). Equal to Bridgeport 590-DC12 or Arlington Snap2IT 38A.

F. MC Luminary cable - Equal to AFC Cable Systems MC-TUFF Luminary:

1. Steel armor, #12awg copper, with green ground conductor.
2. #16awg copper shielded twisted jacketed pair (purple/gray) for 0-10v lighting control.
3. Phase conductors color-coded per specifications.
4. Lock-nut method of connection when terminating mc cable to a junction box (do not use snap-in connectors). Equal to Bridgeport 590-DC12 or Arlington SG50A

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Power Systems, Inc.
2. O-Z/Gedney; EGS Electrical Group LLC.
3. 3M; Electrical Products Division.
4. Ideal Industries, Inc.
5. ILSCO

B. Description: UL-Listed, Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Conductors smaller than or equal to No. 8 AWG are permitted to be spliced or tapped with spring pressure, screw-on, pre-insulated connectors rated for the circuit involved.

D. Conductors larger than No. 8 AWG shall be spliced with compression connectors (fully insulated).

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders & Branch Circuits: **Copper**. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION, APPLICATIONS AND WIRING METHODS

A. Service Entrance and all other underground circuits: Type THWN-2, single conductors in raceway.

B. Feeders & Branch Circuits: Type THHN/THWN-2, single conductors in raceway.

C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

D. MC cable shall be permitted to be used only as follows:

1. Wood Frame Construction only. If the construction type is NOT wood frame, MC cable is NOT permitted.
2. 20A branch circuits only.
3. Color-coded throughout building per specifications.
4. Use EMT with individual conductors for all homeruns out of panelboard to 1st j-box; set 1st j-box in area of branch circuit load, then convert to mc cable.
5. Use lock-nut method of connection when terminating mc cable to a junction box (do not use snap-in connectors).

E. MC Luminary cable shall be permitted to be used only as follows:

1. For 0-10v LED lighting control applications.
2. 20A branch circuits only.

3. Dedicated to specific room lighting zone. Do not use MC cable between rooms/zones.
4. Use lock-nut method of connection when terminating mc cable to a junction box (do not use snap-in connectors).

F. Class 1 Control Circuits: Type THHN-THWN, in raceway.

G. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."

B. Conceal conductors & cables in finished walls, ceilings, and floors, unless otherwise indicated via raceway.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed conductors & cables (in raceway) parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Identify and Color-code conductors and cables according to Section 260553 "Identification for Electrical Systems." Note: All conductors shall have fully colored, factory applied insulation.

H. Seal around cables/raceways penetrating fire-rated elements according to Section 078413 to restore original fire-resistance rating of assembly. Seal cable and wire (between conduit and conductor) entering a building from underground where the conductor(s) exit the conduit, with a non-hardening compound listed for such use.

I. Neatly form and tie all wires inside panelboards, cabinets, wireways, switches, equipment enclosures, etc.

J. Install cable supports (split wedge type) inside raceways for all vertical feeder runs in accordance with the NFPA 70.

K. Where quantities of conductors in a raceway system are not shown / missing on the drawings, provide the number as required to maintain function, control and number of circuits indicated.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Electrical Connections: Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer and per NFPA 70 Article 110.14. See receptacle wiring detail on drawings.

C. Wiring at Outlets: Install conductor at each outlet, with at least 8 **inches** of slack.

D. All wires shall be routed within conduit, shall be of the same insulation type and shall be continuous between outlets and boxes (no splices or taps in conduit).

E. Keep all splicing to a minimum. Splicing will not be allowed in panelboards, switchboards or other enclosures where the conductor(s) are to be terminated.

1. Make splices and taps that are compatible with conductor material (copper) and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors. All conductor splices larger than #6AWG shall be spliced using compression method insulated with a heavy wall shrink tubing.
2. Unsatisfactory splices or terminations shall be re-worked as directed by the Engineer at no additional cost to the Owner.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test conductors for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Test electrical insulation using megger testing. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

End of Section 260519

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 and NFPA 70, Article 250 for grounding and bonding methods, materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Use only **Copper** wire or cable insulated for 600 V. Comply with Section 260519 Low Voltage Electrical Power Conductors and Cables.

1. Equipment Grounding Conductors: Insulated with green-colored insulation.
2. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use factory colored green w/yellow stripe, continuous over length of conductor.

