STATE OF DELAWARE

DEPARTMENT OF TRANSPORTATION

APPENDIX A – TOLL INFRASTRUCTURE SPECIFICATIONS

for

CONTRACT **T201711301**

US 301 – TOLL INFRASTRUCTURE

NEW CASTLE COUNTY

Toll Infrastructure CSI Specs

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SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. All cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, shall be in accordance with Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement. This Section includes cast-in-place concrete for the following:

1. Gantry foundation

2. Equipment hut foundation and slab

3. Emergency generator slab

END OF SECTION 033000

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Concrete masonry insulating units (CMIU)
3. Face brick.
4. Mortar and grout.
5. Steel reinforcing bars.
6. Masonry joint reinforcement.
7. Ties and anchors.
8. Embedded flashing.
9. Miscellaneous masonry accessories.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."

2. Retain subparagraph below for flashing material that is specially fabricated for corners, end dams, etc.

3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Material Certificates: For each type and size of the following:

1. Masonry units.
   a. For masonry units, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.

3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.

4. Grout mixes. Include description of type and proportions of ingredients.

5. Reinforcing bars.

6. Joint reinforcement.

7. Anchors, ties, and metal accessories.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.

2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

A. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

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

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

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

1.8 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges, and projections from mortar droppings.

3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

2. Provide bullnose units for outside corners unless otherwise indicated.

B. CMUs, Load-Bearing Units: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.

2. Density Classification: Lightweight unless otherwise indicated.

3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

2.3 CONCRETE MASONRY INSULATING UNITS (CMIU)

A. Load - Bearing Concrete Masonry Units, ASTM C90, Medium Weight.

B. Manufacture units with integral polymeric water - repellent admixture such as "Dry - Block" by Grace Masonry Products, "SGS Block - Ade" by Solomon Grind - Chem Service, Inc., "Rheomix Rheopol" by Master Builders, Inc. or approved equal.

C. Insulate units with expanded polystyrene thermal barriers after block manufacturing process in the block plant or at the project site. Insulation to be located adjacent to the interior face shell. Substitution of foamed-in-place insulation is NOT ACCEPTABLE.

1. 8 - inch Korfil Hi-R CMIU: Provide minimum calculated R - value of 9.5.

2. 8 - inch Korfil 2-Core CMIU: Provide minimum calculated R - value of 5.17.

D. Face Type and Profile as follows:

1. Split Face; 7-5/8 inches by 15-5/8 inches by thickness indicated.

2. Matte Face; 7-5/8 inches by 15-5/8 inches by thickness indicated.

E. Colors: To be chosen by owner.

F. Acceptable Manufacturers:

1. Beavertown Block Co., Inc.

2. York Building Products Co.

3. Nitterhouse Concrete Products.

4. New Holland Concrete.

5. Or Approved Equal.

2.4 FACE BRICK

A. ASTM C 216, Grade SW, Type FBS. Style, color and dimensions as follows:

1. Modular: 3 5/8” x 2 1/4” x 7 5/8”.

2. Style: Molded

3. Color: To be chosen by Owner

B. Manufacturers:

1. Glen-Gery Brick.

2. Redland Brick.

3. Or Approved equal.

2.5 CONCRETE AND MASONRY LINTELS

A. General: Provide one of the following:

B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C 91.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Lafarge North America Inc.; Lafarge Masonry Cement.
   b. Lehigh Cement Company; Lehigh Masonry Cement.
   c. National Cement Company, Inc.; Coosa Masonry Cement.
   d. Or approved equal.

E. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

F. Aggregate for Grout: ASTM C 404.

G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

H. Water: Potable.

2.7 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.

2. Exterior Walls: Hot-dip galvanized, carbon steel.

3. Wire Size for Side Rods: 0.148-inch diameter.

4. Wire Size for Cross Rods: 0.148-inch diameter.

5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.

6. Provide in lengths of not less than 10 feet.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.8 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.

2. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.

B. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 7.6 to 12.7 mm and an amplitude of 0.06 to 0.10 inch made from 0.030-inch-thick, steel sheet, galvanized after fabrication.

2.9 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.

C. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

D. Postinstalled Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 unless otherwise indicated.

3. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.10 EMBEDDED FLASHING MATERIALS

A. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Copper-Laminated Flashing: 5-oz./sq. ft. copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
      2) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
      3) York Manufacturing, Inc.; Multi-Flash 500.
      4) Or approved equal.

2. Asphalt-Coated Copper Flashing: 5-oz./sq. ft. copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.
   a. Products: Subject to compliance with requirements**,** provide one of the following:
      1) Advanced Building Products Inc.; Cop-R-Cote.
      2) Hohmann & Barnard, Inc.; H & B C-Coat Flashing.
      3) Sandell Manufacturing Co., Inc.; Coated Copper Flashing.
      4) Or approved equal.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

A. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

C. Weep/Vent Products: Use one of the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from cotton, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity. Use only for weeps.

2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch OD by 4 inches long.

2.12 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.

3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type S.

2. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.

2. Proportion grout in accordance with ASTM C 476, Table 1.

3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

2. Verify that foundations are within tolerances specified.

3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.

2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.

3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.

2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

G. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

H. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.

3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.

2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.

3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.

4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer 3/4 inch or more in width.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.

2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.

3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.

2. Anchor masonry with anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

2. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.9 LINTELS

A. Install steel lintels where indicated.

B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

3. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products or open head joints to form weep holes.

2. Space weep holes 24 inches o.c. unless otherwise indicated.

3. Space weep holes formed from plastic tubing or wicking material 16 inches o.c.

4. Trim wicking material flush with outside face of wall after mortar has set.

3.11 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Limit height of vertical grout pours to not more than 60 inches.

3.12 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.13 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 042000

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Structural steel.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

2. Include embedment drawings.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify slip-critical high-strength bolted connections.

5. For structural-steel connections indicated to comply with design loads, include structural design data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint qualified by testing, including the following:

1. Power source (constant current or constant voltage).

2. Electrode manufacturer and trade name, for demand critical welds.

D. Qualification Data: For qualified Installer fabricator professional engineer and testing agency.

E. Welding certificates.

F. Certificate of conformance from the Galvanizer.

G. Mill test reports for structural steel, including chemical and physical properties.

H. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.

2. Direct-tension indicators.

3. Tension-control, high-strength bolt-nut-washer assemblies.

4. Shear stud connectors.

5. Shop primers.

6. Nonshrink grout.

I. Source quality-control reports.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Shop-Painting Applicators: SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.

2. AISC 341 and AISC 341s1.

3. AISC 360.

4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

F. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

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

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.

2. Clean and relubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:

1. W-Shapes: 60 percent.

2. Channels, Angles-Shapes: 60 percent.

3. Plate and Bar: 25 percent.

4. Cold-Formed Hollow Structural Sections: 25 percent.

5. Steel Pipe: 25 percent.

6. All Other Steel Materials: 25 percent.

C. W-Shapes: ASTM A 992/A 992M.

D. Channels, Angles-Shapes: ASTM A 36/A 36M.

E. Plate and Bar: ASTM A 36/A 36M.

F. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, fy = 46 ksi, structural tubing.

G. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

1. Weight Class: Standard.

2. Finish: Galvanized.

H. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.

I. Steel Forgings: ASTM A 668/A 668M.

J. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

B. Headed Anchor Rods: ASTM F 1554, Grade 36, weldable, straight.

1. Nuts: ASTM A 563 heavy-hex carbon steel.

2. Plate Washers: ASTM A 36/A 36M carbon steel.

3. Washers: ASTM F 436, Type 1, hardened carbon steel.

4. Finish: Plain.

C. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

D. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

2.3 PRIMER

A. Primer: Comply with Division 09 painting sections.

B. Galvanizing Repair Paint: ASTM A 780.

2.4 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Fabricate beams with rolling camber up.

2. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.

3. Mark and match-mark materials for field assembly.

4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

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

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.

2. Base Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.5 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.6 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.

2. Surfaces to be field welded.

3. Surfaces to be high-strength bolted with slip-critical connections.

4. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."

2. SSPC-SP 3, "Power Tool Cleaning."

3. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."

4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."

5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."

6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

7. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."

8. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."

9. SSPC-SP 8, "Pickling."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.7 Galvanizing: All steel, including structural members, shapes, and hardware shall be galvanized in accordance with ASTM A 123, A 153, and A 767, unless otherwise noted on drawings.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.

2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

3. Ultrasonic Inspection: ASTM E 164.

4. Radiographic Inspection: ASTM E 94.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Plates:

1. Set plates for structural members on wedges or shims, then use setting nuts underneath adjust as required.

2. Snug-tighten anchor rods after supported members have been positioned and plumbed. Remove wedges or shims after nuts have been properly tightened.

3. Do not pack grout between top of foundation pedestal and bearing plates. This space is to be left open.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Engineer. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

END OF SECTION 051200

SECTION 054250 - COLD-FORMED METAL ROOF TRUSS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SECTION INCLUDES

A. Section includes pre-engineered, pre-fabricated light gauge cold formed steel framing elements, anchorage, bracing, and bridging.

1.3 RELATED SECTIONS:

A. Sheathing - Section 061600.

1.4 REFERENCES

A. American Iron and Steel Institute (AISI):
   1. Specification for the Design of Cold-Formed Steel Structural Members, 2007.
   2. Standard for Cold-Formed Steel Framing Truss Design, 2001.

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 370 – Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
   2. ASTM A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   3. ASTM A 653/A 653M-94 – Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.
   4. ASTM A 780 – Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

C. American Welding Society (AWS):
   1. AWS D1.1 Structural Welding Code - Steel.
   2. AWS D1.3 Structural Welding Code - Sheet Steel.

D. International Building Code, 2006.

E. American Society of Civil Engineers – Minimum Design Loads for Buildings and other Structures (ASCE 7-05).

F. Light Gauge Structural Engineers Association (LGSEA)
   1. Field Installation Guide for Cold-Formed Steel Trusses.
   2. LGSEA 551d – Design Guide for Construction Bracing of Cold Formed Steel Trusses.
   3. LGSEA 551e – Design Guide for Permanent Bracing of Cold Formed Steel Trusses.

G. ANSI/AISI/COFS/TRUSS – Standard for Cold-Formed Steel Framing – Truss Design.

H. The Society for Protective Coatings (SSPC):
   1. SSPC Paint 15 – Steel Joist Shop Paint
   2. SSPC Paint 20 – Zinc-Rich Primers (Type I – Inorganic and Type II – Organic).

1.5 SYSTEM DESCRIPTION

A. Provide design of trusses by Truss Component Manufacturer, using design methodologies recommended in the AISI and LGSEA references.

B. Structural Performance: Design, engineer, fabricate, and erect cold-formed steel trusses to withstand specified design loads within limits and under conditions indicated unless more stringent requirements are imposed by the governing code; these requirements take precedence when more stringent than the governing code.
   1. Live/Snow Loads on Roof Systems: Use 25 psf ground snow load plus sliding or drifting snow loads. Consider unbalanced snow load in design cases.
   2. Dead Load – Total of all permanently installed material including roofing, insulation, decking, ceiling materials, accessories, and equipment that is in fixed position.
   3. Miscellaneous Dead Load: Truss and portions thereof shall resist the most critical effects resulting from one of the following: (1) 5 psf vertical load applied to the top chord, (2) a 10 psf vertical load applied to the bottom chord, or (3) a 5 psf vertical load applied to both chords simultaneously.
      a. Verify the bottom truss chord can support a 250 pound concentrated load fastened anywhere along the length of the truss.
   4. Wind Loads (per IBC 2006/ASCE 7-05): Exposure C, Importance Factor I=1.0, Wind Velocity = 90 miles per hour.
   5. Seismic Loads: Design and size the components to withstand seismic loads and sway displacement as calculated in accordance with IBC 2006/ASCE 7-05.
   6. Deflections:
      a. Vertical Live Load Deflection: 1/360 of the span maximum.
      b. Total Design Load Deflection: 1/240 of the span maximum.
   7. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change (range) of 120 deg F.
   8. Truss system, with framing components and accessories, shall provide a complete framing system ready for roofing material installation.

C. Permanent Bracing System Requirements:
   1. A permanent diagonal bracing system, to resist the lateral loads imposed on the completed building by wind forces, shall be designed and provided by the Truss Supplier as part of the roof truss system.

D. Coordination:
   1. Truss supplier shall provide bearing attachments with all necessary anchors and uplift connections.
   2. Truss supplier shall provide and coordinate all bracing, bridging, and blocking members.

1.6 SUBMITTALS

A. Submit manufacturer's product data and installation instructions for each type of cold-formed steel framing and accessory required.

B. Submit shop drawings showing member, type, location, spacing, size, and gage of members, method of attachment to supporting members and all necessary erection details. Indicate supplemental bracing, strapping, splices, bridging, accessories, and details required for proper installation.

C. Submit detailed roof truss layouts.

D. Submit truss drawings and calculations, sealed and signed by a qualified registered Professional Engineer in the State of Delaware, verifying truss' ability to meet local code and design requirements. Include:
   1. Description of design criteria.
   2. Engineering analysis depicting member stresses and truss deflection.
   3. Truss member sizes and gauges and connections at truss joints.
   4. Truss support reactions.
   5. Top chord, bottom chord, and web bracing requirements.
   6. Permanent bracing system.
   7. Truss connections to the masonry structure including uplift resistance calculation.

E. Mill Certifications: Submit mill certifications for steel delivered to site.

F. Guarantee: Submit guarantee all steel used in this project is American produced.

G. The Owner shall engage an Independent Quality Assurance Testing and Inspection agency who submit inspection and testing reports required by this Section. Reports shall include data on type(s) of tests and inspections conducted, and test and inspection results. Contractor shall provide access during the fabrication and installation.

H. Recycled Content Data: Submit written affidavits from the steel deck manufacturer indicating the percentage of post-industrial recycled content and post-consumer recycled content.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Fabrication shall be performed by a cold-formed steel truss fabricator with experience designing and fabricating cold-formed steel truss systems equal in material, design, and extent to the systems required for this Project.
   1. Cold Formed steel truss system installation shall be performed by an experienced installer approved by the steel truss system fabricator. Installer shall have experience equal to or greater to systems required for this project.

B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code – Steel" and AWS D1.3 "Structural Welding Code – Sheet Steel".
   1. Qualify welding processes and welding operators in accordance with AWS Standard Qualification Procedure.

C. Pre-Fabrication Meetings:
   1. Meet at job site prior to schedule beginning of fabrication activities of truss to review requirements of this section.
   2. Attendees:
      a. Truss fabricator.
      b. Installer of truss.
      c. Other entities directly affecting, or affected by, construction activities of this section including but not limited to:
         1) The installer of the support framing.
         2) The installer of the mechanical systems.
      d. Representative of the Owner.
   3. Review potential interface conflicts, coordinate layout and support provisions for the trusses.
   4. Regular job progress and coordination meetings as required.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers or bundles, fully identified by name, brand, type, and grade. Exercise care to avoid damage during unloading, storing, and erection.

B. Store trusses on blocking, pallets, platforms or other supports off the ground and in an upright position sufficiently braced to avoid damage from excessive bending.

C. Protect trusses and accessories from corrosion, deformation, damage, and deterioration when stored at job site. Keep trusses free of dirt and other foreign matter.

D. Store trusses in a manner to allow draining of water and water buildup. Additionally, prevent ponding of water on truss members.

1.9 PROJECT CONDITIONS

A. During construction, adequately distribute all loads applied to trusses so as not to exceed the carrying capacity of any one joist, truss, or other component.

B. Construction loads shall not be placed on unbraced trusses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer:
   1. TrusSteel Division of Alpine Engineered Products Inc.
   2. Aegis Metal Framing Division of MiTek.
   3. Dietrich Metal Framing, A Worthington Industries Company.
   4. Or approved equal.

2.2 COMPONENTS

A. Provide manufacturer's standard steel truss members, bracing, bridging, blocking, reinforcements, fasteners, and accessories with each type of steel framing required, as recommended by the manufacturer for the applications indicated and as needed to provide a complete light gauge cold formed steel truss system.

B. Shop fabricate from cold formed steel components in accordance with shop drawings, using jigging systems to ensure consistent component placement and alignment components and to maintain specified tolerances as indicated below.

C. Field fabrication of trusses is strictly prohibited unless performed by an authorized fabricator as determined by the Owner. This fabricator must use shop assemblers and proper jigging systems.

2.3 MATERIALS

A. Materials:
   1. All component gauges: Fabricate components of structural quality steel sheet per ASTM A 653 with minimum yield strength of 45,000 psi.
   2. Bracing, bridging and blocking members: Fabricate components of commercial quality steel sheet per ASTM A 653 with minimum yield strength of 33,000 psi.

B. Steel Truss Members: Provide sizes, shapes and gages required to suit design indicated on shop drawings:
   1. Design Uncoated-Steel Thickness: 22 ga. 0.0300 inch.
   2. Design Uncoated-Steel Thickness: 20 ga. 0.0350 inch.
   3. Design Uncoated-Steel Thickness: 18 ga. 0.0460 inch.
   4. Design Uncoated-Steel Thickness: 16 ga. 0.0570 inch.
   5. Design Uncoated-Steel Thickness: 14 ga. 0.0730 inch.

C. Finish: Provide components with protective zinc coating complying with ASTM A 653, minimum G60 coating.

D. Fastenings:
   1. Manufacturer recommended self-drilling, self-tapping screws with corrosion-resistant plated finish. Fasteners shall be of sufficient size and number to ensure the strength of the connection.
   2. Welding: Comply with AWS D1.1 when applicable and AWS D1.3 for welding base metals less than 1/8" thick.
   3. Other fasteners as accepted by truss engineer.

2.4 FABRICATION

A. Factory fabricate cold-formed steel trusses plumb, square, true to line, and with connections securely fastened, according to manufacturer's recommendations and the requirements of this Section.
   1. Fabricate truss assemblies in jig templates.
   2. Cut truss members by sawing or shearing or plasma cutting.

3. Fasten cold-formed steel truss members by welding or screw fastening or other methods as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to cold-formed steel truss component manufacturer's instructions with screw penetrating joined members by not less than 3 exposed screw threads.

B. Care shall be taken during handling, delivery and erection. Brace, block, or reinforce truss as necessary to minimize member and connection stresses.

C. Fabrication Tolerances: Fabricate trusses to a maximum allowable tolerance variation from straight, plumb, level, and true to line of 1/8 inch in 10 feet, and as follows:
   1. Spacing: Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed steel truss to a maximum out-of-square tolerance of 1/8 inch.
   3. Overall Length: Fabricate trusses to less than plus or minus 1/2 inch from design length.
   4. Overall Height: Fabricate trusses to less than plus or minus 1/2 inch from design height.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine structure, substrates, and installation conditions. Do not proceed with cold-formed steel truss installation until unsatisfactory conditions have been corrected.
   1. Written notification of unsuitable conditions shall be submitted by the Installer.

B. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.2 INSTALLATION, GENERAL

A. General:
   1. Erection of trusses, including proper handling, safety precautions, temporary (construction) bracing, permanent bracing and other safeguards or procedures, are the responsibility of the Contractor and Contractor's installer.
   2. Exercise care and provide erection bracing required to prevent toppling of trusses during erection.

B. Erect trusses with plane of truss webs vertical and parallel to each other, accurately located at design spacing indicated on Truss Fabricator's shop drawings.

C. Provide proper lifting equipment suited to sizes and types of trusses required, applied at lift points recommended by truss fabricator. Exercise care to avoid damage to truss members during erection and to keep horizontal bending of the trusses to a minimum.

D. Provide framing anchors as indicated or accepted on the engineering design drawing or erection drawings. Anchor trusses securely at bearing points.

E. Install roof framing and accessories plumb, square, true to line, and with connections securely fastened, according to manufacturer's recommendations.
   1. DO NOT cut truss members without prior approval of truss engineer.
   2. Fasten cold-formed steel roof framing by welding or screw fastening, as standard with fabricator. Wire tying of roof framing is not permitted.
      a. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to cold-formed roof framing manufacturer's instructions with screw penetrating joined members by not less than 3 exposed screw threads.
      c. Install roof framing in one-piece lengths, unless splice connections are indicated.
      d. Provide temporary bracing and leave in place; bracing shall not be removed.

F. Erection Tolerances: Install trusses to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet and as follows:

G. Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.3 ROOF TRUSS INSTALLATION

A. Install, bridge, and brace trusses according to manufacturer's recommendations and requirements of this Section.

B. Trusses shall be spaced at 48 inches on center unless noted otherwise on Truss Fabricator's shop drawings.

C. Do not alter, cut, or remove truss members or connections of truss members.

D. Erect trusses with plane of truss webs plumb and parallel to each other, align, and accurately position at spacing indicated.

E. Erect trusses without damaging truss members or connections.

F. Align truss bottom chords with load-bearing studs or continuously reinforce track to transfer loads to structure. Anchor trusses securely at all bearing points.

G. Install continuous bridging and permanent truss bracing per truss design requirements prior to the application of any loads.

H. Install necessary roof cross and diagonal bracing per truss designer's recommendations.

3.4 REPAIRS AND PROTECTION

A. Repair or replace damaged chords and web members as directed and approved in writing by the Contracting Officer and by the Truss Fabricator in advance of the work being performed.

B. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanizing repair paint according to ASTM A 780 and the manufacturer's instructions.

3.5 QUALITY ASSURANCE TESTING

A. An Independent Quality Assurance Testing and Inspection Agency shall be engaged to perform inspections at the Fabrication Shop and Construction site, quality control testing, and prepare test reports.
   1. The Agency shall conduct and interpret test results.

END OF SECTION 054250

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.

2. Steel framing and supports for applications where framing and supports are not specified in other Sections.

3. Shelf angles.

4. Metal floor plate and supports.

5. Miscellaneous steel trim including steel angle corner guards and embedded edge angles.

6. Metal bollards.

7. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section:

1. Loose steel lintels.

2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ladders, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling,

opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.4 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

B. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Qualification Data: For qualified professional engineer.

D. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

E. Welding certificates.

F. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

F. Steel Tubing: ASTM A 500, cold-formed steel tubing.

G. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

H. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm) unless indicated otherwise.

2. Material: Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33, with G90 coating; 0.108-inch nominal thickness.

I. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 NONFERROUS METALS

A. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.

B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.

2. Provide stainless-steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Eyebolts: ASTM A 489.

G. Machine Screws: ASME B18.6.3.

H. Lag Screws: ASME B18.2.1.

I. Wood Screws: Flat head, ASME B18.6.1.

J. Plain Washers: Round, ASME B18.22.1.

K. Lock Washers: Helical, spring type, ASME B18.21.1.

L. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

M. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

N. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.

2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

O. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Division 09 painting Sections.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

F. Concrete: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.

2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with primer specified in Division 09 Section "High Performance Coatings”, where indicated.

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.

2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with primer specified in Division 09 Section "High Performance Coatings".

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

D. Prime miscellaneous steel trim with primer specified in Division 09 Section "High Performance Coatings".

2.10 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe.

1. Fill bollards with concrete. Round concrete at top of bollard to hemisphere profile

B. Fabricate bollards for direct embedment in concrete footing.

C. Match drill sleeve and bollard for 3/4 inch steel machine bolt.

D. Prime bollards with primer specified in Division 09 Section "High Performance Coatings".

2.11 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with primer specified in Division 09 Section "High Performance Coatings."

2.12 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with primer specified in Division 09 Section "High Performance Coatings."

2.13 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.14 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.15 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Division 09 Painting Sections indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3. Items Indicated to Receive Primers Specified in Division 09 Section "Painting": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.16 ALUMINUM FINISHES

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

B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.

2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout base plates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

A. Fill bollards solidly with concrete and allow concrete to cure seven days before installing.

B. Anchor bollards in concrete. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

C. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

3.4 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Wood blocking and nailers.

2. Plywood backing panels.

1.3 DEFINITIONS

A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

C. Timber: Lumber of 5 inches nominal or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.

2. NLGA: National Lumber Grades Authority.

3. RIS: Redwood Inspection Service.

4. SPIB: The Southern Pine Inspection Bureau.

5. WCLIB: West Coast Lumber Inspection Bureau.

6. WWPA: Western Wood Products Association.

1.4 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

C. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

D. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.

2. Fire-retardant-treated wood.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

3. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with

fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.

2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat items indicated on Drawings, and the following:

1. Concealed blocking.

2. Roof construction.

3. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

2. Nailers.

3. Rooftop equipment bases and support curbs.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exterior, C-C Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

1. Plywood 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 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1.

F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

E. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.

2. Use copper naphthenate for items not continuously protected from liquid water.

G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.

2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

H. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

I. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

1. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.2 BLOCKING AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

3.3 WOOD FURRING INSTALLATION

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- size furring horizontally or vertically at 24 inches o.c.

3.4 PROTECTION

A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes sufficiently wet that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Roof sheathing.

2. Soffit sheathing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.

2. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.

3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For following products, from ICC-ES:

1. Fire-retardant-treated plywood.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction

that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from GA-600, "Fire Resistance Design Manual."

2.2 WOOD PANEL PRODUCTS

A. Emissions: Products shall meet 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. Plywood: DOC PS 1.

C. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

D. Factory mark panels to indicate compliance with applicable standard.

2.3 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.

2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat plywood indicated on Drawings, and the following:

1. Soffit sheathing.

2.4 ROOF SHEATHING

A. Plywood Roof Sheathing: Exterior, Structural I sheathing.

1. Span Rating: Not less than 40/20.

2. Nominal Thickness: Not less than 3/4 inch.

2.5 SOFFIT SHEATHING

A. Plywood Sheathing: Exterior, Structural I sheathing.

1. Span Rating: Not less than 32/16.

2. Nominal Thickness: Not less than 5/8 inch.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For roof and soffit sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

1. For roof and soffit sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.

2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall and soffit sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

B. Fastening Methods: Fasten panels as indicated below:

1. Roof and Soffit Sheathing:
   a. Screw to wood framing.
   b. Screw to cold-formed metal framing.

END OF SECTION 061600

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Foam-plastic board insulation

2. Perimeter rigid slab/foundation insulation

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

C. Research/Evaluation Reports: For foam-plastic insulation, from **ICC-ES**.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

A. Glass Fiber / Organic Mat Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Atlas Roofing Corporation.
   b. Dow Chemical Company (The).
   c. Rmax, Inc.
   d. Or approved equal.

B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

2.2 PERIMETER RIGID SLAB/FOUNDATION INSULATION

A. ASTM C 578, Type IV; Extruded expanded polystyrene board with either natural skin or cut cell surfaces; with the following characteristics:

1. Board Size: 48 x 96 inch.

2. Board Thickness: 2 inches.

3. Board Edges: Square.

4. Thermal Conductivity (k factor) at 25 degrees F: 0.20.

5. Compressive Resistance: 40 psi.

6. Board Density: 1.6 lb/cu ft.

7. Water Absorption, maximum: 0.3 percent, volume.

8. Surface Burning Characteristics: Flame spread/Smoke developed index of 5/165, when tested in accordance with ASTM E 84.

9. Manufacturers:
   a. Dow Chemical USA; STYROFOAM SM Brand.
   b. U.C. Industries, Inc.; FOAMULAR 250.
   c. Amoco Foam Products Co.; AMOFOAM CM.
   d. Or approved equal

2.3 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.

1. Products: Subject to compliance with requirements, provide the one of the following:
   a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
   b. Gemco; Spindle Type.
   c. Or approved equal.

2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

B. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. AGM Industries, Inc.; RC150.
   b. Gemco; R-150.
   c. Or approved equal.

2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
   a. Crawl spaces.
   b. Ceiling plenums.
   c. Attic spaces.
   d. Where indicated.

C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. AGM Industries, Inc.; TACTOO Adhesive.
   b. Gemco; Tuff Bond Hanger Adhesive.
   c. Or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

A. On vertical footing and foundation wall surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.

3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

3.5 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

A. Install insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.

2. After adhesive has dried, install insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.

3. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.6 INSTALLATION OF ROOF INSULATION

A. Install board insulation on roof construction where indicated on Drawings according to insulation manufacturer's written instructions.

1. Secure insulation in place with FM listed mechanical screw and plate fasteners at intervals so that there is a minimum of one fastener and plate per 2 square feet of insulation.

3.7 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.8 INSULATION SCHEDULE

A. Insulation Type 1: Foil-faced, polyisocyanurate board insulation.

B. Insulation Type 2: Extruded polystyrene, bead adhesive application, 1/2 inch thick protection board.

END OF SECTION 072100

SECTION 072600 - VAPOR RETARDERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SECTION INCLUDES

A. Vapor Retarders: Materials to make concrete slabs water vapor-resistant.

1.3 RELATED SECTIONS

A. Section 072100 - Thermal Insulation: Perimeter Rigid Slab Insulation.

1.4 REFERENCES

A. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials; 1995.

B. ASTM D 226 - Asphalt-Saturated Organic Roofing Felt for use in Membrane Waterproofing and Built-Up Roofing.

C. ASTM D 312 - Asphalt used in Roofing.

1.5 SUBMITTALS

A. Product Data: Provide data on material characteristics and performance criteria.

B. Manufacturer's Installation Instructions: Indicate preparation, installation methods, and storage and handling criteria.

1.6 QUALITY ASSURANCE

A. Vapor Permeability (Perm): Measure in accordance with ASTM E 96 Method E.

PART 2 - PRODUCTS

2.1 SHEET SEAL MATERIALS

A. Vapor retarder
   1. Thickness: 10 mil.
   2. Minimum Permeance: .03 perms
   3. Acceptable Manufacturers:
      a. Stego Wrap (10 mil.) Stego Industries: www.stegoindustries.com

b. Griffolyn by Reef Industries, Inc.
c. Moistop Ultra by Fortifiber Industries
d. Or approved equal

B. Tape: Polyethylene self adhering type, 2 inches wide, compatible with sheet material.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces and conditions are ready to accept the work of this section.

3.2 PREPARATION

A. Inspect installed aggregate backfill (slab sub base), and verify that leveling and compaction of such has been completed prior to installation of vapor barrier. Aggregate backfilling performed as work of Division 2 - Site Work.

3.3 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Install vapor barrier in widest widths practical with joints parallel to direction of concrete pour.

C. Install vapor barrier without ruptures or tears with joints overlapped a minimum of 6 inches and sealed.

D. Install vapor barrier just prior to installation of concrete reinforcement work. Concrete reinforcement work performed as work of Division 3 - Concrete.

E Place vapor barrier only under all concrete slabs scheduled to receive finished floor materials.

END OF SECTION 072600

SECTION 074113 - METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Standing-seam metal roof panels.

1.3 DEFINITIONS

A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Metal roof panels shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Design metal roof panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of roof area when tested according to ASTM E 1680 at the following test-pressure difference:

1. Positive Preload Test-Pressure Difference 15.0 lbf/sq. ft..

2. Negative Preload Test-Pressure Difference: 10.0 lbf/sq.ft. (48 Pa).

D. Water Penetration: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:

1. Test-Pressure Difference: Not less than 6.24 lbf/sq. ft. and not more than 12.0 lbf/sq. ft..

E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.

F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

G. Structural Performance: Provide metal roof panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592:

1. Wind Loads: Determine loads based on the following minimum design wind pressures:
   a. Uniform pressure of 30 lbf/sq. ft., acting inward or outward.

2. Snow Loads: 30 lbf/sq. ft..

3. Deflection Limits: Metal roof panel assemblies shall withstand wind and snow loads with vertical deflections no greater than 1/240 of the span.

H. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F , material surfaces.

I. Energy Performance: Provide roof panels that are listed on the U.S. Department of Energy's ENERGY STAR Roof Products Qualified Product List for steep-slope roof products.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of roof panel and accessory.

B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, side-seam and endlap joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.

1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
   a. Flashing and trim.
   b. Snow guards.

C. Sample: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Metal Roof Panels: 12 inches long by actual panel width. Include fasteners, clips, closures, and other metal roof panel accessories.

2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.

3. Accessories: 12-inch- long Samples for each type of accessory.

D. Delegated-Design Submittal: For metal roof panel assembly 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. Snow Retention System Calculations: Include calculation of number and location of snow guards based on snow load, roof slope, panel length and finish, and seam type and spacing.

E. Coordination Drawings: Roof plans, drawn to scale, on which the following are shown and coordinated with each other, based on input from installers of the items involved:

1. Roof panels and attachments.

2. Pre-engineered Steel Trusses.

3. Roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, snow guards, and items mounted on roof curbs.

F. Manufacturer Certificates: Signed by manufacturer certifying that roof panels comply with energy performance requirements specified in "Performance Requirements" Article.

1. Submit evidence of meeting performance requirements.

G. Qualification Data: For qualified Installer and professional engineer.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

I. Field quality-control reports.

J. Maintenance Data: For metal roof panels to include in maintenance manuals.

K. Warranties: Samples of special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

C. Source Limitations: Obtain each type of metal roof panels from single source from single manufacturer.

D. Preinstallation Conference: Conduct conference at Location selected by the Contractor.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, metal roof panel Installer, metal roof panel manufacturer's representative, deck Installer, and installers whose work interfaces with or affects metal roof panels including installers of roof accessories and roof-mounted equipment.

2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

3. Review methods and procedures related to metal roof panel installation, including manufacturer's written instructions.

4. Examine deck substrate conditions for compliance with requirements, including flatness and attachment to structural members.

5. Review structural loading limitations of deck during and after roofing.

6. Review flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.

7. Review precautions necessary for working adjacent to active highway.

8. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.

9. Review temporary protection requirements for metal roof panel assembly during and after installation.

10. Review roof observation and repair procedures after metal roof panel installation.

11. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.

B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal roof panels on platforms or pallets, covered with suitable weather-tight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal roof panel work to be performed according to manufacturer's written instructions and warranty requirements.

B. Field Measurements: Verify actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

1.9 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal roof panels with rain drainage work, flashing, trim, and construction of decks, parapets, walls, and other adjoining work to provide a leak-proof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including rupturing, cracking, or puncturing.
   b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality, 24 ga.

2. Surface: Smooth, flat finish.

3. Exposed Coil-Coated Finish:
   a. 2-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

B. Panel Sealants:

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

2. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.

2.2 FIELD-INSTALLED THERMAL INSULATION

A. Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1 or 2 felt or glass-fiber mat, Grade 3, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core.

B. Unfaced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and with a nominal density of 3 lb/cu. ft..

C. Mineral-Fiber-Blanket Insulation: ASTM C 665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.

1. Type I (blankets without membrane covering), passing ASTM E 136 for combustion characteristics.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: 30 to 40 mils thick minimum, consisting of slip-resisting, polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.

2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.

3. Products: Subject to compliance with requirements, provide one of the following:
   a. Carlisle Coatings & Waterproofing Inc., Div. of Carlisle Companies Inc.; CCW WIP 300HT.
   b. Grace Construction Products; a unit of Grace, W. R. & Co.; Ultra.
   c. Henry Company; Blueskin PE200 HT.
   d. Or approved equal.

B. Felts: ASTM D 226, Type I (No. 15), asphalt-saturated organic felts.

C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS METAL FRAMING

A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G60 hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.

B. Hat-Shaped, Rigid Furring Channels:

1. Nominal Thickness: 0.040 inch.

2. Depth: As indicated, or 7/8 inch.

C. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

2.5 MISCELLANEOUS MATERIALS

A. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.6 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels MP-1: Formed with vertical ribs at panel edges and flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and mechanically seaming panels together.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sentrigard ML-150 or comparable product by one of the following:
   a. Englert, Inc.
   b. Fabral.
   c. McElroy Metal, Inc.
   d. Merchant & Evans.
   e. Or approved equal.

2. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch nominal thickness.
   a. Exterior Finish: 2-coat fluoropolymer.
   b. Color: Old Town Gray.

3. Clips: Floating to accommodate thermal movement.
   a. Material: 0.064-inch- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

4. Joint Type: Double folded.

5. Panel Coverage: 16 inches.

6. Panel Height: 1.5 inches.

2.7 ACCESSORIES

A. Roof Panel Accessories: Provide components approved by roof panel manufacturer and as required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.

2. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

3. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

B. Flashing and Trim: Formed from same material as roof panels, prepainted with coil coating, minimum 0.018 inch thick. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

C. Gutters: Formed from same material roof panels. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels**.**

D. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot- long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual". Finish downspouts to match gutters.

2.8 SNOW GUARDS

A. Snow Guards: Prefabricated, noncorrosive units designed to be installed without penetrating metal roof panels, and complete with predrilled holes, clamps, or hooks for anchoring.

1. Seam-Mounted, Bar-Type Snow Guards: Aluminum rods or bars held in place by stainless-steel clamps attached to vertical ribs of standing-seam metal roof panels.
   a. Aluminum Finish: Mill.
   b. Products: Subject to compliance with requirements, provide one of the following:
      1) Alpine SnowGuards, Div. of Vermont Slate & Copper Services, Inc.; # 3000 Snow Guard with S-5! block.
      2) Snow Management Systems, a division of Contek, Inc.; SMS-SC block and two rail system.