B. Grounding Electrode Conductors: #6 solid, larger sizes to be stranded cable

C. Underground Conductors (exposed): Bare, tinned, stranded, unless otherwise indicated.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

E. Grounding Bus: Predrilled rectangular bars of annealed copper, **1/4 by 4 inches** in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Comply with IEEE 837 and UL 467; Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless **compression** type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: **Copper-clad steel; sectional type ¾"dia. by 10 feet (19 mm by 3 m)**.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. **8** AWG and smaller, and stranded conductors for No. **6** AWG and larger unless otherwise indicated.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors.
3. Connections to Ground Rods: Welded connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING INSTALLATION

A. General: At the service entrance equipment, bond the service entrance ground bus, the service entrance neutral bus, the secondary service neutral conductor, the service entrance grounding electrode conductor(s) and the service entrance enclosure together at the point of service disconnect per NFPA 70 Article 250. This will establish the Grounding Electrode System (GES). For remodel projects and building additions, the existing GES shall be verified to be installed per these specifications. Otherwise, provide & install additional grounding to meet specifications.

1. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
2. Install equipment-grounding conductors in all feeder and branch circuit raceways.
3. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
4. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a

bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

B. Ground Rods: Install at least two rods spaced at 10 feet apart.

1. Drive ground rods until tops are 2 inches above finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductor and connect to the main service disconnect ground bus.
3. Make all connections to the rods using exothermic welds, without exposing steel or damaging copper coating.

C. Metal Water Service Pipe (supplemental ground): Provide #3/0 insulated copper grounding conductor, in conduit, from building's main service disconnect ground bus, to main metal water service entrance(s) to building using grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

D. Building Steel: Provide #3/0 insulated copper grounding conductor, in conduit, from building's main service disconnect ground bus, to the building steel.

E. Building Foundation - Ufer: Provide a 20 ft. #3/0 bare copper grounding conductor, incased in the building footing and connected to the reinforcing rebar in at least four locations, from building's main service disconnect ground bus, to the building footing.

F. All raceway bodies (conduit, nipples, wireways, troughs, gutters, etc.) housing phase conductors shall be provided with a full-length "green" insulated grounding/bonding conductor sized according to the respective phase conductors – per the latest edition of the National Electrical Code.

G. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor (green w/yellow stripe) connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from normal ground bus in panelboard grounding terminals. Terminate on isolated ground bus as indicated on plans. In addition to the isolated grounding conductor, install an equipment grounding conductor and bond to receptacle/outlet box.

H. Signal and Communication Systems: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A. For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ¼" x 2" x 12" grounding bus. Install on insulated spacers 2 inches minimum from wall, coordinate exact mounting heights and other requirements with communication system contractor.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode (rod) in addition to installing a separate equipment grounding conductor routed with supply branch-circuit conductors. Use exothermic welded connections for all ground rods. See pole base detail on plans.

3.3 LABELING

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces

B. Exothermic-Welded Connections at all ground rods: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated. Typical application occurs where service entrance feeders stub up through slab with GRS raceways.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected. Perform tests by using clamp-on ground resistance meter.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: **10** ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: **5** ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: **3** ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

D. Provide drawings locating each ground rod and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results.

End of Section 260526

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.; a division of Cooper Industries.
    c. ERICO International Corporation.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut; Tyco International, Ltd.
    g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing: All raceways shall have supports at a maximum spacing of 10-feet and within 3-feet of a box, fitting, elbow, or enclosure. Attach each raceway to each trapeze hanger using fasteners designed for the application.

C. Minimum Hanger Rod Size for Raceway: Provide 3/8" dia. (minimum) threaded steel rods where required. Use galvanized steel materials on installations exposed to weather. Do not use chain, perforated plumbers strap, or wire for supporting raceways.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

E. Spring-steel clamps designed for supporting single conduits with bolts may be used for 1 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings.

F. Conduit "bat-wing clips" may only be used for supporting flexible lighting whips to rod/wire.

G. Junction boxes, pull boxes, fixtures, suspended ceilings, etc. are not approved supporting methods. All raceways shall be supported independently of all aforementioned items.

H. Combination electrical box and conduit hanger/support products shall not be used (commonly known as "barely legal").

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70 and by the Structural Engineer.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater.

Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Support wall boxes to studs using a horizontal, adjustable mounting bracket spanned between and attached to both studs.

G. Raceways, outlet boxes, panelboards, etc. shall not utilize plastic anchors for attachment to building elements. Plastic anchors will not be permitted for use at any location.

H. When using straps, use two hole straps when supporting raceways. Do not use one hole straps.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

End of Section 260529

SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RMC: Rigid metal conduit.

F. RNC: Rigid nonmetallic conduit (Schedule 40 or 80 PVC).

1.3 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. IMC: Comply with ANSI C80.6 and UL 1242.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. FMC: Comply with UL 1; zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:
   a. Material: **Steel** only. Do not use die-cast fittings.
   b. Type: **Set-screw or compression**.
   c. All EMT connectors shall have **insulated throats**.
3. Expansion Fittings: Steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. RNC: Schedule **40 or 80 PVC**, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. LFNC: Comply with UL 1660.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

E. Fittings for LFNC: Comply with UL 514B.

F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, **Type 1 or Type 3R** unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Finish: Manufacturer's standard enamel finish.

D. Wireway Covers: Screw type.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

C. Tele-Power Poles:

1. Material: Galvanized steel with ivory baked-enamel finish or Aluminum with clear anodized finish.
2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: **Fully adjustable**.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: **4 inches square by 2-1/8 inches deep**. Gangable boxes are prohibited.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, **Type 1 or Type 3R** with continuous-hinge cover with flush, lockable latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, **Type 1** or **Type 3R** galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two. Equal to Hubbell Quazite.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with **open** bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering..
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: **RMC** (galvanized rigid steel).
2. Concealed Conduit, Aboveground: Rigid steel, IMC or as noted on plans.
3. Underground Conduit: RNC, (schedule 40 or 80 PVC).
4. Connection to Vibrating Equipment: **LFMC**.
5. Boxes and Enclosures, Aboveground: NEMA 250, **Type 3R**.

B. Indoors: Apply raceway products as specified below unless otherwise indicated.

1. Exposed, finished areas: Wiremold.
2. Exposed, non-finished areas: **EMT**.
3. Exposed and Subject to Severe Physical Damage: **GRC**.
4. Concealed in Ceilings and Interior Walls and Partitions: **EMT**.

5. Connection to Vibrating Equipment: FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: **RMC**.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 **stainless steel** in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size:

1. Interior: 1/2-inch trade size for metallic;
2. Exterior: 3/4-inch trade size for nonmetallic.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use **setscrew or compression**, **steel** fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface, exposed raceways only where indicated on Drawings or where impossible to conceal.

G. Do not install nonmetallic conduit inside the building.

3.2 RACEWAY INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Install raceways level and square and at proper elevations. Provide adequate headroom.

E. Raceways shall not be used as a supporting means for materials other than their contents.

F. Complete raceway installation before starting conductor installation.

G. Use temporary closures to prevent foreign matter from entering raceways.

H. Arrange stub-ups so curved portions of bends are not visible above finished slab.

I. Install no more than the equivalent of four 90-degree bends in any conduit run. Make bends and offsets so ID is not reduced – use standard bending machines. Bending methods which will crease or flatten

raceway shall not be used. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated. Support within 12 inches of changes in direction.

J. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

K. Install raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
3. Run tight to structure wherever possible.

L. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings, locknuts or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings and set-screw connectors to protect conductors.
3. Tighten set screws of threadless, steel fittings with suitable tools.

M. Conceal raceways within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

N. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of **1 inch** of concrete cover in all directions.
4. Do not embed threadless fittings in concrete.
5. Change from ENT to **GRC** before rising above floor.

O. Stub-ups to Above Recessed Ceilings:

1. Use EMT.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

P. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

Q. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

R. Where stubbing out of concrete, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap to prevent corrosion.

S. Raceway Terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box. Use insulated throat metal bushings to protect conductors.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

U. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

V. Provide a ¾" (minimum) empty EMT raceway from each voice, data, TV, and fire alarm outlet to nearest accessible ceiling cavity. Terminate (bend) parallel with ceiling and provide insulated bushing for protection of low voltage wiring when entering/exiting raceway.

W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for **recessed and semi-recessed luminaires,** equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations.