3) or approved equal

2.9 FABRICATION

A. Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal roof panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weathertight and minimize noise from movements within panel assembly.

D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

2. End Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

3. End Seams for Other Than Aluminum: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

6. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA's "Architectural Sheet Metal Manual" or by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

2.10 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

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

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the Work.

B. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

C. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

D. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.

E. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

B. Miscellaneous Framing: Install eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written instructions.

1. Soffit Framing: Mechanically attach furring channels to supports**,** as required to comply with requirements for assemblies indicated.

3.3 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

1. Roof perimeter for a distance up from eaves of 24 inches beyond interior wall line.

2. Valleys, from lowest point to highest point, for a distance on each side of 18 inches. Overlap ends of sheets not less than 6 inches.

3. Rake edges for a distance of 18 inches.

4. Hips and ridges for a distance on each side of 12 inches.

5. Roof to wall intersections for a distance from wall of 18 inches.

B. Felt Underlayment: Apply at locations indicated below, in shingle fashion to shed water, and with lapped joints of not less than 2 inches.

1. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 3 inches, in shingle fashion to shed water.

C. Apply slip sheet over underlayment before installing metal roof panels.

D. Install flashings to cover underlayment to comply with requirements specified in Division 07 Section "Sheet Metal Flashing and Trim."

3.4 THERMAL INSULATION INSTALLATION

A. Polyethylene Vapor Retarder: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Repair tears or punctures immediately before concealment by other work.

B. Board Insulation: Extend insulation in thickness indicated to cover entire roof. Comply with installation requirements in Division 07 Section "Thermal Insulation."

1. Erect insulation and hold in place with screws and insulation washers spaced 24 inches o.c. Retain paragraph below for metal roof panels supported by purlins.

3.5 METAL ROOF PANEL INSTALLATION, GENERAL

A. Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

B. Thermal Movement. Rigidly fasten metal roof panels to structure at one and only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction. Predrill panels for fasteners.

1. Point of Fixity: Fasten each panel along a single line of fixing located at locations indicated on Drawings.

2. Avoid attaching accessories through roof panels in a manner that will inhibit thermal movement.

C. Install metal roof panels as follows:

1. Commence metal roof panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.

2. Field cutting of metal panels by torch is not permitted.

3. Install panels to roof sheathing.

4. Locate and space fastenings in uniform vertical and horizontal alignment.

5. Provide metal closures at rake edges and each side of ridge caps.

6. Flash and seal metal roof panels with weather closures at eaves, rakes, and perimeter of all openings.

7. Install ridge caps as metal roof panel work proceeds.

8. End Splices: Locate panel end splices over, but not attached to, structural supports. Stagger panel end splices to avoid a four-panel splice condition.

9. Install metal flashing to allow moisture to run over and off metal roof panels.

D. Fasteners:

1. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized-steel fasteners for surfaces exposed to the interior.

E. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

F. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

1. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.

G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.

1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.

2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

3.6 METAL ROOF PANEL INSTALLATION

A. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.

1. Install clips to supports with self-tapping fasteners.

2. Install pressure plates at locations indicated in manufacturer's written installation instructions.

3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.

4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

3.7 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

2. Connect downspouts to underground drainage system indicated.

E. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

F. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.8 SNOW GUARD INSTALLATION

A. Bar-Type Snow Guards: Attach bar supports to vertical ribs of standing-seam metal roof panels with clamps or set screws. Do not use fasteners that will penetrate metal roof panels.

1. Provide two rows of snow guards, at locations indicated on Drawings, spaced 24 inches apart, beginning 24 inches up from gutter or change in slope.

3.9 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.

C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed unless otherwise indicated in manufacturer's written installation instructions. On

completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Copings.

2. Reglets and counterflashings.

3. Splash Blocks

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. SPRI Wind Design Standard: Manufacture and install roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:

1. Design Pressure: As indicated on Drawings.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:

1. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.

2. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.

3. Details of termination points and assemblies, including fixed points.

4. Details of special conditions.

C. Samples for Verification: For roof-edge flashings, roof-edge drainage systems, reglets and counterflashings made from 12-inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for roof-edge flashings.

E. Maintenance Data: For roofing specialties to include in maintenance manuals.

F. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at location selected by the Contractor.

1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects roof specialties including installers of roofing materials and accessories.

2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.

3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

1.7 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: **20** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EXPOSED METALS

A. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

B. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation.

1. Surface: Smooth, flat finish.

2. Mill-Phosphatized Finish: Manufacturer's standard for field painting.

3. Exposed Coil-Coated Finishes: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Two-Coat Fluoropolymer: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.

2.2 CONCEALED METALS

A. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

B. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

2. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

3. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.

C. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.4 COPINGS

A. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet, concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Architectural Products Company.
   b. ATAS International, Inc.
   c. Castle Metal Products.
   d. Cheney Flashing Company.
   e. Hickman Company, W. P.
   f. MM Systems Corporation.
   g. National Sheet Metal Systems, Inc.
   h. Or approved equal.

2. Coping-Cap Material: Zinc-coated steel, nominal 0.034-inch thickness .
   a. Finish: Two-coat fluoropolymer.
   b. Color: As selected by Architect from manufacturer's full range.

3. Corners: Factory mitered and mechanically clinched and sealed watertight.

4. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.

5. Face Leg Cleats: Concealed, continuous stainless steel.

2.5 REGLETS AND COUNTERFLASHINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Castle Metal Products.

2. Cheney Flashing Company.

3. Hickman Company, W. P.

4. MM Systems Corporation.

5. National Sheet Metal Systems, Inc.

6. Or approved equal.

B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:

1. Zinc-Coated Steel: Nominal 0.028-inch thickness.

2. Corners: Factory mitered and mechanically clinched and sealed watertight.

3. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.

C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 12 feet designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:

1. Zinc-Coated Steel: Nominal 0.028-inch thickness.

D. Accessories:

1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.

E. Zinc-Coated Steel Finish: Two-coat fluoropolymer.

1. Color: As selected by Architect from manufacturer's full range.

2.6 SPLASH BLOCKS

A. Pre-cast concrete type, of size and profiles indicated; minimum 3000 psi at 28 days, with minimum 5 percent air entrainment. 12” wide by 30” long.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

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

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

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

3.2 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.

2. Provide uniform, neat seams with minimum exposure of solder and sealant.

3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.

4. Torch cutting of roof specialties is not permitted.

5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of self-adhering, high-temperature sheet underlayment.

3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise shown on Drawings.

2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that will penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.

E. Seal joints with elastomeric sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches except reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.3 COPING INSTALLATION

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings to meet performance requirements.

1. Interlock face leg drip edge into continuous cleat anchored to substrate at 16-inch centers or manufacturer's required spacing that meets performance requirements. Anchor back leg of coping with screw fasteners and elastomeric washers at 16-inch centers or manufacturer's required spacing that meets performance requirements.

3.4 REGLET AND COUNTERFLASHING INSTALLATION

A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

B. Embedded Reglets: See Division 03 Section "Cast-in-Place Concrete" for installation of reglets.

C. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing

joints a minimum of 4 inches and bed with elastomeric sealant. Fit counterflashings tightly to base flashings.

3.5 CLEANING AND PROTECTION

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

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

C. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Silicone joint sealants.

2. Urethane joint sealants.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 or manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

2. Submit not fewer than four pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.

3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.

2. Conduct field tests for each application indicated below:
   a. Each kind of sealant and joint substrate indicated.

3. Notify Architect seven days in advance of dates and times when test joints will be erected.

4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
   a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
      1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.

6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.

2. Joint-sealant manufacturer and product name.

3. Joint-sealant formulation.

4. Joint-sealant color.

D. Penetration Fire Stopping Material: Product Data.

E. Qualification Data: For qualified Installer.

F. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

G. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

I. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.

2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

J. Field-Adhesion Test Reports: For each sealant application tested.

K. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

D. Preinstallation Conference: Conduct conference at site selected by the Contractor.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.

2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.

2. Disintegration of joint substrates from natural causes exceeding design specifications.

3. Mechanical damage caused by individuals, tools, or other outside agents.

4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.

2. Sealant Primers for Nonporous Substrates: 250 g/L.

3. Sealant Primers for Porous Substrates: 775 g/L.

C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

F. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Corning Corporation; 795.
   b. GE Advanced Materials - Silicones; SilPruf SCS2000.
   c. Sika Corporation, Construction Products Division; SikaSil-C995.
   d. Single-Component, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant:
   e. Or approved equal.

2.3 URETHANE JOINT SEALANTS

A. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements**,** provide one of the following:
   a. BASF Building Systems; Sonolastic SL 1.
   b. Bostik, Inc.; Chem-Calk 950.
   c. Pecora Corporation; Urexpan NR-201.
   d. Sika Corporation. Construction Products Division; Sikaflex - 1CSL.
   e. Or approved equal.

2.4 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
   a. Concrete.
   b. Masonry.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal.
   b. Glass.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.

2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.

2. Completely fill recesses in each joint configuration.

3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.

2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.

5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
   a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 INSTALLATION OF PENETRATION FIRESTOPPING:

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.5 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
   a. Perform five (5) tests for the first 500 feet of joint length for each kind of sealant and joint substrate.
   b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:
   a. Whether sealants filled joint cavities and are free of voids.
   b. Whether sealant dimensions and configurations comply with specified requirements.
   c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.6 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.7 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.8 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations:
   a. Isolation and contraction joints in cast-in-place concrete slabs.
   b. Other joints as indicated.

2. Urethane Joint Sealant: Single component, pourable, traffic grade, Class 25.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
   a. Construction joints in cast-in-place concrete.
   b. Joints between metal panels.
   c. Joints between different materials listed above.
   d. Perimeter joints between materials listed above and frames of doors windows and louvers.
   e. Control and expansion joints in ceilings and other surfaces.

2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 25.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:
   a. Isolation joints in cast-in-place concrete slabs.
   b. Other joints as indicated.

2. Urethane Joint Sealant: Single component, pourable, traffic grade, Class 25.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Perimeter joints of exterior openings where indicated.
   c. Vertical joints on exposed surfaces of interior walls and partitions.
   d. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
   e. Other joints as indicated.

2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 25.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Standard hollow metal doors and frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door design.

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

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

4. Locations of reinforcement and preparations for hardware.

5. Details of each different wall opening condition.

6. Details of anchorages, joints, field splices, and connections.

7. Details of accessories.

8. Details of moldings, removable stops, and glazing.

C. Other Action Submittals:

1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

B. 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 as close to neutral pressure as possible.

C. Preinstallation Conference: Conduct conference at location selected by the Contractor.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1. Provide additional protection to prevent damage to finish of factory-finished units.

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

C. 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.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

A. 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ceco Door Products; an Assa Abloy Group company.

2. Mesker Door Inc.

3. Steelcraft; an Ingersoll-Rand company.

4. Or approved equal.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. Glazing: Comply with requirements in Division 08 Section "Glazing."

J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS

A. General: Provide 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.

1. Design: Flush panel.

2. Core Construction: Manufacturer's standard polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
   a. Fire Door Core: As required to provide fire-protection ratings indicated.
   b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
      1) Locations: Exterior doors.

3. Vertical Edges for Single-Acting Doors: Beveled edge.
   a. Beveled Edge: 1/8 inch in 2 inches.

4. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.

5. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick, end closures or channels of same material as face sheets.

6. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. 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:

1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush).

C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated. 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:

1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush).

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

E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD HOLLOW METAL FRAMES

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

B. Exterior Frames: Fabricated from metallic-coated steel sheet.

1. Fabricate frames as face welded unless otherwise indicated.

2. Frames for Level 3 Steel Doors: 0.053-inch- thick steel sheet.

C. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.

1. Fabricate frames as face welded unless otherwise indicated.

2. Frames for Level 3 Steel Doors: 0.053-inch- thick steel sheet.

3. Frames for Borrowed Lights: 0.053-inch- thick steel sheet.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, 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.

2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.

3. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

2.6 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.7 LOUVERS

A. Provide louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.020-inch- thick, cold-rolled steel sheet set into 0.032-inch- thick steel frame.

1. Sightproof Louver: Stationary louvers constructed with inverted V-shaped or Y-shaped blades.

2.8 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- wide steel.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.9 FABRICATION

A. 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. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

2. Glazed Lites: Factory cut openings in doors.

3. Astragals: Provide overlapping astragal 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.

D. Hollow Metal Frames: 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.

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

2. Sidelight 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.

3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

5. 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. Compression Type: Not less than two anchors in each jamb.
   d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated 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."

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

2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.

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

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

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.

2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.

3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

4. Provide loose stops and moldings on inside of hollow metal work.

5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.10 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. 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; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 PREPARATION

A. 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.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

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

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent ANSI/SDI A250.11.anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
   a. At fire-protection-rated openings, install frames according to NFPA 80.
   b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   c. Install frames with removable glazing stops located on secure side of opening.
   d. Install door silencers in frames before grouting.

e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.

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

5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.

9. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

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.

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

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

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. 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.

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

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes: Finish Hardware for swinging doors.
1. Provide all components including fasteners, brackets and accessories required for complete, properly functioning and operable openings.

B. Related Sections:

1. 081100 Metal Doors and Frames
2. Division 26 Electrical

C. References:

National Fire Protection Association
NFPA 80 Standard for Fire Doors and Other Opening Protectives
Builders Hardware Manufacturers Association
ANSI/BHMA A156.1 Butts & Hinges
ANSI/BHMA A156.3 Exit Devices
ANSI/BHMA A156.4 Door Controls - Closers
ANSI/BHMA A156.13 Mortise Locks and Latches
ANSI/BHMA A156.18 Materials and Finishes
Americans with Disabilities Act Accessibility Guidelines ADAAG
Door and Hardware Institute (DHI)
Keying Systems and Nomenclature
Sequence and Format
Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames

1.2 SUBSTITUTIONS:

A. Comply with Division 1

1.3 SUBMITTALS:

A. Comply with Division 1

B. Product Data: Submit 6 copies which include technical data indicating design, grade, function and relevant accessories of each hardware item indicated in the hardware sets. Highlight in some manner only information relative to the scheduled products. Provide wiring riser diagrams for all openings scheduled with electrified hardware.

C. Shop Drawings: Submit 6 copies of a detailed Hardware Schedule in a vertical format as outlined in the DHI publication "Sequence and Format." Include the following:

1. Door numbers corresponding to Architects door numbers as indicated on the architectural drawings.
2. Manufacturers List of each hardware product group scheduled
3. Abbreviations List
4. Riser and point to point diagrams with an operations description for each opening with electrified hardware.

D. Templates: Submit templates and "reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable timely door and frame preps.

1. Submit Templates, wiring diagrams and "reviewed Hardware Schedule" of electrical terms to electrical for coordination and verification of voltages and locations.

E. Samples: Provide as requested by Architect.

F. Contract Closeout Submittals: Comply with Division 1 including specific requirements indicated.

1. Operating and maintenance manuals: Submit the following in a three ring binder:

a. "As Built" Hardware Schedule
b. Catalog Cuts
c. Installation instructions for each hardware item
d. Warranties
e. Approved Keying Schedule
f. Point to point and Riser diagrams for each opening scheduled with electrified hardware

QUALITY ASSURANCE

G. Comply with Division 1.

1. Statement of qualification for distributor and installers.
2. Statement of compliance with regulatory requirements and single source responsibility.
3. Distributor's Qualifications: Firm with 3 years experience in the distribution of commercial hardware.

a. Distributor to employ a full time Door and Hardware Institute certified Architectural Hardware Consultant (AHC) for the purpose of scheduling and coordinating hardware, establishing a keying schedule and be available for consultation at reasonable times throughout the project until final completion.

4. Installer's Qualifications: Firm with 3 years experienced in installation of similar hardware to that required for this Project, including specific requirements indicated.
5. Regulatory Label Requirements: Provide testing agency label or stamp on hardware for labeled openings.

a. Provide UL listed hardware for labeled and 20 minute openings in conformance with requirements for class of opening scheduled.
b. Provide and install hardware for fire rated openings in conformance with NFPA 80.

6. Single Source Responsibility: Except where specified in hardware schedule, furnish products of only one manufacturer for each type of hardware.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Comply with Division 1.

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Package hardware to prevent damage during transit and storage.
3. Mark hardware to correspond with "reviewed hardware schedule".

B. Storage and Protection: Store hardware in a clean, dry, secure area.

1.5 PROJECT CONDITIONS:

A. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for the proper installation and function of each opening.

B. Review Shop Drawings for doors and entrances to confirm that adequate provisions will be made for the proper installation of hardware.

1.6 WARRANTY:

A. Refer to Conditions of the Contract

B. Manufacturer’s Warranty:

1. Closers: Ten years
2. Exit Devices: Three Years
3. Exit Devices Electrified: One Year
4. Locksets: Three years

1.7 OWNER’S INSTRUCTION:

A. Instruct Owner’s personnel in operation and maintenance of hardware units.

1.8 MAINTENANCE:

A. Extra Materials: provide owner with any manufacture's product installation tools and remaining fasteners at project completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. The following manufacturers are approved subject to compliance with requirements of the Contract Documents. Manufacturers indicated with an asterisk are those specified in the hardware sets. Approval of manufacturers or approved equal other than those listed shall be in accordance with Division 1.