3.3 BOX INSTALLATION: Install boxes, as indicated below, and according to manufacturer's written instructions.

A. All outlets for receptacles and lighting fixtures, and low voltage (voice, data, TV, intercom, etc.) shall be 4-inch square, code gauge steel galvanized knockout boxes (depth as required for service and device used).

1. Concrete installations: Boxes shall be installed in forms of exact dimensions from bench marks, columns, walls or floors.
2. Masonry installations: Boxes shall be roughed in to general location before installation of walls and furring. Set to exact dimensions at time of wall installation.

B. Mount boxes at heights indicated. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to **bottom** of box unless otherwise indicated or required by ADA.

1. Mount all light fixture boxes over mirrors in restrooms to allow for a 2-inch separation between fixture and mirror.
2. Standard switch mounting heights are 4'-0" A.F.F.
3. Standard receptacle mounting heights are 1'-4" A.F.F.
4. Install counter-top receptacles at 8" above the counter, measured to the bottom of the box. Where this dimension interferes with back-splash or upper cabinets, consult the Architect for exact placement.
5. All mounting height requirement shall be maintained within a ¼" tolerance. Refer to the drawings for all other outlet elevations.

C. Install boxes (covers) flush in finished walls and ceilings when connecting to concealed raceways.

1. Provide plaster rings for boxes to suit adjacent construction and device to be installed. Install boxes not more than 1/8" back from finished walls.
2. Boxes that are installed crooked, more than 1/8" back from wall, or sticking out beyond surface of wall shall be reworked at the discretion of the engineer without additional cost.
3. Above ceiling surface boxes that are installed "floating" off of the wall due to improper conduit rough-in methods shall be reworked at the discretion of the engineer without additional cost.

D. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Rated walls require back to back outlets to be spaced a minimum of 24" apart horizontally.

E. Locate boxes so that cover or plate will not span different building finishes.

F. Install wall boxes to studs using a horizontal, adjustable mounting bracket spanned between and attached to both studs.

G. Install all light switch boxes on the latch side of door. Verify door swings prior to rough in.

H. Locate boxes in columns to be "off center" to allow for future furniture partitioning, such as open office settings.

I. Install boxes level and plumb and true to finish lines in a secure and substantial manner.

J. Install additional pull boxes and junction boxes where needed to prevent damage to wires and cables during pulling. All pull boxes and junction boxes shall be accessible.

K. Provide blank plates for all junction boxes, pull boxes, and outlet boxes (not being used).

L. Only remove the knockout(s) associated with the raceway(s) entering and exiting the box. Plug all unused knockout openings with appropriate plug to match box construction.

M. Install outlets for water coolers to be concealed but accessible. Coordinate with water cooler manufacturer and/or the Mechanical Contractor.

N. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

O. Set metal floor boxes level and flush with finished floor surface.

P. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

Q. Provide 1" minimum empty raceway (for low voltage) stubbed to accessible ceiling cavity for all multi-service floor boxes, unless noted otherwise to have larger raceway.

R. All coverplates shall be installed parallel and perpendicular to finish lines and shall completely cover openings separating finished and unfinished areas. The Electrical Contractor shall notify the General Contractor of all locations where faulty work by other trades will not allow coverplates to cover (gaps, holes or spaces).

3.4 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground feeders and service entrance raceways: Install manufactured rigid steel or fiberglass 90's and sweeps when using PVC underground.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.5 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, below grade.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.8 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.9 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

End of Section 260533

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductors: Color shall be factory applied over the entire length of conductor. This includes all conductor sizes.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.6 NAMEPLATES AND INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes. Lettering shall be “machine engraved”. Home-made engraved nameplates will not be accepted.

1. Normal Power: Engraved legend with black letters on white face.
2. Emergency Power: Engraved legend with white letters on red face.
3. Punched or drilled for mechanical fasteners.
4. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Nameplates and Signs: Rivets or stainless-steel machine screws with nuts and flat lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device. Do not use self-adhesive identification for equipment labeling.

D. Attach signs and nameplates with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas. Apply the following colors to the systems listed below:

1. Fire Alarm System: Red
2. Security System: Yellow
3. Telecommunication System: Blue

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall. Install underground-line warning tape for both direct-buried cables and cables in raceway.

G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application. Paint all Fire Alarm junction boxes red.

H. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

3.2 IDENTIFICATION SCHEDULE

A. Circuit Identification Labels on Boxes: Install labels externally. Includes all receptacle coverplates/boxes.

1. Exposed Boxes/coverplates: Pressure-sensitive, self-adhesive vinyl label on cover (1/8" black letters on clear tape).
2. Concealed Boxes: Permanent black marker.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number.

B. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than **30** A, and **120** V to ground: Install labels at **30-foot (9-m)** maximum intervals.

1. Label shall Include voltage, amperage and panel I.D.

C. Power-Circuit Conductor Identification, 600 V or Less:

1. Color-code throughout the electrical system. Color-Coding for Phase and Voltage Level Identification, Use colors listed below; Color shall be factory applied over the entire length of conductor.

a. Colors for 208/120-V Circuits:
Phase A: Black.
Phase B: Red.
Phase C: Blue.

Neutral: White.
Ground: Green.
Isolated Ground: Green with yellow stripe.

b. Colors for 480/277-V Circuits:

Phase A: Brown.
Phase B: Orange.
Phase C: Yellow.
Neutral: White with a colored stripe or gray.
Ground: Green.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using engraved plastic-laminated labels.

E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.

I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer or power disconnect.

K. Equipment Identification Labels (Nameplates): Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Apply nameplates for each unit of the following categories of equipment using mechanical fasteners (adhesive labels for equipment identification is not acceptable). All nameplates shall adequately describe the function or use of the particular equipment involved.

1. Panelboards, switchgear, switchboards and enclosures; Include panel designation, amperage, voltage, phase, color coding of phases, and A.I.C. rating. See detail on plans.
2. Access doors and panels for concealed electrical items. Motor-control centers.
3. Disconnect switches; Include size & type of fuse used if fusible.
4. Enclosed circuit breakers.
5. Motor starters.
6. Push-button stations.
7. Power transfer equipment.
8. Contactors.
9. Transformers.

End of Section 260553

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles.
2. Wall switches
3. Wall-box dimmers.
4. Wall plates.
5. Fustats

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. IG: Isolated Ground

C. TVSS: Transient voltage surge suppressor.

D. AF: Arc Fault

E. USB: USB charging receptacle

F. TR: Tamper Resistant

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Receptacles:

	P & S	Hubbell	Leviton	Arrow-Hart
Duplex:	5352	5352AB	5362-S	5362
Single:	5361	HBL5361	5361	5361
GFCI:	2097	GFRST20	8899	SGF20
IG:	IG6300	IG5352	5862-IG	IG5362
TVSS w/IG:	IG5362-SP	IG5362SA	5380-IG	IG5362S
Tamper Res.:	TR5352	BR20TR	--	TRSGF20
USB Charging:	TR5361USB	IG5362S	--	TR7756
ARC Fault:	AF20DFW	AFR20TR	--	TRAFCI20

B. Switches:

Toggle 1-pole:	CSB120	CS1221	CSB1-20	CSB120
Toggle 3-Way:	CSB320	CS1223	CSB3-20	CSB320
Toggle 4-Way:	CSB420	CS1224	CSB4-20	CSB420
Key 1-pole:	20AC1-L	HBL1221L	1221-2L	AH1221L
Toggle Pilot 1P:	20AC1-RPL	HBL1221PL	1221-PLR	AH1221PL

C. Shunt Trip Switches:

1. Pushbutton, mushroom head, 2-position switch. **Square D #9001KR9RH13.**
2. Enclosure. **Square D #9001KY1**.
3. Locking mechanism. **Square D #9001K62**.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

B. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. All receptacles listed above shall be grounded, with back & side wired terminations, and rated at 20A-125V. All receptacles shall be constructed using a High-Impact Thermoplastic material and shall carry the Federal Specification mark. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A and FS W-C-596.

D. All receptacles shown on the drawings with a weather-proof indication "WP" are to be GFCI devices mounted under a raintight coverplate. Use heavy duty, cast aluminum, single-gang, vertical mount, for "while in use" protection. All exterior GFCI receptacles shall bear an "outdoor/weather proof" rating.

E. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

F. Refer to the drawings for special outlet configuration specifications (special outlet schedule).

G. All switches listed above shall be 20A, back & side wired, provided with a ground terminal, quiet operating, and rated for the voltage indicated on the drawings. Comply with NEMA WD 1, UL 20, and FS W-S-896.