Item:	Manufacturer:	Approved:
Hinges	*Stanley	Bommer, Hager
Continuous Hinges	*Stanley	ABH, Markar
Locksets & Cylinders	*Best	Schlage, Sargent
Exit Devices	*Precision	Von Duprin, Sargent
Closers	*Stanley	LCN, Sargent
Push / Pulls	*Rockwood	Trimco, Burns
Protective Plates	*Rockwood	Trimco, Burns
Stops	*Rockwood	Trimco, Burns
OH Stops	*ABH	Rockwood, Rixson
Thresholds	*National Guard	Reese, Zero
Gasketing	*National Guard	Reese, Zero

2.2 MATERIALS:

A. Hinges:

1. *Stanley (ST): CB168, CB179, CB191, CB199. *Refer to Part 2.1.A for approved manufacturers.
2. Concealed bearing
3. Provide hinges for fire rated doors conforming to NFPA 80
4. Furnish heavy weight hinges at high frequency or high abuse locations and as indicted in the hardware sets
5. Provide hinge types as listed in schedule
6. Furnish 3 hinges per leaf to 7 foot 6 inch height. Add one for each additional 30 inches in height or fraction thereof
7. Furnish 5 inch height hinges for doors over 36 inches wide
8. Furnish NRP (Non Removable Pin) on hinges at all reverse bevel exterior doors and as indicated in the hardware sets
9. Certified to ANSI / BHMA A156.1

B. Mortise Locks and Latches:

1. *Best (BE) 45H series. Lever trim 15H. *Refer to Part 2.1.A for approved manufacturers.
2. Locksets and cylinders to be furnished from the same manufacturer
3. Certified to ANSI / BHMA A156.13, Series 1000, Operational Grade 1, Extra Heavy Duty, Security Grade 2.
4. Functions as indicated in the hardware groups.
5. Solid, one-piece, 3/4-inch (19mm) throw, anti-friction latchbolt made of self-lubricating stainless steel.
6. Deadbolt functions shall have 1 inch (25mm) throw bolt made of hardened stainless steel.
7. Provide sufficient curved strike lip to protect door trim.
8. Furnish locksets with 7-pin removable and interchangeable core cylinders.
9. Core face must be the same finish as the lockset.
10. Provide extended spindles and extended screw length at openings with doors thicker than 1 ¾".
11. Furnish and install strike boxes at each location scheduled for locks

C. Exit Devices:

1. *Precision (PR) 2000 series. *Refer to Part 2.1.A for approved manufacturers.
2. Certified to ANSI / BHMA A156.3 Grade 1
3. Exit devices for fire rated doors to bear a label indicating "Fire Exit Hardware"
4. Touchpad shall be “T” style
5. Provide strikes conforming to ANSI / A115.1
6. Furnish strikes as required by application.
7. Fire exit devices to be listed for UL10C
8. UL listed for Accident Hazard
9. Furnish electrified exit device power supplies from the same manufacturer of exit devices
10. Furnish fasteners of proper length at doors over 1 3/4"inches thick.
11. Furnish and install conforming to NFPA 80 at fire rated openings
12. Lever handles to match lockset design

D. Cylinders:

1. Provide necessary cylinder housings, collars, rings & springs as recommended by the manufacturer for proper installation.
2. Provide the proper cylinder cams or tail piece as required to operate all locksets and other keyed hardware items listed in the hardware sets.
3. Furnish removable and interchangeable cores for all cylinders and locks.
4. Coordinate and provide as required for related sections.

E. Door Closers:

1. *Stanley (ST) D4550/4551 series. Alternates LCN 4040/4041, Sargent 250/251series. *Refer to Part 2.1.A for approved manufacturers.
2. Certified to ANSI / BHMA A156.4 Grade 1
3. Conform to ADAAG for opening and closing requirements
4. Separate adjusting valves for closing and latching speed, and backcheck
5. Provide adapter plates, drop plate brackets, shim spacers and blade stop spacers as required by frame and door conditions. Furnish drop plates and spacers as required at aluminum and glass doors
6. Furnish with adjustable spring power
7. Mount closers on non-public view side of door, unless otherwise noted in specification
8. Surface mounted closers shall be non-handed, non-sized and multi-sized 1 through 6
9. Provide D4550 CS or EDA functions on exterior and interior out swing doors
10. Furnish with full cover
11. Furnish sex nuts and bolts on metal doors without closer reinforcing and wood doors without blocking
12. Install conforming to NFPA 80 at fire rated openings.

F. Kickplates: *Rockwood K1O50 .050 thickness. Furnish with four beveled edges, 10 inches high by width less 2 inches on single doors and width less 1 inch on pairs of doors, unless indicated otherwise in hardware sets. Furnish oval-head countersunk screws to match finish. *Refer to Part 2.1.A for approved manufacturers.

G. Mop Plates: *Rockwood K1050 .050 thickness. Furnish with four beveled edges, 4 inches high by width less 1 inch. *Refer to Part 2.1.A for approved manufacturers.

H. Pushplates: *Rockwood 70C size 4 x 16. *Refer to Part 2.1.A for approved manufacturers.

I. Pull Plates: *Rockwood 110 x 70C. *Refer to Part 2.1.A for approved manufacturers.

J. Thresholds: *National Guard 425E ½" x 5" saddle. *Refer to Part 2.1.A for approved manufacturers.

K. Weatherstrip: *National Guard 700ES. *Refer to Part 2.1.A for approved manufacturers.

L. Smoke Seal: *National Guard 5050C. *Refer to Part 2.1.A for approved manufacturers.

M. Door Sweep *National Guard 200N. *Refer to Part 2.1.A for approved manufacturers.

N. Seal at fire rated doors. *National Guard 5050C. *Refer to Part 2.1.A for approved manufacturers.

O. Flush Bolts: *Rockwood: 555 / 1840 series. Auto flush bolts are to be self latching. Provide manufacturers dust proof strike. *Refer to Part 2.1.A for approved manufacturers.

Q. OH Stops: *ABH 9000 surface series. *Refer to Part 2.1.A for approved manufacturers.

R. Wallstops: *Rockwood (RO) 400 series. Wrought Convex Provide proper fasteners to suit conditions. *Refer to Part 2.1.A for approved manufacturers.

S. Silencers: *Rockwood 608. *Refer to Part 2.1.A for approved manufacturers.

T. Access Control: Provided by Owner's Security Vendor

FINISHES:

A. Provide finishes as scheduled. Use manufacturer's standard finishes conforming to ANSI/BHMA A156.18 including coordination with traditional U.S. finishes used by certain manufacturers for their products. Match finishes as closely as possible between products. General Finishes scheduled: 626 Satin Chromium, 630 Satin Stainless Steel, 689 Sprayed Aluminum Closers, 628 Aluminum or Mill finish.

2.3 KEYS AND KEYING:

A. Provide a new factory keyed Master Key System meeting Owner's requirements. Provide keyed brass construction cores and keys during the construction period. Construction control and operating keys and core shall not be part of the Owner's permanent keying system or furnished in the same keyway (or key section) as the Owner's permanent keying system. Permanent cores and keys will be furnished to the Owner.

B. Cylinders, removable and interchangeable core patented system: Best Patented Cormax 7-pin.

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

D. Furnish keys in the following quantities:

1. 4 each Masterkeys
2. 3 each Change Keys for each keyed core
3. 4 each Construction Keys
4. 2 each Control Keys

E. Keying Schedule: Arrange for a keying meeting with Architect, Owner and hardware supplier. Furnish 3 copies of keying schedule as outlined in the DHI Publication "Keying Systems and Nomenclature" to the Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine doors, frames, related items and conditions under which work is to be performed and identify conditions detrimental to proper and or timely completion.

1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 HARDWARE LOCATIONS:

A. Mount hardware units at heights indicated in the following publications except as specifically indicated or required to comply with the governing regulations:

1. Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames

2. Recommended Locations for Architectural Hardware For Flush Wood Doors

3.3 INSTALLATION:

A. Install each hardware item per manufacturer's instructions and recommendations. Do not install surface mounted items until finishes have been completed on the substrate. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

B. Install conforming to ADAAG for operational closer requirements and other applicable hardware requirements.

C. Install hardware using the manufacturers fasteners provided. Drill and tap all screw holes located in metallic materials. Do not use “Riv-Nuts” or similar products.

D. Wallstops where used to be located centered on spindle of lever handles.

E. Install lock strike boxes at each opening receiving locks.

F. Install hardware at fire rated openings conforming to NFPA 80.

3.4 FIELD QUALITY CONTROL AND FINAL ADJUSTMENT

A. After installation is complete, inspect completed door openings on site to verify installation of hardware is complete and properly adjusted, in accordance with both the Contract Documents and final shop drawings.

1. Check and adjust closers to ensure proper operation.

2. Ensure latchset, lockset, and exit devices are properly installed and adjusted for proper operation.

a. Verify levers are free from binding.
b. Ensure latchbolts and dead bolts are engaged into strike and hardware is functioning.

3. Report findings, in writing, to the Architect that all hardware is installed properly and provides complete, properly functioning, operating openings. Indicate corrective actions and recommendations if necessary for compliance.

3.5 SCHEDULE OF FINISH HARDWARE:

SET #1

2	Hinges	CB168 4 1/2 X 4 1/2	652	ST
1	Hinge – electric	CECB168 4 ½ x 4 ½- 18	652	ST
1	Exit Device	TDS FL2103 x 4903A	630	PR
1	Rim Cylinder	1E72 PATD	626	BE
1	Closer	D-4550 CS	689	ST
1	Wall Bumper	408	626	RO
3	Silencers	608	Grey	RO
1	Threshold	425E	628	NA
1	Weatherstrip	700ES	628	NA
1	Door Sweep	200N	628	NA
1	Electric Strike	By Security Vendor		
1	Card Reader	By Security Vendor		
1	Power Supply	By Security Vendor		
1	Door Position Switch	By Security Vendor		

Operation: Door is normally closed and locked. Entry is by key in cylinder or by card swipe which releases electric strike gate allowing entry by pulling lever. When panic bar is pushed, Request to Exit in panic bar (TDS), momentarily shunts alarm for egress at all times.

SET #2

3	Hinges	CB179 4 1/2 X 4 1/2	652	ST
1	Lockset	45H7 D 15H PATD	626	BE
1	Closer	D-4551	689	ST
1	Threshold	425E	628	NA
1	Smoke Seal	5050C	Cha	NA
1	Weatherstrip	700ES	628	NA

1	Door Sweep	200N	628	NA
1	Electric Strike	By Security Vendor		
1	Card Reader	By Security Vendor		
1	Power Supply	By Security Vendor		
1	Door Position Switch	By Security Vendor		
1	Request to Exit	By Security Vendor		

Operation: Door is normally closed and locked. Entry is by key in cylinder or by card swipe which releases electric strike gate allowing entry by pulling lever. Egress is always free from non keyed side.

DR	HW Set
101	1
102	2

END OF SECTION 087100

SECTION 096723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section includes resinous flooring systems with epoxy body coat(s).

1. Application Method: Self-leveling slurry with broadcast aggregates.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. Samples for Initial Selection: For each type of exposed finish required.

C. Product Schedule: For resinous flooring.

D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

E. Material Certificates: For each resinous flooring component, from manufacturer.

F. Material Test Reports: For each resinous flooring system.

G. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply full-thickness mockups on 48-inch- square floor area selected by Architect.
   a. Include 48-inch length of integral cove base with inside and outside corner.

2. Simulate finished lighting conditions for Architect's review of mockups.

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide Polymerica Master Quartz DES or comparable product by one of the following:

1. Polymerica, Incorporated.

2. Crossfield Products Corp.; Dex-O-Tex.

3. RBC Industries, Hallemite Quartz System

4. Or approved equal.

2.2 MATERIALS

A. VOC Content of Resinous Flooring: Provide resinous flooring systems, for use inside the weatherproofing system, that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Resinous Flooring: 100 g/L.

2.3 RESINOUS FLOORING

A. Resinous Flooring: Abrasion-, impact- and chemical-resistant, decorative-aggregate-filled, epoxy resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base using the double broadcast system.

B. System Characteristics:

1. Color and Pattern: As selected by Architect from manufacturer's full range.

2. Wearing Surface: Textured for slip resistance.

3. Overall System Thickness: 1/4 inch.

C. Primer

1. Master Shield IEP 100% Solids penetrating primer

D. Base Coats (Two required): Master Shield IEB squeegee-applied epoxy

1. Resin: Epoxy.

2. Formulation Description: 100 percent solids.

3. Application Method: Self-leveling slurry with broadcast aggregates.
   a. Thickness of First Coat: 10 mils DFT (0.25 mm) – (160 sq. ft. per mixed gallon)
   b. Thickness of Second Coat: 10-20 mils DFT (0.25- 0.51 mm) – (75-100 sq. ft. per mixed gallon).
   c. Number of Coats: Two.

4. Aggregates: Master Quartz Colored Quartz (ceramic coated silica), broadcast to excess or rejection.
   a. Application Rate – First Broadcast: 300 lbs. per 1,000 sq. ft.
   b. Application Rate – Second Broadcast: 300 – 500 lbs. per 1,000 sq. ft.

E. Topcoat: Master Shield CRF – Chemical Resistant Finish – 10 mils..

1. Resin: Epoxy.

2. Formulation Description: 100 percent solids.

3. Type: Clear.

4. Finish: Matte.

5. Number of Coats: One.

F. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Compressive Strength: 11,500 p.s.i. per ASTM C579.

2. Tensile Strength: 2,250 p.s.i. per ASTM C307

3. Flexural Strength: 4,500 p.s.i. per ASTM C580.

4. Water Absorption: 0.1% per ASTM C413.

5. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch permanent indentation per MIL-D-3134.

6. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch per MIL-D-3134.

7. Abrasion Resistance: 64.8 mg maximum weight loss per ASTM D 4060.

8. Flammability: Self-extinguishing per ASTM D 635.

9. Bond Strength: 350 psi, 100 percent concrete failure per ACI 503R.

2.4 ACCESSORIES

A. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

B. Waterproofing Membrane: Type recommended by the manufacturer for substrate and primer and body coats indicated.

C. Reinforcing Membrane: Flexible resin formulation that is recommended by manufacturer for substrate and body coats indicated, and that prevents substrate cracks from reflecting through the resinous flooring.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:
   a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
   b. Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.

3. Verify that concrete substrates are dry.
   a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
   b. Perform plastic sheet test, ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
   c. Perform relative humidity test recommended by manufacturer. Proceed with installation only after passing tests.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

F. Saw cut kerf into existing concrete slab at all edges for keyed joint. Also provide saw-cut kerf at all joints with floor drains and other embedded items in the floor.

3.2 APPLICATION

A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.

2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.

3. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

4. Apply joint sealant to comply with manufacturer’s written recommendations.

B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.

1. Integral Cove Base: 4 inches high.

D. Apply self-leveling slurry body coats in thickness indicated for flooring system.

1. Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.

E. Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, remove trowel marks and roughness using method recommended by manufacturer.

F. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

END OF SECTION 096723

SECTION 099000 - PAINTS AND COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section includes surface preparation and application of high-performance coating systems on the following substrates:

1. Interior Substrates for the Building:
   a. Concrete masonry units (CMU).
   b. Steel (not galvanized).
   c. Plywood

1.3 RELATED SECTIONS

A. Section 055000 - Metal Fabrications: Shop-primed items.

B. Section 061000 – Rough Carpentry.

1.4 REFERENCES

A. ASTM D 4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 1992 (Reapproved 1997).

B. SSPC (PM1) - Steel Structures Painting Manual, Vol. 1, Good Painting Practice; Society for Protective Coatings; 1993, Third Edition.

C. SSPC (PM2) - Steel Structures Painting Manual, Vol. 2, Systems and Specifications; Society for Protective Coatings; 1995, Seventh Edition.

1.5 SUBMITTALS

A. Product Data: Provide data on all finishing products.

B. Samples: Submit two paper chip samples, 2 x 2 inch in size illustrating range of colors available for each surface finishing product scheduled.

C. Manufacturer's Instructions: Indicate special surface preparation procedures.

D. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

E. Submit copies of manufacturer's complete color charts for each coating system. Owner to make color selections.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Paint manufacturer will provide wet and dry mil thicknesses of proposed paints. Paint manufacturer will test paint thicknesses for this project in the field and will issue a written report that certifies that the minimum standards for paint thickness has been met.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

C. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.

D. Minimum Application Temperature for Varnish Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.9 EXTRA MATERIALS

A. Supply 3 gallons of each color; store where directed.

B. Label each container with color in addition to the manufacturer's label.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Paints, primer/ sealers and block fillers:
   1. Duron.
   2. Glidden.
   3. McCormick.
   4. Sherwin Williams.
   5. Benjamin Moore
   6. PPG Architectural Finishes, Inc.
   7. Or approved equal.

2.2 PAINTS AND COATINGS - GENERAL

A. Paints and Coatings: Ready mixed, except field-catalyzed coatings. Prepare pigments:
   1. To a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.
   2. For good flow and brushing properties.
   3. Capable of drying or curing free of streaks or sags.
   4. Colors to be selected by Owner.

B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.

2.3 PAINT SYSTEMS - INTERIOR

A. Paint CI-OP-5L – New Concrete / Masonry, Opaque, Latex, 5 Coat:
   1. Two coats of block filler.
   2. Eggshell: Three coats of latex enamel; Rich Lux Eggshell Latex Enamel.

B. Paint CI-OP-3L - Concrete/Masonry, Opaque, Latex, 3 Coat:
   1. Semi-gloss: Three coats of latex enamel; Rich Lux Semi-Gloss Latex Enamel.

C. Paint MI-OP-3A - Ferrous Metals, Unprimed, Alkyd, 3 Coat:
   1. One coat of alkyd primer.
   2. Semi-gloss: Two coats of alkyd enamel; Fresh Kote Semi-Gloss.

D. Paint MI-OP-2A - Ferrous Metals, Primed, Alkyd, 2 Coat:
   1. Touch-up with alkyd primer.
   2. Semi-gloss: Two coats of alkyd enamel; Fresh Kote Semi-Gloss.

E. Paint MgI-OP-3A - Galvanized Metals, Alkyd, 3 Coat:
   1. One coat galvanize primer.
   2. Semi-gloss: Two coats of alkyd enamel; Fresh Kote Semi-Gloss.

F. Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat:
   1. One coat of latex primer sealer, tinted to match topcoat.
   2. Two coats of latex enamel; eggshell finish.

G. Paint CI-OP-3E - Concrete/Masonry, Epoxy Enamel, 3 Coat:
   1. One coat of catalyzed epoxy primer

2. Gloss: Two coats of catalyzed epoxy enamel.

H. Paint WI-OP-3A – Wood, Opaque, Alkyd, 3 Coat:
1. One coat of alkyd primer sealer.
2. Semi-gloss: Two coats of alkyd enamel.

2.4 ACCESSORY MATERIALS

A. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin application of coatings until substrates have been properly prepared.

B. Verify that surfaces are ready to receive Work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Test existing walls for compatibility of proposed paint systems. Report any condition that may potentially affect proper application.

D. Test shop-applied primer for compatibility with subsequent cover materials.

E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
1. Plaster and Gypsum Wallboard: 12 percent.
2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
3. Interior Wood: 15 percent, measured in accordance with ASTM D 4442.
4. Concrete Floors: 8 percent.

3.2 PREPARATION

A. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

B. Surfaces: Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions. Correct defects that affect work of this section.

C. Marks: Seal with shellac those that may bleed through surface finishes.

D. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate

and bleach. Rinse with clean water and allow surface to dry.

E. Concrete and Unit Masonry Surfaces to be painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

F. Gypsum Board Surfaces to be painted: Fill minor defects with filler compound. Spot prime defects after repair.

G. Galvanized Surfaces to be painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

H. Shop-Primed Steel Surfaces to be finish painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime coat bare steel surfaces. Re-prime entire shop-primed item.

I. Interior Wood Items to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

J. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.3 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

D. Apply each coat to uniform appearance. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.

E. Sand wood and metal surfaces lightly between coats to achieve required finish.

F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

G. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.

H. Spray painting is not permitted except for exposed structure exposed to view.

3.4 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to Division 15 & 16 for schedule of color-coding of equipment, duct work, piping, and conduit.

B. Paint shop-primed equipment, where indicated.

C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

D. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.5 CLEANING

A. Collect waste material that may constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.6 SCHEDULE - SURFACES TO BE FINISHED

A. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically noted.
   2. Fire rating labels, equipment serial number and capacity labels.
   3. Stainless steel items.

B. Paint the surfaces described below under Schedule - Paint Systems.

C. Mechanical and Electrical: Use paint systems defined for the substrates to be finished.
   1. Paint all insulated and exposed pipes, conduit, and hangers, brackets, collars and supports occurring in finished areas to match background surfaces, unless otherwise indicated.
   2. Paint all equipment exposed to weather or to view on the roof and outdoors.
   3. Paint shop-primed items occurring in finished areas.
   4. Paint interior surfaces of air ducts that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
   5. Paint dampers exposed behind louvers, grilles, to match face panels.

3.7 SCHEDULE - PAINT SYSTEMS

A. New Concrete, Concrete Block: Finish all surfaces exposed to view.
   1. Interior: CI-OP-5L, eggshell.

B. Existing Concrete Block, Concrete: Finish all surfaces exposed to view.
   1. Interior Walls: CI-OP-3L, eggshell.

C. Gypsum Board: Finish all surfaces exposed to view.
   1. Interior Ceilings and Bulkheads: GI-OP-3L, flat.
   2. Interior Walls: GI-OP-3L, eggshell.

D. Wood: Finish all surfaces exposed to view.
   1. Interior trim and frames: WI-OP-3A, semi-gloss.

E. Steel Doors and Frames: Finish all surfaces exposed to view; MI-OP-3A, semi-gloss.

F. Steel Fabrications: Finish all surfaces exposed to view.
   1. Interior: MI-OP-3A, semi-gloss.

G. Shop-Primed Metal Items: Finish all surfaces exposed to view.
   1. Finish the following items:
      a. Exposed surfaces of lintels.
      b. Exposed surfaces of steel stairs and railings.
      c. Mechanical equipment.
      d. Electrical equipment.
   2. Exterior: ME-OP-2A.
   3. Interior: MI-OP-2A.

END OF SECTION 099000

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

C. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

D. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Failure of hydrostatic test according to NFPA 10.
   b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.

1. Basis-of-Design Product: Subject to compliance with requirements, provide J.L. Industries or comparable product by one of the following:
   a. J. L. Industries, Inc.; a division of Activar Construction Products Group.
   b. Larsen's Manufacturing Company.
   c. Pyro-Chem; Tyco Safety Products.
   d. Or approved equal.

2. Valves: Manufacturer's standard.

3. Handles and Levers: Manufacturer's standard.

4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.2 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Basis-of-Design Product: Subject to compliance with requirements, provide J.L. Industries standard wall mounted bracket, or comparable product by one of the following:
   a. J. L. Industries, Inc.; a division of Activar Construction Products Group.
   b. Larsen's Manufacturing Company.
   c. Potter Roemer LLC.
   d. Or approved equal.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
   a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

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

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 210500 COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Retain or delete this article in all Sections of Project Manual.Division 100 General Provisions of the Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. “Specifications for Road and Bridge Construction, August 2001including all revisions up to the date of advertisement
Prepared by The Delaware Department of Transportation”

C. Related Sections:
1. Section 09 906 00 High Performance Coatings
2. Section 21 05 10 Clean Agent Fire Suppression System

1.2 SUMMARY

A. Section includes procedures for the fire protection work for this project.

1.3 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.25 - Buttwelding Ends.
6. ASME B16.3 - Malleable Iron Threaded Fittings.
7. ASME B16.4 - Gray Iron Threaded Fittings.
8. ASME B16.5 - Pipe Flanges and Flanged Fittings.
9. ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.

B. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
3. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
4. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
5. ASTM B32 - Standard Specification for Solder Metal.
6. ASTM B75 - Standard Specification for Seamless Copper Tube.
7. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

8. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
9. ASTM D3309 - Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems.
10. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
11. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
12. ASTM F442/F442M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
13. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:
1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

E. National Fire Protection Association:
1. NFPA 13 - Installation of Sprinkler Systems.
2. NFPA 14 - Standard for the Installation of Standpipe, Private Hydrants and Hose Systems.
3. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.

F. Underwriter Laboratories, Inc.:
1. UL 1887 - Fire Tests of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.

1.4 SUBMITTALS

A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

B. Product Data: Submit manufacturer’s catalogue information. Indicate valve data and ratings.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and tag numbering.

B. Operation and Maintenance Data: Submit spare parts lists.

1.6 QUALITY ASSURANCE

A. Provide fire sprinkler piping located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with UL 1887.

B. Perform Work in accordance with NFPA 13 State of Delaware Fire Code. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.

B. Furnish cast iron and steel valves with temporary protective coating.

C. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.10 WARRANTY

A. Furnish five year manufacturer warranty for basic fire suppression materials and methods.

1.11 EXTRA MATERIALS

A. Furnish two sets of valve stem packing for each size and type of valve installed.

B. Provide stock of spare sprinklers, and sprinkler wrenches as per NFPA-13.

PART 2 PRODUCTS

A. Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install piping in accordance with NFPA 2001.

B. Install Work in accordance with State of Delaware Fire Code.

C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

D. Install piping to conserve building space, to not interfere with use of space and other work.

E. Group piping whenever practical at common elevations.

F. Install pipe sleeve at piping penetrations through partitions and walls. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Pipe Hangers and Supports:
1. Install in accordance with NFPA -2001.
2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
3. Place hangers within 12 inches of each horizontal elbow.
4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
7. Install copper plated hangers and supports for copper piping.
8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

I. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.

J. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Do not penetrate building structural members unless indicated.

K. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.

L. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

M. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.

N. Install plug valves for shut-off or isolating service.

O. Install drain valves at main shut-off valves, low points of piping and apparatus.

P. Where inserts are omitted, drill through concrete slab from below and install through-bolt with recessed square steel plate recessed into and grouted flush with slab.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.4 CLEANING

A. Clean entire system after other construction is complete.

END OF SECTION

SECTION 210510 - CLEAN AGENT FIRE SUPPRESSION SYSTEM

PART 1 **GENERAL**

1.1 RELATED DOCUMENTS

A. Retain or delete this article in all Sections of Project Manual.

B. The Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

C. Related Sections:

1. Section 210500 Common Work Results for Fire Suppression

1.2 SUMMARY:

A. This specification outlines the requirements for a “Total Flood” Clean Agent Fire Suppression System utilizing known by its ASHRAE designation HFC-227ea as the fire extinguishing agent and with a detection and control system. The work described in this specification includes all engineering, materials, equipment and services necessary, and required, to complete and test the suppression and detection system.

1.3 APPLICABLE STANDARDS AND PUBLICATIONS:

A. The design, equipment, installation, testing and maintenance of the clean agent System shall be in compliance and accordance with the applicable requirements set forth in the latest edition of the following codes, standards, and third party approval agencies:

1. NFPA No. 2001 - Clean Agent Fire Extinguishing Systems
2. NFPA No. 70 - National Electrical Code
3. NFPA No. 72 - National Fire Alarm Code
4. FM Approvals
5. Underwriters Laboratory
6. Requirements of the Authority Having Jurisdiction (AHJ)

B. The standards listed, as well as all other applicable codes and standards shall be used a "minimum" design standards. Also to be considered are the requirements of the "Authority Having Jurisdiction" and good engineering practices.

1.4 REQUIREMENTS:

A. The Clean Agent Fire Suppression System installation shall be made in accordance with the drawings, specifications and applicable standards. Should a conflict occur between the drawings and specifications, the specifications shall prevail.

1.5 QUALITY ASSURANCE:

A. MANUFACTURER:

1. The manufacturer of the clean agent system hardware and detection components shall have a minimum of 10 years experience in the design and manufacture of similar types of suppression systems and who refer to similar installations providing satisfactory service.
2. The name of the manufacturer, part numbers and serial numbers shall appear on all major components.
3. All devices, components and equipment shall be the products of the same manufacturer.
4. All devices, components and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended.
5. All devices and equipment shall be U.L listed or FM approved.
6. Locks for all cabinets shall be keyed alike.

B. INSTALLER:

1. The installing contractor shall be trained by the supplier to design, install, test and maintain a clean agent system.
2. When possible, the installing contractor shall employ a NICET certified special hazard designer, level 2 or above, who will be responsible for this project.
3. The installing contractor shall be an experienced firm regularly engaged in the installation of automatic clean agent, or similar, fire suppression systems in strict accordance with all applicable standards.
4. The installing contractor must have a minimum of five (5) years experience in the design, installation and testing of clean agent, or similar, fire suppression systems. A list of systems of a similar nature and scope shall be provided on request.
5. The installing contractor shall show evidence that his company carries a minimum $2,000,000.00 liability and completed operations insurance policy. These limits shall supersede limits required in the general conditions of the specifications.
6. The installing contractor shall maintain, or have access to, a clean agent recharging station. The installing contractor shall provide proof of his ability to recharge the largest clean agent system within 24 hours after a discharge. Include the amount of bulk agent storage available.
7. The installing contractor shall be an authorized stocking distributor of the clean agent system equipment so that immediate replacement parts are available from inventory.
8. The installing contractor shall show proof of emergency service available on a twenty-four hour, seven-day-a-week basis.

C. SUBMITTALS:

1. The installing contractor shall submit the following design information and drawings for approval prior to starting work on this project:

    a. Field installation layout drawings having a scale of not less than 1/8"=1'-0"

(1:100m) detailing the location of all agent storage tanks, pipe runs including pipe sizes and lengths, control panel(s), detectors, manual pull stations, abort stations, audible and visual alarms, etc.

b. Auxiliary details and information such as maintenance panels, door holders, special sealing requirements and equipment shutdowns.
c. Separate layouts, or drawings, shall be provided for each level, (i.e.; room, underfloor, and above ceiling) and for mechanical and electrical work.
d. A separate layout or drawing, shall show isometric details of agent storage containers, mounting details and proposed pipe runs and sizes.
e. Electrical layout drawings shall show the location of all devices and include point-to-point conduit runs and a description of the method(s) used for detector mounting. Provide an internal control panel wiring diagram which shall include power supply requirements and field wiring termination points.
f. Graphic Annunciator wiring schematics and dimensioned display panel illustration shall be provided. (Optional device)
g. Complete hydraulic flow calculations, from Manufacturer's UL/FM Approved Flow Calculation Program, shall be provided for all engineered Clean Agent systems. The individual sections of pipe to be used, as shown on the isometrics, must be identified and included in the calculation. Total agent discharge time must be shown and detailed by zone.
h. Provide calculations for the battery stand-by power supply taking into consideration the power requirements of all alarms, initiating devices and auxiliary components under full load conditions.
i. A complete sequence of operation shall be submitted detailing all alarm devices, shutdown functions, remote signaling, damper operation, time delay and agent discharge for each zone or system.

2. Submit drawings, calculations and system component data sheets for approval to the local Fire Prevention Agency, owners Insurance Underwriter, and all other Authorities Having Jurisdiction before starting installation. Submit approved plans to the Architect/Engineer for record.

1.6 SYSTEM DESCRIPTION AND OPERATION:

A. The system shall be a Clean Agent Fire Suppression System utilizing HFC-227ea as the fire extinguishing agent.

B. The Clean Agent Fire Suppression System shall provide a minimum design concentration of 7%, by volume, in all areas and/or protected spaces, at the minimum anticipated temperature within the protected area. Per NFPA 2001, the system design shall not exceed a maximum exposure limit concentration level of 10.5%, by volume, unless provisions for room evacuation, before agent release, are provided. All personnel should be able to leave the protected space prior to the discharge or at least within 5 minutes of the commencement of discharge.

C. The system shall be complete in all ways. It shall include all mechanical and electrical installation, all detection and control equipment, agent storage containers, suppression agent, system actuation equipment, discharge nozzles, pipe and fittings, manual release and abort

stations, audible and visual alarm devices, auxiliary devices and controls, shutdowns, alarm interface, caution/ advisory signs, functional checkout and testing, training and all other operations necessary for a functional U.L. Listed and/or F.M. Approved Clean Agent Fire Suppression System.

D. Provide two (2) inspections during the first year of service. Inspections shall be made at 6 month intervals commencing when the system is first placed into normal service.

E. The general contractor shall be responsible for sealing and securing the protected spaces against agent loss and/or leakage during the 10 minute "hold" period.

F. The system(s) shall be actuated by a combination of ionization and/or photoelectric installed in accordance with the guidelines stated in NFPA 72.

G. Detectors shall be wired in Sequential Detection method of operation, standard Cross-Zoned detection, or single detector release. No other detection / wiring arrangements will be acceptable.

H. Automatic operation of each protected area shall be as follows:

1. Actuation of one (1) detector, within the system, shall:

    a. Illuminate the "ALARM" lamp on the control panel face.
    b. Energize an alarm bell and/or an optional visual indicator.
    c. Transfer sets of 5 Amp rated auxiliary contacts which can perform auxiliary system functions such as:

        1. Transmit a signal to a fire alarm system.

    d. Light an individual lamp on an optional graphic annunciator.

2. Actuation of a 2nd detector, within the system, shall:

    a. Illuminate the "PRE-DISCHARGE" lamp on the control panel face.
    b. Energize a pre-discharge horn or horn/strobe device.
    c. Operate door holder/closures on access doors.
    d. Shut down the HVAC system and/or close dampers.
    e. Start time-delay sequence (not to exceed 60 seconds).
    f. System abort sequence is enabled at this time.
    g. Light an individual lamp on an optional graphic annunciator.

3. After completion of the time-delay sequence, the Clean Agent Fire Suppression System shall activate and the following shall occur:

    a. Illuminate a "RELEASE" lamp on the control panel face.
    b. Shutdown of all power to high-voltage equipment
    c. Energize a visual indicator(s) outside the hazard in which the discharge occurred.
    d. Energize a "System Release" audible device. (Optional)

4. The system shall be capable of being actuated by manual discharge devices located at each hazard exit. Operation of a manual device shall duplicate the sequence description above except that the time delay and abort functions SHALL be bypassed. The manual discharge station shall be of the electrical actuation type and shall be supervised at the main control panel.

5. The system shall be capable of providing a "PRE-ALARM" feature that can give advanced warning of a possible alarm condition.

PART 2 **PRODUCTS**

2.1 MATERIALS AND EQUIPMENT:

A. GENERAL REQUIREMENTS:

1. The Clean Agent Fire Suppression System materials and equipment shall be standard products of the supplier's latest design and suitable to perform the functions intended. When one or more pieces of equipment must perform the same function(s), they shall be duplicates produced by one Manufacturer.

   a. All devices and equipment shall be U.L. Listed and/or F.M. Approved.

B. AGENT STORAGE AND DISTRIBUTION:

1. Each system shall have its own supply of clean agent.

2. The system design can be modular, central storage, or a combination of both design criteria utilizing a fast acting rupture disc valve. The valve shall contain a scored, non-fragmenting, rupture disc to provide immediate total discharge of the suppression agent.

3. Systems shall be designed in accordance with the manufacturer's guidelines.

4. Each supply shall be located within the hazard area, or as near as possible, to reduce the amount of pipe and fittings required to install the system.

5. The clean agent shall be stored in Clean Agent Storage Containers. Containers shall be super-pressurized, with dry Nitrogen, to an operating pressure of 360 psi @ 70° F (25 bar @ 21° C). Containers shall be of high-strength alloy steel construction and conform to NFPA 2001.

6. Containers shall be actuated by the following methods:

   a. Single container applications – By an Impulse Valve Operator (IVO) wired through an Impulse Releasing Module (IRM). This method allows mechanical release.
   b. Multiple container applications – The 1st container is operated by an Impulse Valve Operator (IVO) wired through an Impulse Releasing Module (IRM). 6 additional

containers equipped with Impulse Valve Pneumatic Operator(s) (IVPO) can be operated by the pressure from the 1st container. This method allows mechanical release.

c. Multiple container applications (Electric) – By Impulse Valve Operators (IVO) wired through an Impulse Releasing Modules (IRM), located at each agent storage container (maximum 6 container system). This method does not allow mechanical release.

7. Each container shall have a pressure gauge and low pressure switch to provide visual and electrical supervision of the container pressure. The low pressure switch shall be wired to the control panel to provide an audible and visual "Trouble" alarm in the event the container pressure drops below 288 psi (19 bar). The pressure gauge shall be color coded to provide an easy, visual indication of container pressure.

8. Each container shall have a pressure relief provision that automatically operates when the internal temperature exceed 150° F (66° C).

9. Engineered discharge nozzles shall be provided, within the manufacturer's guidelines, to distribute the suppression agent throughout the protected spaces. The nozzles shall be designed to provide proper agent quantity and distribution.

   a. Nozzles shall be available in NPT sizes ¼" – 2.0" (8mm- 50mm). Each size shall be available in 180° and 360° distribution patterns.

10. Distribution piping, and fittings, shall be installed in accordance with the manufacturer's requirements, NFPA 2001 and approved piping standards and guidelines. All distribution piping shall be installed by qualified individuals using good, accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations.

    a. All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly.
    b. All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male thread ONLY.

2.2 ELECTRICAL COMPONENTS

A. CONTROL PANEL:

1. The control panel shall be a SHP PRO Conventional Control Panel.

2. The SHP PRO Control System, and its components, shall be UL listed and FM approved for releasing service and be suitable for Deluge/Pre-action sprinkler service.

3. The SHP PRO Control System shall perform all functions necessary to operate the system detection, actuation and auxiliary functions, as outlined.

4. The SHP PRO Control System shall be capable of providing 7AH or 40AH battery

standby power supplies.

5. The SHP PRO Control System shall be microprocessor based with hardware and software integration designed to guarantee reliability.

6. The SHP PRO Control System shall support Cross Zoned, Sequential, Single Detector Release and Manual Release detection/actuation methods.