H. Provide all pilot light switches with a red illuminated toggle in the on position.

I. Provide all key switches keyed alike for master key operation.

J. Refer to the drawings for special switch/control applications.

K. Comply with NFPA 70.

L. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

1. Compatibility:

a. Dimming control components shall be compatible with lighting fixtures, drivers, and transformers.
b. Coordinate with actual lighting submittals to ensure compatible dimmers are utilized.

M. Control: Continuously adjustable slider; with single-pole or three-way switching as required. Comply with UL 1472.

N. LED Lamp Dimmer Switches: Verify with LED lighting manufacturer for list of compatible dimmers.

2.3 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
3. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant**, die-cast aluminum** with lockable cover.

2.4 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: Almond, Black, Brown, Gray, Ivory, or White **as selected by Architect** unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.

B. Wall Plate Color: For plastic covers, match device color.

2.5 FUSTATS

A. Provide fustat devices for motor protection (local disconnect and over-current) as follows:

1. ½ HP-120V or less: Bussmann "SSY".
2. ¾ HP-120V: Bussmann "SOY"

B. Mount fustat(s) inside, on, or adjacent to housing of equipment served. Size fuses at 125% of motor F.L.A. or as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Verify all locations on the job prior to rough in. Locations (not quantities) may be altered by the Architect prior to rough in without additional cost to the Owner.

C. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install counter-top receptacles at 8" above the counter, measured to the bottom of the box. Where this dimension interferes with back-splash or upper cabinets, consult the Architect for exact placement.
5. Install wiring devices after all wall preparation, including painting, is complete.

D. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Do not share neutral conductors on any device branch circuit. (separate neutral conductor for each phase conductor).

E. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor and to box.
7. Isolated-Ground Receptacles: Connect wiring device grounding terminal to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.
8. Use a torque screwdriver when a torque is recommended or required by manufacturer.
9. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
10. Tighten unused terminal screws on the device.
11. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
12. Install devices and assemblies plumb and secure.
13. Install non-feed-through-type GFCI receptacles. Do not use one GFCI device to downstream protect another device (feed-through method).

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

G. Device Types:

1. Use tamper resistant receptacles in all areas required by the National Electrical Code.

2. Use hospital grade receptacles in all areas required by the National Electrical Code.
3. Use GFCI receptacles in all areas required by the National Electrical Code. Note: use GFCI circuit breaker in lieu of GFCI receptacle where receptacle is not readily accessible.
4. Use AFCI receptacles in all areas required by the National Electrical Code.

H. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

I. Dimmers:

1. Install dimmers within terms of their listing.
2. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.
3. Verify that dimmers used are listed for the load application.
4. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

J. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

K. Adjust locations of floor service outlets and telephone/power service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.

B. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate (black text on clear tape) and durable wire markers or tags within outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Receptacles:

1. Line Voltage: Acceptable range is 115 to 125 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Check TVSS receptacle indicating lights for normal indication.
6. Using the test plug, verify that the device and its outlet box are securely mounted.
7. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

End of Section 262726

SECTION 262813

FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA FU 1 for cartridge fuses.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

Subject to compliance with requirements, provide products by one of the following:

	Gould-Shawmut	Bussmann	LittleFuse	Edison
Class J: (600A or less; 600V or less)	AJT	LPJ	JTD	JDL
Class L: (over 600A; 600V or less)	A4BQ	KRP-C	KLPC	LCL

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

B. Only one (1) manufacturer will be allowed to supply fuses associated with this project. Do not intermix fuse manufacturers.

C. Fuses for motor loads shall be sized from the nameplate data on the motor per NFPA 70. Notify Engineer of any discrepancies.

D. Provide (3) spare fuses of each size in original packages for Owner's future use. Store these spare fuses in a new fuse cabinet – Gould Shawmut cat. No. GSFC-M (or equal). Mount fuse cabinet near service entrance point of main disconnect.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

A. Service Entrance: Class L, time delay and Class J, time delay according to amperage and application.

B. Feeders: Class J, time delay.

C. Motor Branch Circuits: Class J, time delay.

D. Other Branch Circuits: Class J, time delay.

E. Control Circuits: Class CC, fast acting.

3.2 INSTALLATION

A. Check for proper fuse clip provisions (clip spacing/types) prior to installing fuses.

B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

End of Section 262813

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Shunt trip switches.
4. Molded-case circuit breakers (MCCBs).
5. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Cutler-Hammer; Siemens; Square D; GE