7. The SHP PRO Control System shall provide the following capabilities and functions:

   a. Three (3) Class B (Style Y) notification appliance circuits rated for 2.0 amps @ 24 VDC.
   b. Up to two (2) Style B initiating device circuits capable of sequential alarm, cross-zone, or single detector release operation with an overall system capacity of 50 detectors maximum.
   c. Three (3) Style B initiating device circuits capable of monitoring closed contact devices.
   d. Optional Class A module that converts all five initiating device circuits to Style D wiring and operation.
   e. Optional Class A module that converts all five output circuits to Style Z (3 NAC, 2 Releasing)
   f. Eight (10) Status LEDs plus alpha-numeric display for troubleshooting: AC normal; alarm; pre-discharge; release; supervisory; trouble; panel silenced; abort; release disabled; and ground fault.
   g. Programmable pre-discharge and discharge timers
   h. Resettable and continuous auxiliary output power
   i. Five (5) optional Abort types
   j. Intelligent Transistor protection to prevent noise spikes and microprocessor failure from inadvertently activating release outputs
   k. A dedicated Disarm switch for release outputs
   l. Dedicated alarm and trouble contacts programmable for alarm, trouble, pre-discharge, discharge, abort, supervisory or water flow functions, depending on panel configuration.
   m. Two (3) Form “C” relays, rated at 2 amps, are provided on the SHP PRO™ panel board. Installation of up to two (2) optional CRM4 Relay Module (P/N 10-2204) will provide up to eight (8) additional 2 amp relays.
   n. Multiple input power source - 120 VAC or 240 VAC
   o. 4.0 amp @ 24 VDC power supply to operate high current draw horns and strobes.
   p. Available in either Red or Gray finish

B. DETECTOR BASES:

1. The detector bases shall be selected according to their operational characteristics and size of base.

   a. 430 ohm bases are used to provide Sequential or Cross Zone detection on the SHP PRO initiating circuits.
   b. 220 ohm bases are used to provide Cross Zone or Single Detector Release detection

on the SHP PRO initiating circuits.

c. When using the SHP PRO in conjunction with a Graphic Annunciator panel, the following old style bases must be used.

C. MANUAL RELEASE (Electric):

1. The electric manual release switch shall be a dual action device which provides a means of manually discharging the Clean Agent Fire Suppression System when used in conjunction with the SHP PRO Control System.

   a. The Manual Release switch shall be a Manual Pull station.
   b. The Manual Release switch or Manual Pull station shall be a dual action device requiring two distinct operations to initiate a system actuation.
   c. Manual actuation shall bypass the time delay and abort functions, shall cause the system to discharge and shall cause all release and shutdown devices to operate in the same manner as if the system had operated automatically.
   d. A Manual Release or Manual Pull switch shall be located at each exit from the protected hazard and shall have an advisory sign, provided at each location.
   e. The Manual Release or Manual Pull station shall be connected to a FRCM which is programmed for the intended function.

D. MANUAL RELEASE:

1. Mechanical Manual Release shall be made available in the event all battery back-up and commercial power is lost. The Impulse Valve Operator (IVO) is equipped with a manual strike button for mechanical manual release. Consideration should be given for convenience of operation and egress from the hazard area(s).

E. ABORT STATION:

1. The optional Abort Station shall be the "Dead Man" type and shall be located next to each manual switch.

   a. "Locking" or "Keyed" abort stations shall not be permitted.
   b. The Abort Station shall be supervised and shall indicate a trouble condition at the SHP PRO Control Panel, if depressed, and no alarm condition exists.
   c. The (optional) Abort Station shall be located adjacent to each manual station and can be furnished in combination with a Manual Release Switch or in combination with a Manual Release Switch and (optional) Digital Countdown Timer.
   d. The Abort Station shall be connected to a FRCM which is programmed for the intended function.

F. AUDIBLE and VISUAL ALARMS:

1. Alarm audible and visual signal devices shall operate from the SHP PRO Control Panel.

   a. The Alarm Bell, Alarm Horn and Horn/Strobe devices shall be UL 464 and UL 1971. An HFC-227ea label shall be attached to the strobe lens when required.

b. The visual alarm unit shall be a Vertical Strobe device, or equal in quality, performance and features. An HFC-227ea label shall be attached to the strobe lens when required.
c. A Strobe device shall be placed outside, and above, each exit door from the protected space. Provide an advisory sign at each light location.

G. CAUTION and ADVISORY SIGNS:

1. Provide signs, as required, to comply with NFPA 2001 and the recommendations of the equipment supplier:

a. Entrance sign: One (1) required at each entrance into a protected space.
b. Manual Discharge sign: One (1) required at each manual discharge station.
c. Flashing Light sign: One (1) required at each flashing light over each exit from a protected space.

H. AUXILIARY PANELS:

1. A Graphic Annunciator panel will be mounted adjacent to the SHP PRO control panel. The graphic annunciator shall show a scale layout of the protected area(s) and have indicator lamps to locate each system detector and/or other system components. The panel shall have a lamp test switch located on the panel face. Other panel options shall be available. Scale shall not be less than 1/8" = 1'-0".

2.3 SYSTEM PIPING:

A. Piping material must conform to the requirements as outlined in the NFPA 2001, Latest Edition. The thickness of the piping wall shall be calculated in accordance with ASME B31.1 Power Piping Code based on a minimum piping design pressure of 500 psig at 70 degrees F.

B. Cast iron pipe or steel pipe conforming to ASTM A120, or nonmetallic pipe shall not be used.

C. The following piping materials and configurations are acceptable:

1. Schedule 40 Black Steel ASTM A106C Seamless

2. Schedule 40 Black Steel ASTM A53B or A 106B Seamless

3. Schedule 40 Black Steel A-53B ERW

4. Schedule 40 Black Steel A-53A or A-106A Seamless

5. Schedule 40 Black Steel A053A ERW

6. Schedule 40 Black Steel A-53F.

D. Fitting material must conform to the requirements outlined in NFPA 2001, latest edition. In

general Class 300 malleable or ductile iron fittings are acceptable through 3" NPT sizes. One Thousand Pound ductile of forged steel fittings are required for all sizes greater than 3" NPT. Class 300 fittings are acceptable for all pipe sizes.

E. All grooved fittings must be UL listed and conform to the pressure requirements outlined in NFPA 2001, latest edition. Cat Iron fittings are not acceptable.

F. Pipe size changes, to increase or decrease the size can be done at three different locations in the piping network, at a tee, at an elbow, at a coupling.

G. When the change in pipe size is done at a tee, this is accomplished by either a reducing tee or a standard tee and reducing fittings. All reducers must be concentric bell reducers or concentric reduced couplings.

H. When the change in pipe size is done at an elbow, this is accomplished by using wither reducing elbows or a standard elbow with concentric bell reducers or concentric reducing couplings.

I. When the change in pipe size is accomplished at a coupling, only concentric bell reducers or concentric reducing couplings can be used.

J. Reducing bushings, weld-o-let, and hole cutting fittings are not acceptable on this piping system.

K. Piping is to be supported by use of UL/FM approved clevis type hangers located every ten feet on center, and immediately upstream and downstream of every fitting.

L. The hangers are to be connected directly to structure.

PART 3 **EXECUTION**

3.1 SYSTEM and CONTROL WIRING:

A. All system wiring shall be furnished and installed by the contractor.

1. All wiring shall be installed in electrical metallic tubing (EMT), or conduit, and must be installed and kept separate from all other building wiring.

2. All system components shall be securely supported independent of the wiring. Runs of conduit and wiring shall be straight, neatly arranged, properly supported, installed parallel and perpendicular to walls and partitions.

3. The sizes of the conductors shall be those specified by the manufacturer. Color coded wire shall be used. All wires shall be tagged at all junction points and shall be free from shorts, earth connections (unless so noted on the system drawings), and crosses between conductors. Final terminations between the SHP PRO control panel and the system field wiring shall be made under the direct supervision of a factory trained representative.

4. All wiring shall be installed by qualified individuals, in a neat and workmanlike manner, to conform to the National Electrical Code, Article 725, and Article 760, except as otherwise permitted for limited energy circuits, as described in NFPA 72 -1993 edition. Wiring installation shall meet all local, state, province and/or country codes.

5. The complete system electrical installation, and all auxiliary components, shall be connected to earth ground in accordance with the National Electrical Code.

3.2 SYSTEM INSPECTION and CHECKOUT:

A. After the system installation has been completed, the entire system shall be checked out, inspected and functionally tested by qualified, trained personnel, in accordance with the manufacturer's recommended procedures and NFPA standards.

1. All containers and distribution piping shall be checked for proper mounting and installation.
2. All electrical wiring shall be tested for proper connection, continuity and resistance to earth.
3. The complete system shall be functionally tested, in the presence of the owner or his representative, and all functions, including system and equipment interlocks, must be operational at least five (5) days prior to the final acceptance tests.

a. Each detector shall be tested in accordance with the manufacturers recommended procedures, and test values recorded.
b. All system and equipment interlocks, such as door release devices, audible and visual devices, equipment shutdowns, local and remote alarms, etc. shall function as required and designed.
c. Each SHP PRO control panel circuit shall be tested for trouble by inducing a trouble condition into the system.

3.3 TRAINING REQUIREMENTS:

A. Prior to final acceptance, the installing contractor shall provide operational training to each shift of the owners personnel. Each training session shall include system SHP PRO Control Panel operation, manual and (optional) abort functions, trouble procedures, supervisory procedures, auxiliary functions and emergency procedures.

3.4 OPERATION and MAINTENANCE:

A. Prior to final acceptance, the installing contractor shall provide complete operation and maintenance instruction manuals, four (4) copies for each system, to the owner. All aspects of system operation and maintenance shall be detailed, including piping isometrics, wiring diagrams of all circuits, a written description of the system design, sequence of operation and drawing(s) illustrating control logic and equipment used in the system. Checklists and procedures for emergency situations, troubleshooting techniques, maintenance operations and procedures shall be included in the manual.

3.5 AS-BUILT DRAWINGS:

A. Upon completion of each system, the installing contractor shall provide four (4) copies of system As-Built" drawings to the owner. The drawings shall show actual installation details including all equipment locations (i.e.: control panel(s), agent container(s), detectors, alarms, manuals and aborts, etc.) as well as piping and conduit routing details. Show all room or facilities modifications, including door and/or damper installations completed. One (1) copy of reproducible engineering drawings shall be provided reflecting all actual installation details.

3.6 ACCEPTANCE TESTS:

A. At the time "As-Built" drawings and maintenance/operations manuals are submitted, the installing contractor shall submit a "Test Plan" describing procedures to be used to test the control system(s). The Test Plan shall include a step-by-step description of all tests to be performed and shall indicate the type and location of test apparatus to be employed. The tests shall demonstrate that the operational and installation requirements of this specification have been met. All tests shall be conducted in the presence of the owner and shall not be conducted until the Test Plan has been approved.

B. The tests shall demonstrate that the entire control system functions as designed and intended. Al circuits shall be tested: automatic actuation, solenoid and manual actuation, HVAC and power shutdowns, audible and visual alarm devices and manual override of abort functions. Supervision of all panel circuits, including AC power and battery power supplies, shall be tested and qualified.

C. A room pressurization test shall be conducted, in each protected space, to determine the presence of openings, which would affect the agent system concentration levels. The test(s) shall be conducted using the Retro-Tec Corp. Door Fan system, or equivalent, with integrated computer program. All testing shall be in accordance with NFPA 2001, current edition.

D. If room pressurization testing indicates that openings exist which would result in leakage and/or loss of the extinguishing agent, the installing contractor shall be responsible for coordinating the proper sealing of the protected space(s) by the general contractor or his sub-contractor or agent. The general contractor shall be responsible for adequately sealing all protected space(s) against agent loss or leakage. The installing contractor shall inspect all work to ascertain that the protected space(s) have been adequately and properly sealed.

1. THE SUPPRESSION SYSTEM INSTALLING CONTRACTOR SHALL BE RESPONSIBLE FOR THE SUCCESS OF THE ROOM PRESSURIZATION TESTS.

2. If the first room pressurization test is not successful, in accordance with these specifications, the installing contractor shall direct the general contractor to determine, and correct, the cause of the test failure. The installing contractor shall conduct additional room pressurization tests, at no additional cost to the owner, until a successful test is obtained. Copies of successful test results shall be submitted to the owner for record.

E. Upon acceptance by the owner, the completed system(s) shall be placed into service.

3.7 SYSTEM INSPECTIONS:

A. The installing contractor shall provide two (2) inspections of each system, installed under this contract, during the one-year warranty period. The first inspection shall be at the six month interval, and the second inspection at the 12 month interval, after system acceptance. Inspections shall be conducted in accordance with the manufacturer's guidelines, and the recommendations of NFPA 2001.

B. Documents certifying satisfactory system(s) operation shall be submitted to the owner upon completion of each inspection.

3.8 WARRANTY:

A. All system components furnished, and installed under this contract, shall be guaranteed against defects in design, materials and workmanship for the full warranty period which is standard with the manufacturer, but in no case less than one (1) year from the date of system acceptance.

END OF SECTION

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. "Specifications for Road and Bridge Construction, August 2001 including all revisions up to the date of advertisement, Prepared by The Delaware Department of Transportation"

C. Related Sections:

1. Section 03 30 00 - Cast In Place Concrete
2. Section 05 50 00 - Metal Fabrications
3. Section 06 10 00 - Rough Carpentry
4. Section 07 84 00 - Firestopping
5. Section 08 31 13 - Access Doors and Frames
6. Section 09 96 00 - High Performance Coatings
7. Section 23 05 13 – Common Motor Requirements for HVAC Equipment
8. Section 23 05 29 – Hangers and Supports fro HVAC Piping and Equipment
9. Section 23 05 53 – Identification for HVAC Piping and Equipment
10. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC Equipment
11. Section 23 07 00 – HVAC Insulation
12. Section 23 09 00 – Instrumentation and Controls for HVAC
13. Section 23 09 23 – Direct Digital Control for HVAC
14. Section 23 21 13 – Hydronic Piping
15. Section 23 21 16 – Hydronic Piping Specialties
16. Section 23 21 23 – Hydronic Pumps
17. Section 23 23 00 – Refrigerant Piping
18. Section 23 29 23 – Variable Frequency Motor Controllers
19. Section 23 31 00 – HVAC Ducts and Casings
20. Section 23 33 00 – Air Duct Accessories
21. Section 23 34 00 – HVAC Fans
22. Section 23 36 00 – Air Terminal Units
23. Section 23 37 00 – Air Outlets and Inlets
24. Section 23 52 37 – Condensing Boilers
25. Section 23 64 11 – Modular Packaged Air Cooled Chiller
26. Section 23 73 00 – Indoor Central Station Air Handling Units
27. Section 23 81 03 – Packaged Outdoor Air Conditioning Units
28. Section 23 81 10 – Air to Air Energy Recovery Units
29. Section 23 81 23 – Computer Room Air Conditioners
30. Section 23 82 00 – Convection Heating Units

1.2 SUMMARY

A. This Section includes the following materials and methods common to other Sections of this Division:

1. Concrete equipment base construction requirements.
2. Formed steel channel.
3. Sleeves and Seals
4. Identification for Piping and Equipment.
5. Cutting and Patching
6. Welding Procedures
7. Piping Specialties
8. Fire-stopping
9. Access Doors
10. Joint Materials
11. Field Painting
12. Motors

1.3 REFERENCES

A. The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic definition only. Use latest edition of publication.

B. American National Standards Institute (ANSI):
1. ANSI/ASME B31; Code for Pressure Piping.
2. A 13.1 Scheme for the Identification of Piping Systems.
3. B 31 Code for Pressure Piping.

C. American Society of Mechanical Engineers (ASME):
1. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

D. American Welding Society (AWS):
1. Soldering Manual. 2nd ed. 1977.
2. Brazing Manual. 4th ed. 1991.
3. A 5.8 Specifications for Filler Metals for Brazing.
4. D 1.1 Structural Welding Code for Steel.

E. National Electric Manufacturer's Association (NEMA) Standards as apply to specified products.
1. NEMA MG1; Motors and Generators.

F. Steel Structures Painting Council (SSPC):

1.4 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and other Divisions of this specification. Submit in sufficient detail to show full compliance with Contract Documents.

B. Product Data:
   1. Submit manufacturer's product data for each product and material
   2. Indicate manufacturer, trade names, and model numbers, components, arrangement, and accessories being provided.
   3. Include applicable literature, catalog material or technical brochures.
   4. Include material and equipment specifications, sizes, types, dimensions, weights, rated capacities, and performance tables or performance curves.
   5. Include utility requirements for wiring, piping, and service connection data, motor sizes complete with electrical characteristics.

C. Shop Drawings: Submit shop drawings where required under other individual Sections of this Division:
   1. Include dimensional data for rough in and installation instructions.
   2. Indicate typical layout including dimensions and utility connections.
   3. Submit Fabrication Drawings for construction and connections to equipment.
   4. Submit drawings showing field measured conditions.
   5. Shop drawings detailing fabrication and installation for equipment pads, metal and wood supports and anchorage for materials and equipment.
   6. Coordination drawings for access panel and door locations.
   7. Submit for piping and equipment identification list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
   8. Requirements of this section do not relieve the contractor of requirement to address specific shop drawing requirements for each technical specification section under division 23.

D. Samples:
   1. Submit samples where required under other individual Sections of this Division.

1.5 CLOSEOUT SUBMITTALS:

A. Record Documents
   1. Record installed locations and position of systems, components, and accessories.
   2. Maintain and update documents on a daily basis.
   3. Provide electronic files of Record Documents in addition to Printed copies.

B. Operation and Maintenance Manuals: Submit operation and maintenance manuals for each of the following items of equipment or systems.
   1. Boilers.
   2. Air Handling Units
   3. Mechanical Piping Systems.
   4. Heating and Cooling Equipment.
   5. Water Treatment.
   6. Pumps, Accessories, and Specialties
   7. Air Distribution Systems
   8. HVAC Control Systems.

C. Include the following elements in each O & M manual:
   1. Erection or installation instructions.

2. Start-up procedures.
3. Recommended and alternative operating procedures.
4. Schedule of preventive maintenance requirements.
5. Schedule of recommended spare parts to be stocked, complete with part number, inventory quantity, and ordering information.
6. Detailed maintenance procedures.
7. Schedule of lubrication requirements.
8. Corrected and approved control and wiring diagrams.
9. Data sheet listing pertinent equipment or system information, as well as the addresses and telephone numbers of the nearest sales and service representatives.

D. Submit Operation and Maintenance Manuals by complete system.

1.6 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with construction requirements of State, County, and such other local political subdivision's specifications as may exceed the requirements of the codes, standards, and approving bodies referenced herein.
1. Perform Work in accordance with the Uniform Construction Code.
2. Perform Work in accordance with local Authorities having Jurisdiction

B. Maintain one copy of each document on site.

C. Qualify welding processes and operators for structural steel according to AWS D1.1.

D. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX.
1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

E. All equipment or apparatus of any one system must be the product of one manufacturer or equivalent products of a number of manufacturers which are suitable for use in a unified or assembled system.

F. Comply with requirements of the National Fire Protection Association (NFPA) Standards referenced in the various Specifications Sections, and as directly appropriate to the work and workmanship.

G. Comply with requirements for both the Underwriters' Laboratories, Inc. (UL) Listings, Labels, and Approvals and the National Electrical Manufacturers' Associations (NEMA) Stamps or Seals as applicable to electrical equipment or apparatus forming parts of the Mechanical Equipment.

H. Certificates and Permits: Upon completion of work, and prior to final payment, furnish to the A/E formal certification of final inspections from authorities having jurisdiction and secure required permits, if any, from such authorities. Additionally, prepare detailed diagrams and drawings, which may be required by those authorities having jurisdiction.

I. Source Quality Control: Products used throughout these specifications, and as indicated on the Drawings, are those of companies having established reputations in the

manufacture of the particular materials, equipment, or apparatus specified. Such products may be of their own make, or products of others for which they assume full responsibility when used in said assemblies (which are not manufactured completely by them), and with replacement parts available.

1.7 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. Provide: Furnish and install.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and equipment to the Project site in a clean condition with openings plugged or capped (or otherwise sealed by packaging) both during shipping and during temporary storage.

B. Delivered equipment crating and/or packaging shall clearly identify pick-points or lift-points. In the absence of crating or packaging, pick-points or lift-points must be identified on the equipment.

C. When unloading materials and equipment provide special lifting harness or apparatus as may be required by manufacturers. Handle materials and equipment in accordance with manufacturer's written instructions.

D. The Contractor shall determine the required equipment needed for unloading operations and have such equipment on site to perform unloading work on the date of equipment delivery.

E. Store materials and equipment, both on and off site, in accordance with manufacturer's written instructions.

1.9 DRAWING INTERPRETATION AND COORDINATION

A. Mechanical Drawings are diagrammatic and indicate the general arrangement of systems and equipment, unless indicated otherwise by dimensions or Detail Drawings.

B. Plans are intended to show size, capacity, approximate location, direction, and general relationship of one work phase to another, but not the exact detail or arrangement.

C. For locations of building elements, refer to dimensioned Architectural and Structural Drawings and perform field measurements to verify exact locations.

D. Equipment outlines shown on Detail Drawings, or dimensions indicated anywhere on the Drawings, are limiting dimensions. Equipment exceeding approximate dimensions indicated by equipment outlines on Detail Drawings and any equipment or arrangements that reduce indicated clearances or exceed specific equipment dimensions may not be used.

E. Electrical Service Devices:

1. Provide starters, fused disconnect switches or combination starter fusible disconnect switches required for motors and equipment of this Division of the Specifications.
2. Correct sizing of starters and disconnect switches is the joint responsibility of the Contractor and the equipment or apparatus manufacturer.
3. Motor starters shall be minimum NEMA Size 1. Electrical enclosures to be NEMA 12 for indoor units and NEMA 4 for outdoor units unless otherwise indicated on the Drawings.
4. Starters shall be complete with two sets of auxiliary contacts; one set normally open; one set normally closed.
5. For motors 25 HP or greater, provide auto - transformer type reduced voltage starters.
6. Motor starters and disconnect switches shall be located as indicated on the Drawings.

1.10 MATERIALS, EQUIPMENT AND WORKMANSHIP

A. Install equipment in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment. Obtain these instructions from the manufacturer and such instructions shall be considered a part of these Specifications. Type, capacity and application of equipment shall be suitable and capable of satisfactory operation.

B. All equipment or apparatus of any one system must be the product of one manufacturer or equivalent products of a number of manufacturers which are suitable for use in a unified or assembled system.

1.11 WARRANTY

A. Extended Warranties: See individual Sections for extended Warranties.

B. Submit manufacturer’s warranty and verify that forms are completed in Owner’s name and registered with manufacturer.

C. Date warranties to date of Substantial Completion for Project.

D. Correct defective Work within a one year period after Date of Substantial Completion.

1.12 MAINTENANCE

A. Provide service and maintenance for one year from date of Substantial Completion, except where longer service is indicated in individual sections.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Use of Trade Names: The use of trade names on the drawings or other documents is to establish a basis of design, constructability, and level of quality. It is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with contract requirements.

B. Alternates and Substitutions: In accordance with the Contract Documents, including General and Supplemental Conditions.

2.2 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or gage thick galvanized steel.

C. Sealant: Refer to other Divisions of this specification for additional information.

2.3 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. Or approved equal.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.4 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Or approved equal.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.5 CONCRETE

A. Refer to other Divisions of this Specification for additional information.

B. Concrete work for mechanical installations is specified in this specification. Provide dimensional drawings, templates, anchor bolts and accessories required for mounting and anchoring equipment.

2.6 GROUT:

A. Non-shrink, Nonmetallic Grout: ASTM C 1107, Grade B.
   1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory-packaged.

2.7 ACCESS DOORS

A. Refer to other Divisions of this Specification for additional information.

B. Provide access doors for maintenance or adjustments purposes for all mechanical system components including valves, volume and splitter dampers, fire dampers, clean outs and traps, controls, coils and terminal units, and expansion joints.

C. Unless indicated otherwise, access doors to match surrounding surface, provided with recess to accept matching finish. Provide UL rated doors in fire rated construction.

D. Provide flush type steel framed panel with concealed hinges, size minimum 12 x 12 inch for inspection and hand access, and minimum 18 x 18 inch for man access.

E. Provide cam type locking device with hand or key lock when located in public corridors and washrooms complete with master keys.

2.8 PIPE AND PIPE FITTINGS:

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

2.9 JOINING MATERIALS:

A. Refer to individual piping system specification Sections in Division 23 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, except where thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.

2. ASME B16.20 for grooved, ring-joint, steel flanges.
3. AWWA C110, rubber, flat face, 1/8 inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Solder Filler Metal: ASTM B 32.
1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.
2. Alloy Sn50: Tin (50 percent) and lead (50 percent).
3. Alloy E: Tin (approximately 95 percent) and copper (approximately 5 percent), having 0.10 percent maximum lead content.
4. Alloy HA: Tin-antimony-silver-copper-zinc, having 0.10 percent maximum lead content.
5. Alloy HB: Tin-antimony-silver-copper-nickel, having 0.10 percent maximum lead content.
6. Alloy Sb5: Tin (95 percent) and antimony (5 percent), having 0.20 percent maximum lead content.

E. Brazing Filler Metals: AWS A5.8.
1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Couplings: Iron body sleeve assembly, fabricated to match outside diameters of plain-end pressure pipes.
1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A 47, Grade 32510 or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.10 PIPING SPECIALTIES:

A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves.
1. Inside Diameter: Closely fit around pipe, tube, and insulation.
2. Outside Diameter: Completely cover opening.
3. Cast Brass: Split casting, with concealed hinge and set-screw.
4. Finish: Polished chrome plate.
5. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome-plated finish.

2.11 IDENTIFICATION FOR PIPING AND EQUIPMENT

A. Refer to Section 23 05 53 for additional information

B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light background color.

C. Plastic Tags: Laminated three-layer plastic with engraved black letters on light background color, minimum 1-1/2 inches diameter.

D. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Color and Lettering: Conform to ASME A13.1.

E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Color and Lettering: Conform to ASME A13.1.

F. Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.12 FIRESTOPPING

A. Refer to other Divisions of this Specification for additional information.

B. Provide fire-stopping against the spread of fire, smoke and gases where penetrations occur for piping and ductwork.

2.13 FLASHING

A. Flash and counter flash where mechanical equipment passes through exterior or waterproofed walls, floors and roofs.

B. Flash pipes projecting 12 inch minimum above finished roof surface with flashing worked 1 inch minimum into hub, 8 inch minimum clear on sides with minimum 24 x 24 inch sheet size. For pipes through outside walls turn flange back into wall and caulk.

C. Provide curbs for mechanical roof installations 12 inch minimum high. Flash and counter flash with galvanized steel, soldered and made waterproof.

2.14 PAINTING

A. Shop Paint: For primer coats provide only those primers that are compatible with field coats specified in this specification

2.15 MOTORS

A. Provide energy efficient motors of sufficient capacity to operate the equipment under all conditions of operations without loading beyond the nameplate current or power.

B. In no case are the motors offered to be less than the horsepower specified except when it can be demonstrated that because the efficiency of the driven equipment is greater than that specified, a lesser horsepower will suffice.

C. Provide motors one-half horsepower and larger designed to operate on 460volt, three phase, 60 Hertz current unless indicated otherwise or specified otherwise.

D. Provide motors smaller than one-half horsepower designed to operate on 120 volt, single phase, 60-Hertz current unless otherwise specified.

E. Motors of drip proof, ball bearing type unless otherwise specified.

F. Provide motors designed to operate in an ambient temperature of 40 degrees C. in continuous operation with a service factor of 1.15.

G. Explosion proof motors shall comply with requirements of Class I, Division I, Group D, Hazardous Locations, as defined by the National Electrical Code.

H. Provide totally enclosed fan cooled motors where motors are located outdoors.

I. When integral horsepower, poly-phase squirrel-cage induction type motors are provided, their design shall incorporate high efficiency, high power factor features and be certified by the manufacturer as having been tested in accordance with the latest edition or revision of NEMA standard MG1-12.53b (IEEE Standard 112, Test Method B).

J. Motor Connections:
   1. Use lugged connections on motors 10 HP and larger. Wire nuts are not acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Refer to equipment specifications in other Sections for roughing-in requirements.

3.2 INSTALLATION

A. General Requirements: Install equipment, components, and materials at locations indicated on the Drawings and in accordance with manufacturer’s instructions..

3.3 EQUIPMENT INSTALLATION--COMMON REQUIREMENTS:

A. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the CM.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

D. Perform required interconnection of mechanical systems to other mechanical and electrical equipment, devices, or apparatus, regardless of where such Products are specified, in order to ensure the completeness of such mechanical systems.

E. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

F. Install equipment giving right-of-way to piping systems installed at a required slope.

G. All equipment shall operate without objectionable noise or vibration as determined by the Owner. If such objectionable noise or vibration should be produced by apparatus, piping, ducts or other parts of this work, make necessary changes, as determined by the Owner without additional compensation.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, unless piping Sections specify otherwise. Individual piping Sections specify unique piping installation requirements.

B. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:

C. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish.

D. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.

E. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.

F. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.

G. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.

3.5 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 2 inches above finished floor level. Caulk sleeves full depth and provide floor plate.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install stainless steel escutcheons at finished surfaces.

G. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

3.6 CONCRETE BASES

A. Where indicated, mount equipment on reinforced concrete housekeeping bases poured directly on prepared structural floor slab.

B. Provide dimensional drawings, templates, anchor bolts and accessories required for mounting and anchoring equipment.

C. Construct concrete bases of dimensions indicated, but not less than 4 inches thickness and 6 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations.

D. Concrete Mix: 4000-psig, 28-day compressive-strength concrete and reinforcement.

E. Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Locate holes and provide sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

C. Repair cut surfaces to match adjacent surfaces.

D. Perform patching in finished construction of building under the sections of specifications covering these materials.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGE:

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGE:

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 GROUTING

A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placing of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases to provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's written instructions.

3.11 FIRESTOPPING

A. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant material.

3.12 INSTALLATION - PIPING AND EQUIPMENT IDENTIFICATION

A. Refer to Section 23 05 53 – Identification for HVAC Piping and Equipment for additional information.

B. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

C. Install plastic tags with corrosion resistant metal chain.

D. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of mechanical equipment.

E. Install plastic nameplates with adhesive.

F. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows, showing duct system service and direction of flow.

G. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

3.13 PAINTING AND FINISHING

A. Refer to other Divisions of this Specification for additional information.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.14 FIELD QUALITY CONTROL

A. General: Perform cleaning, testing, startup, adjusting, balancing, and commissioning operations as specified in other Sections included under Division 23 - Mechanical.

3.15 PROTECTION

A. Protect equipment and materials in storage on site, during and after installation until final acceptance. Leave factory covers in place and take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

B. Protect equipment with polyethylene covers and crates.

C. Protect installed work from subsequent construction activities.

D. Operate, drain and flush bearings and refill with change of lubricant before final acceptance.

E. Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Provide extended nipples for lubrication.

END OF SECTION

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Related Sections:
1. Section 23 05 00 – Common Work Results for HVAC

1.2 SUMMARY

A. Section Includes:
1. Manufacturers
2. Concrete Inserts
3. Beam Clamps
4. Hanger Rods
5. Auxiliary Steel
6. Vibration Isolators
7. Pipe supports
8. Guides, Anchors and Expansion Joints
9. Duct Supports
10. Anchors and Fasteners
11. Sleeves and Seals
12. Source Quality Control

1.3 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.5 - Refrigeration Piping.

B. ASTM International:
1. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

C. ASTM International:
1. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.

3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

1.4 SUBMITTALS

A. Refer to other Divisions of this Specification for additional information.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit calculations sealed by a registered professional engineer.

E. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with a minimum of 5 years experience.

B. Fabricator Qualifications: Company specializing in manufacturing products specified in this Section with a minimum of 5 years experience.

C. Installer Qualifications: experience on at least 5 projects of a similar nature in past 5 years, and acceptable to the Owner.

D. Regulatory Requirements:
1. Perform Work in accordance with State code.

E. Standards Compliance:
1. ACI Compliance
2. AISI Compliance
3. ANSI Compliance
4. ASTM Compliance
5. NEMA Compliance
6. NFPA Compliance
7. UL and FM Compliance

F. Certifications:

G. Field Samples and Mock-Ups:

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 WARRANTY

A. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
1. Grinnell Corp.
2. Carpenter & Patterson, Inc.
3. B-Line Systems, Inc.
4. National Pipe Hanger Corp.
5. Unistrut Corp.
6. Pipe Shields, Inc.
7. Hilti, Inc.
8. Roof Products Systems (RPS) Corporation.
9. The Pate Company.
10. Portals Plus Inc.
11. Consolidated Kinetics Company.
12. Mason Industries, Inc.
13. Korfund Dynamics, Corp.
14. Creative Pultrusions, Inc.
15. Morrison Molded Fiber Glass Co.
16. Keflex; Series CP.
17. Hyspan Precision Products, Inc.; Series 9500.
18. Metraflex Co.
19. U.S.E. Diamond, Inc.; FORWAY System.
20. Or approved equal.

B. Hydronic Piping:
1. Conform to MSS SP58, MSS SP69, MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.

3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, carbon steel ring, adjustable.

C. Refrigerant Piping:
1. Conform to ASME B31.5, MSS SP58, MSS SP69, MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inchMalleable ironCarbon steel, adjustable swivel, split ring.
3. Vertical Support: Steel riser clamp.
4. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
5. Copper Pipe Support: Copper-plated carbon-steel ring.

2.2 CONCRETE INSERTS

A. For upper attachments in cast-in-place concrete structures provide cast-in inserts made of carbon steel ASTM A 36 or malleable iron ASTM A 47.

B. Where attached loads exceed the recommended load for an individual insert, provide multiple inserts with a trapeze type connecting member below the concrete.

2.3 BEAM CLAMPS

A. For upper attachments on structural steel provide beam clamps of carbon steel ASTM A 36 or forged steel ASTM A 181.

B. Holes drilled in structural steel for hanger support rods will not be permitted.

C. Provide clamps with hardened steel cup-point set screw and lock-nut for anchoring in place.

D. Provide retaining straps with beam clamps to prevent movement of clamp due to vibration.

E. Base clamp size selection on required load being supported.

2.4 HANGER RODS

A. Carbon steel conforming to ASTM A 576.

B. Diameter of rods for piping system support shall conform to ANSI B31.1.

1. In no case shall hanger rods less than 3/8-inch diameter be provided for support of pipe sizes two inches and smaller, or less than 1/2-inch diameter rod for supporting pipe sizes 2-1/2-inch and larger.

C. Size hanger rods for duct work systems in accordance with SMACNA standards.

D. Size hanger rods for mechanical equipment support based on installation instructions as obtained from equipment manufacturers.

1. All-thread hanger rods not permitted for equipment supports.

2.5 AUXILIARY STEEL

A. Provide auxiliary steel where support of piping systems and equipment is required between building structural elements. Provide light gauge and structural steel shapes conform to requirements of ASTM A 36.

B. Contractor shall have the option to use pre-engineered support systems of electrogalvanized steel products such as Kindorf, UniStrut or B-Line. MIXTURE OF SUPPORT SYSTEM MANUFACTURER'S PRODUCTS NOT PERMITTED.

C. Where auxiliary steel is indicated as stainless steel, provide AISI Type 304 stainless steel conforming to ASTM A 167, in No. 1 Finish.

2.6 VIBRATION ISOLATORS

A. Suspended application design, composed of either a steel spring and glass fiber isolator placed in series and encased in a welded steel bracket; or rubber in shear isolator placed in a welded steel bracket.

B. Select isolators to provide 50 percent overload capacity with operating static deflections as recommended by the isolator manufacturer.

2.7 PIPE SUPPORTS

A. Base Supports: Where base supports are indicated for valves and pipe fittings provide saddles supported by pipe columns.

1. Saddles: Consisting of devices similar to ITT Grinnell Figure 258 Cast Iron Pipe Saddle Support; and pipe column designed to adequately support the applied loads with a steel base anchored to floor.

2. Pipe Column: Pipe nipple of Schedule 80 galvanized steel pipe ASTM A 53.

3. Riser Clamps: Support vertical runs of piping at each floor, or closer where required, with carbon steel clamps ASTM A 36 bolted around pipes and attached to the building construction.

4. Provide copper plated clamps for copper tubing support.

5. Provide two bolt type clamps designed for installation under insulation on insulated pipe runs.

B. Offset Pipe Clamp: Where pipes are indicated as offset from wall surfaces, provide double-leg design two-piece pipe clamp similar to Figure 366 by Fee & Mason. Clamp material as indicated on the Drawings.

C. Hangers: Fabricated of malleable iron ASTM A 47, or carbon steel ASTM A 36.

D. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

1. Hangers for pipe sizes 2-l/2-inches or larger shall incorporate a means of vertical adjustment after erection while supporting the load.