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac (as indicated), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, quick-make and quick-break type, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position. Handle defeat feature for opening switch cover while energized by authorized personnel.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

2.2 SHUNT TRIP SWITCHES (elevators)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Cooper Bussmann, Inc., Ferraz Shawmut, Inc, Littlefuse Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Oil tight key switch for key-to-test function.
2. Oil tight ON pilot light.
3. Isolated neutral lug.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Cutler-Hammer; Siemens; Square D; GE

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

F. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
7. Alarm Switch: One **NO** contact that operates only when circuit breaker has tripped.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Areas: NEMA 250, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

B. Manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Check for proper fuse clip provisions (clip spacing/types) prior to installing fuses. Install fuses in fusible devices.

C. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Comply with NECA 1.

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each line and load side circuit.

C. Tests and Inspections:

1. Follow NECA 90, Annex A Electrical Testing Procedures.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device. Follow instructions of test equipment used.
4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. CLEANING

1. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

End of Section 262816

SECTION 265100

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, drivers and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

1.2 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Provide adequate descriptions/data on housings, lenses, mounting, features, accessories, and the following:

1. Dimensions of fixtures.
2. Photometrics - certified results of laboratory tests for fixtures and lamps.
3. Emergency lighting unit battery and charger information.
4. Fluorescent and high-intensity-discharge ballasts.
5. LED Drivers.
6. Types and quantity of lamps for each fixture type.
7. Driver, Ballast & Lamp warranty certificates.
8. Pre-manufactured lighting whips.

1.3 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system, structure, and other trades.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product(s) as shown in the light fixture schedule on the drawings. **The base bid price shall include the entire light fixture package that is scheduled on the drawings. All other light fixture packages (by other manufacturers / representatives) requesting to bid on the project shall be submitted as AN ALTERNATE BID (DEDUCT) price**. **Final evaluation/approval of any lighting package other than what is scheduled on the drawings will be performed by the Engineer after bid opening, based on the amount of savings and accuracy of being an equal product.**

1. Note: All alternate light fixture packages shall be subject to the following:
   a. Must be represented by Mercer-Zimmerman, Premier Lighting, Foley Group, or Key Lighting.

b. Must be equal to the specified fixtures, including lumen output, photometry, CRI, kelvin temperature, efficiency, appearance, finishes, and over-all quality.

2. Refer to all light fixture layouts and details on the drawings for additional information, which may not be indicated in the light fixture schedule, but may be necessary for correct pricing. This includes all architectural elevations.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Comply with UL 1598.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Form and support to prevent warping and sagging.

1. Steel unless otherwise indicated.

D. All parts are to be painted after fabrication with factory applied baked enamel finish. Pre-painted (before fabrication) fixtures will not be accepted.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

F. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: 0.125 inch minimum. "Nominal" 0.125 inch lens which actually measure less than 0.125 inch shall not be permitted (provide greater thickness if necessary to meet this minimum requirement).
   b. UV stabilized.
2. Glass: Annealed crystal glass unless otherwise indicated.

G. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

2.3 EMERGENCY LED POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate LED lamp(s) continuously at an output of **1300** lumens. Connect un-switched circuit to battery-inverter unit and switched circuit to fixture driver.
2. Minimum five (5) year full warranty (not pro-rata).
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

   a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type, with 7 to 10 year life expectancy.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
7. Equal to Bodine BSL series.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
   a. Incandescent lamp sources are not permitted.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   f. Minimum five (5) year warranty.

C. Refer to the drawings for number of faces, directional arrows, and mounting (wall/ceiling).

D. Wire Guard: In gymnasiums and other locations as indicated on plans, heavy-chrome-plated wire guard arranged to protect fixtures.

2.5 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, nickel-cadmium type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

7. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures. Provide wire guards wherever fixture is prone to damage, such as gymnasiums.
8. Integral Time-Delay Relay: Holds unit on for fixed interval of **10** minutes when power is restored after an outage.
9. Minimum five (5) year full warranty.

2.6 EMERGENCY TRANSFER DEVICE UNIT

A. Used for transferring light fixture(s) and/or light fixture circuits from normal power to emergency (generator) power.

B. Internal Type: Self-contained unit enclosed in galvanized steel case. Comply with UL 1008 and the following:

1. All inputs fused at 3A maximum. Unit shall draw 280ma and 1.6 watts during normal operation.
2. Dual input voltage - unit shall operate at 120V or 277V
3. Minimum five (5) year warranty.
4. Equal to Bodine Catalog #GTD (individual fixture unit) or #GTD20 (multiple fixture unit).

2.7 LIGHTING WHIPS

A. Pre-manufactured lighting whips equal to AFC catalog #4705.

B. Comply with UL E96572 and the following:

1. All whips shall be ½" FMC and contain #12AWG (minimum) THHN copper conductors and shall be constructed from galvanized, flexible metal conduit.
2. All whips shall utilize threaded conduit connectors (with locknut) at each end. Snap-in connectors are not acceptable.
3. All whips shall contain a #12AWG green grounding conductor and appropriate phase conductor colors (120V = red, black, blue; 277V = orange, brown, yellow).

2.8 LED LUMINAIRES

A. General: Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules. All LED fixtures and drivers shall have a Five (5) year Full Warranty (minimum).

B. Material and specifications for each luminaire are as follows:

1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).

2. Each luminaire shall be rated for a minimum operational life of 50,000 hours of operations at an average operating time of 10 hours per day.

3. The rated operating temperature range shall be -30°C to +40°C.

4. Each luminaire shall be capable of operating above 100°F, but not expected to comply with photometric requirements at elevated temperatures.

5. Photometry must be compliant with IESNA LM-79 and shall be conducted at 25°C ambient temperature.

6. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.

7. Luminare shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.

8. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or an equivalent standard from a nationally recognized testing laboratory.

C. Technical Requirements

1. Electrical

a. Power Consumption: Maximum power consumption allowed for the luminaire shall be determined by application. The luminaire shall not consume power in the off state.

b. Operation Voltage: The luminaire shall operate from a 60 HZ ±3 HZ AC line over a voltage ranging from 115 VAC to 480 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.

c. Power Factor: The luminaire shall have a power factor of 0.90 or greater.

d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 10 percent.

e. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

f. RF Interference: LED Drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.

g. Drivers shall have a Class A sound rating.

2. Photometric Requirements

a. Illuminance: The luminance shall not decrease by more than 30% over the expected operating life. The measurements shall be calibrated to standard photopic calibrations.

b. Light Color/Quality: The luminaire shall have a correlated color temperature (CCT) range of 2700K to 4,000K. The color rendition index (CRI) shall be 80 or greater. Binning of LEDs shall conform to ANSI/ G. NEMA SSL 3-2010.

3. Thermal Management

a. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the Luminaire over the expected useful life.

b. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.

c. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

d. The Luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

e. The heat sink material shall be aluminum.

4. Physical and Mechanical Requirements

a. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit, unless specified otherwise.

2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, **12 gauge**

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, **12 gauge**.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. and secure according to manufacturer's written instructions and approved submittal materials. Install new lamps in each new fixture and in each existing fixture noted to be re-used (applies to remodel projects).

B. Comply with NFPA 70 for minimum fixture supports.

C. Connect (wire) all lay-in fixtures per the NEC, as shown on plans and as follows:

1. Provide & Install J-Box on structure above suspended ceiling. Route U.L. listed ½" flexible metallic conduit whips (#12AWG THHN/THWN conductors – quantity as indicated, including "Green" insulated ground) to light fixtures below such that each fixture can be relocated (1) grid space in any direction without tension on the whip. Route EMT conduit between J-Boxes, Switches, and panelboard.

D. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees above ceiling.

E. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging. Support High-Bay HID Fixtures as shown on drawings.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Suspend from aircraft-cable installed according to fixture manufacturer's written instructions and details on Drawings. Verify mounting heights with Architect.

F. Adjust aimable lighting fixtures to provide required light intensities.

G. All recessed mounted “can” fixtures shall be mounted with trim flush to ceiling, free of gaps, cracks, or light leaks.

H. Electrical Contractors shall notify and coordinate with General Contractor for required fireproofing around recessed fixtures installed in fire-rated ceilings per UL and UBC requirements.

I. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage or defects (cracks, chips, rust, dents, etc.). Replace damaged or defective fixtures and components.

B. Test for normal operation of each fixture installation.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.3 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Wipe lamps prior to installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light uniformity and intensity.

End of Section 265100