2. Adjustable Band Hangers: Carbon steel band type hangers designed for suspension on hanger rods with provisions for vertical adjustments and locking in position using supporting and locknuts. Provide band hangers to support non-insulated pipe.

3. Clevis Hangers for Non-Insulated Pipe: Carbon steel yoke and U-strap type with cross bolt over pipe.

4. Clevis Hangers for Insulated Pipe: Carbon steel yoke and U-strap type hanger designed for installation under insulation with cross bolt outside the insulation.

5. UL and NFPA Approved Hangers: Clevis type, adjustable swivel type, or adjustable flat-iron type. Where adjustable flat iron hangers cannot be used, hangers may be universal channel type or C-type with retaining strap.

E. Brackets: Where piping is run adjacent to walls or steel columns, provide welded steel brackets ASTM A 36 and pre-punched with a minimum of two fastener holes.

F. Racks: Multiple pipe racks or trapeze hangers fabricated from steel ASTM A 36, and designed to suit conditions at points of installation.

1. Keep pipes in their relative positions to each other by the use of clamps or clips. Lines subject to thermal expansion must be free to slide or roll.

G. Pipe Anchors, Guides and Sliding Supports (For Heating System Piping):

1. Anchors fabricated from carbon steel, ASTM A 36.

2. Guides fabricated from carbon steel, ASTM A 36, or cast iron, ASTM A 48.

3. Sliding supports fabricated of cast iron, ASTM A 48.

4. Provide anchors, guides and supports where necessary to keep pipes in accurate alignment, to direct the expansion movement and to prevent buckling and swaying and undue strain.

2.8 GUIDES, ANCHORS AND EXPANSION JOINTS

A. Pipe Alignment Guides: Designed to maintain the longitudinal position of pipe centerlines without axial restraint. Guides to be used in conjunction with hangers, anchors and expansion compensators and joints.

1. Material: Fabricated of welded carbon steel, ASTM A 36.

2. Finish: Surfaces finished with one coat manufacturer's standard enamel paint.

3. Insulation: Factory applied hydrous calcium silicate insulation with vapor barrier and K factor of 0.31 BTUH per sq. ft. per degree per inch at 75 degree F. Maximum operating temperature of 1200 degree F. Insulation thickness same as piping system insulation thickness.

2.9 DUCT SUPPORTS

A. Materials: Hanging and support system materials shall conform to the requirements of referenced SMACNA Standards specified under other Sections of the Specifications, but subject to the following limitations.

1. Wire hangers in lieu of rod or strap hangers not acceptable.

2. Provide hanging and support system in materials and finishes matching that of the ductwork.

2.10 ANCHORS AND FASTENERS

A. Anchor Bolts (Pre-Set): Where anchor bolts are indicated or required as pre-set in cast-in-place concrete, provide anchor bolts of lug or bent shape design.

1. Galvanized Bolts: ASTM A 307 for bolts, nuts and washers; and ASTM B 695 or ASTM A 153 for galvanizing.

2. Stainless Steel Bolts: ASTM A 320, Grade B8, AISC Type 303 or 304.

B. Drilled-In Expansion Anchors and Fasteners:

1. Applications In Masonry (and Precast Concrete Hollow-Core Structural Elements):

   a. Anchors: Provide anchors designed to accept both machine bolts and/or threaded rods. Such anchors shall consist of an expansion shield and expander nut contained inside the shield. Expander nut fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches and bears against the shield bottom.

      1) Shield Body: Consisting of four legs, the inside of each tapered toward shield bottom (or nut end). The end of one leg is elongated and turned across shield bottom. Outer surface of shield body ribbed for grip-action.

      2) Expander Nut: Square design with sides tapered inward from bottom to top.

      3) Material: Die cast Zamac No. 3 zinc alloy of 43,000 psi minimum tensile strength. Shield and nut made in conformance with S.A.E. 90 3 ASTM XI.

   b. Fasteners: Machine bolts conforming to S.A.E. Grade 2, for use with above anchors; nuts and washers conforming to ASTM A 563.

2. Applications in Cast-in-Place Concrete (and Solid Precast Concrete Structural Elements):

   a. Anchor/Fastener: UL Listed and one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1.

   b. Stainless Steel Anchor/Fastener: UL Listed one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1. Stud of AISI Type 303 or 304 stainless and nut and washer of AISI Type 316 stainless.

3. Applications in Horizontal (Floor Mounted) for Adhesive Anchors: Composed of an anchor rod assembly and an anchor rod adhesive cartridge.

   a. Anchor Rod Assembly: Chamfered and threaded stud rod of ASTM A 307 steel with nut and washer of ASTM A 563 steel.

   b. Stainless Steel Anchor Rod Assembly: Chamfered and threaded stud rod of AISI Type 304 stainless with nut and washer of AISI Type 316 stainless.

   c. Adhesive Cartridge: Sealed capsule containing premeasured amounts of resin, quartz sand aggregate, and a hardener contained in a separate vial

within the capsule. Capsule ingredients activated by the insertion procedure of the anchor rod assembly.

4. Note: Hammer drive-type and explosive charge drive-type anchors and fastener systems not acceptable. Lead shields, plastic-inserts, fiber-inserts, and drilled-in plastic sleeve/nail drive systems also not acceptable.

C. Welding Electrodes: Table 4.1.1 of AWS D1.1 as required for applicable base metals and welding process.

2.11 SLEEVES AND SEALS

A. Pipe Sleeve Sizing:

1. Uninsulated Pipes: Size sleeves two pipe sizes larger than pipe passing through, or size sleeves for a minimum of 1/2-inch clearance between inside of sleeve and outside diameter of pipe passing through.

2. Wall Seal Sleeve: Size sleeves to accommodate the pipe plus the hydrostatic Wall Seal.

3. Insulated Pipes: Size sleeves for a minimum of 1/2-inch clearance between inside of sleeve and outside diameter of insulation covering on pipes passing through.

4. Sleeve Length:

a. Wall and Partitions: Equal to total thickness of wall or partitions and terminated flush with finished surfaces.

b. Floors: Equal to total depth of floor construction including finish and extending a minimum of one inch above floor level.

B. Sleeve Materials:

1. Pipe Sleeves In Cast-In-Place Concrete: Fabricate from Schedule 10 black steel pipe and weld a 2-inch wide intermediate anchoring flange of 3/16-inch steel midway on pipe sleeve; or provide sleeve as furnished by wall seal manufacturer.

2. Pipe Sleeves in Masonry: No. 18 gauge galvanized sheet steel.

3. Pipe Sleeves in Wallboard Partitions: No. 18 gauge galvanized sheet steel with anchoring flanges or tabs.

C. Wall Pipe: Cast iron construction with an integral intermediate anchoring flange midway on the pipe exterior.

1. Wall pipe ends of type indicated on Drawings, and where not indicated, pipe end shall match that of adjoining pipe.

2. Provide wall pipes similar to those manufactured by Clow Corporation, American Cast Iron Pipe Co., U.S. Pipe and Foundry Co.

D. Foundation Sleeves: Gray or ductile cast iron with intermediate wall collar anchor and cutting grooves on the plain end.

1. Sleeve designed for mechanical joint gasket and gland and furnished with such. Sleeve designed to pass pipes through interior dimension of sleeve.

2. Provide sleeves similar to those manufactured by Clow Corporation, MJ Wall Sleeve F-1429.

E. Seals and Plates:

1. Wall Seal: Hydrostatic modular compression link seal designed to seal opening between pipes and a through structure opening. Provide Link-Seal by Thunderline Corp.

2. Wall and Ceiling Plates: Cast metal with integral set screw or similar anchoring screw. Hinged or split design plates may be provided.

3. Escutcheons: Provide chrome plated stamped steel hinged plates to close pipe penetrations through structure interior in finished areas. Provide plates designed to lock on pipes using setscrews.

F. Fire Seals: Refer to other Divisions of this Specification for additional information.

G. The pre-fabricated system design shall accommodate multiple pipes and conduits in a single fabricated curb and EPDM pipe portal unit.

2.12 UNIT ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.13 FLASHING

A. Metal Flashing: 26 gagethick galvanized steel.

B. Metal Counterflashing: 22 thick galvanized steel.

C. Lead Flashing:
1. Waterproofing: 5 lb./sq. ftsheet lead.
2. Soundproofing: 1 lb./sq. ftsheet lead.

D. Flexible Flashing: 47 thick sheet compatible with roofing.

E. Caps: Steel, 22 gageminimum; 16 gageat fire resistant elements.

2.14 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division

4. Unistrut Corp.
5. Or approved equal.

B. Product Description: Galvanized 12 gagethick steel. With holes 1-1/2 incheson center.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Verify openings are ready to receive firestopping.

3.03 INSTALLATION

A. General:
1. Install pipe supports and anchors to hold piping straight and true to line both vertically and horizontally.
2. Where thermal movement in piping systems will occur, provide piping system supports capable of supporting the line in all operating conditions.
3. The supporting force at each hanger shall prevent excessive stress in the pipe and connected equipment.
4. Install pipe supports anchored directly to or suspended directly from structural supports. Where pipe hangers fall between structural members provide auxiliary steel supports to carry pipe hangers.
5. Do not support piping from metal decks.
6. Saddles and Shields will be installed in accordance with industry standards or in accordance with manufacturer's recommendations where applicable to prevent damage to insulation.
7. Perforated Strap Iron and Wire will under no circumstances be acceptable as hanger material.
8. Horizontal Piping Expansion: Piping subject to expansion due to temperatures above 180 degrees Fahrenheit shall be supported on roller hangers or supports sized in consideration of insulation and insulation shields.
9. In corrosive conditions or wet areas, provide corrosion resistant supports.

C. Spacing of Hangers and Supports:
1. General:
   a. Space hangers and supports as stated herein and in ANSI B31.1, MSS SP 58 and MSS SP 69, and as indicated on the Drawings.
   b. Give special consideration to spacing of hangers and supports where components such as fittings and valves impose concentrated loads.
2. Cast Iron Soil Pipe: Space hangers on horizontal runs of Cast Iron Soil Pipe according to CISPI 301.
3. Steel Pipe: See Schedule.
4. Copper Tubing: See Schedule.

D. Plastic Piping: Provide hangers at locations and spacing limitations in accordance with pipe manufacturer's installation specifications.

E. Pipe Sleeve Installation:

1. Set pipe sleeves in concrete formwork, walls, partitions, floors and ceilings as construction work progresses. Provide sleeve for each pipe individually.
2. Provide and set sleeves to avoid delaying construction activities of other trades. Perform any additional cutting and boring required due to improperly located or omitted openings without cost to the Owner and perform such additional work under the observation of the Engineer.

F. Equipment Supports and Penetrations Seals for Materials and Equipment Exposed to Weather: Provide stainless steel fasteners for both exposed and concealed attachments in exterior locations.

G. Equipment Supports

1. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

2. Sub-base:

a. All floor mounted mechanical and electrical equipment shall be mounted on a concrete sub-base not less than 4" high unless otherwise indicated. Sub-bases shall rest on structural floor.

b. Electric motor shall be mounted on the same foundation as the driven machine.

c. Piping connections at pumps shall be supported on the same foundation as the pumps.

d. Foundation for machines shall be a minimum of 3000 psi concrete with all exposed surfaces steel trowelled smooth, reinforced with 6" x 6" No. 3 mesh. Chamfer corners of all foundations.

e. Machines shall be secured to bases with anchor bolts of ample size. All machines having bed plates and motors shall be grouted under the full area of the bed plates with a non-shrinking, premixed grout. After grout has set, all wedges, shims, and jack bolts shall be removed and the spaces filled with grout

H. Seals and Plates Installation:

1. Following pipe installation through sleeves in exterior walls below grade, install Wall Seal to render installation leak free. Wall Seal not required in interior walls, partitions, floor and ceilings.

2. Install wall seal as close to outside surface of wall as possible to provide a watertight seal below grade. Apply a coating of coal tar paint or other type-approved coating on bolt heads and other metal parts on below grade wall seals prior to backfilling.

3. Install wall and ceiling plates to close pipe sleeve openings.

4. Install escutcheons to close pipe sleeve openings in finished areas.

I. Fire Seals Installation:

1. Following pipe installation through sleeves in fire-rated walls or partitions and floors, and after Safing Insulation is installed, install Plates secured to adjacent materials.

2. Provide safing insulation fire stop of such thickness as required to meet one, two or three hour ratings as consistent with fire ratings of wall, floors and ceilings where safing is installed.

3. Install Escutcheons on pipes passing through sleeves in finished locations.

J. Fire Seals Installation:

1. Following pipe installation through sleeves in fire-rated walls or partitions and floors install either compound type or mechanical seal, as prior approved.

2. Install seal materials in accordance with manufacturer's installation instructions.

3. Install Escutcheons on pipes passing through sleeves in finished locations.

K. Wall Pipe Installations:

1. Provide wall pipes for those installations indicated on the Drawings where piping is cast integrally into the structure.

2. Provide wall pipes with joining ends as match or mate with those of pipes being connected.

3. Provide the proper gaskets, bolts, nuts and washers as required in the pipe joining to wall pipes.

L. Foundation Sleeve Installation:

1. Provide foundation sleeves for those piping installations where piping is designed to pass through a foundation wall and does not form an integral part of the wall.

2. Provide the proper gland and gasket to make a watertight seal on piping passing through the foundation sleeve.

M. Duct Support Installation:

A. General: Install duct hanging and support systems in conformance with requirements of referenced SMACNA Standards specified under other Sections of the Specifications, but subject to the following limitations.

1. Use upper attachments and anchors and fasteners as specified herein.

2. Do not support ductwork from metal decks.

3.2 ANCHOR AND FASTENER INSTALLATIONS

A. Auxiliary Steel Fabrication: Insofar as possible, fit and shop assemble steel fabrications and make ready for field installation.

1. Drill or punch holes as required for attachment of work and for bolted connections. Burned holes are not acceptable.

2. Perform welding of assemblies in accordance with AWS D1.1. Dress welds smooth and free of sharp edges and corners.

3. Perform shop painting of auxiliary steel as specified in other Divisions of this specification.

B. Threaded Bolts: Draw threaded bolted connections up tight using lock washers to prevent bolt or nut loosening.

C. Anchors and Fasteners Installations in Wood Structural Members:

1. Lag Screw and Drive Screw Installations: For lag screws and drive screws in wood, predrill holes same diameter as root of threads, and enlarge holes to shank diameter for length of shank. Draw screws up tight using lock washers to prevent screw loosening.

D. Drilled-In Expansion Anchor and Fastener Installation:

1. General: In general, install expansion anchors in strict accordance with manufacturer's instructions and in accordance with the following.

2. Drilling Holes: Use rotary hammer type drill and make drill holes to the required diameter and depth as consistent with anchor manufacturer's instructions for size of anchors being installed.

3. Minimum Embedment: Embed expansion anchors to four and one-half bolt diameters, unless otherwise indicated on Drawings.

E. Drilled-In Adhesive Anchor Installation:

1. General: In general, install adhesive anchors in strict accordance with manufacturer's instructions and in accordance with the following.

2. Drilling Holes: Use rotary hammer type drill and make drill holes to the required diameter and depth as consistent with anchor manufacturer's instructions for size of anchors being installed.

a. Prior to setting cartridge and anchor stud clean drilled holes free of loose material by vacuum process, finishing with a blast of compressed air, and cover hole until actual use.

3. Anchor Rod Installation: Following cartridge installation in prepared drill holes, set anchor rod to the required depth. Set anchor rods truly perpendicular (normal) to the base plate of item being anchored.

3.3 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.4 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 2)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4
10	18	22	3/4	7/8
12	19	23	3/4	7/8
14	22	25	7/8	1
16	23	27	7/8	1
18	25	28	1	1
20	27	30	1	1-1/4
24	28	32	1-1/4	1-1/4

B. Plastic Pipe Hanger Spacing:

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
PVC (All Sizes)	4	3/8

C. Note 1:Refer to manufacturer’s recommendations for grooved end piping systems.

D. Note 2: 20 feet maximum spacing, minimum of one hanger for each pipe section close to joint behind bell. Provide hanger at each change of direction and each branch connection. For pipe sizes 6 inches and smaller, subjected to loadings other than weight of pipe and contents, limit span to maximum spacing for water service steel pipe.

END OF SECTION

SECTION 23 07 00 – HVAC INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Related Sections:
1. Section 23 05 00 – Common Work Results for HVAC

1.2 SUMMARY

A. Section Includes:
1. Piping system insulation.
2. Equipment insulation.
3. Pipe insulation jackets.
4. Equipment insulation jackets.
5. Insulation accessories including vapor retarders and accessories.
6. Ductwork insulation.
7. Ductwork insulation jackets.
8. Insulation accessories including vapor retarders and accessories.

1.3 REFERENCES

A. ASTM International:
1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
3. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
4. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
5. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
6. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
7. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
8. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
9. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
10. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.

11. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
12. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
13. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
14. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
15. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
16. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
17. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
18. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
19. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. Sheet Metal and Air Conditioning Contractors':
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible – Third Edition.

C. Underwriters Laboratories Inc.:
   1. UL 1978 - Standard for Safety for Grease Ducts.

1.4 SUBMITTALS

A. Refer to other Divisions of this specification for additional information.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

B. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

C. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

D. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

E. Perform Work in accordance with State of DE standard.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to other Divisions of this Specification for additional information.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Refer to other Divisions of this Specification for additional information.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature during and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Refer to other Divisions of this Specification for additional information.

B. Furnish five year manufacturer warranty for man-made fiber.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Use of Trade Names: The use of trade names on the drawings or other documents is to establish a basis of design, constructibility, and level of quality. It is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with contract requirements.

B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include, but are not limited to, the following:

1. Manville Corporation.
2. Owens-Corning Fiberglas.
3. Knauf.
4. Certainteed.
5. Saint Gobian.
6. Or approved equal.

C. Acceptable Manufacturers for Closed Cell Elastomeric or Polyolefin Insulation Materials:
1. Armstrong AP.
2. IMCOA.
3. Rubatex.
4. Or approved equal.

D. Acceptable Manufacturers for Adhesives, Mastics, and Coatings:
1. Benjamin Foster.
2. Insul-Coustic.
3. Chicago Mastic.
4. 3M Company.
5. Childers.
6. Or approved equal.

E. Acceptable Manufacturers for Metal Jackets:
1. Manville Metal-Loc.
2. Childers.
3. Or approved equal.

F. Acceptable Manufacturers for Fireproofing Insulation:
1. 3M - Firemaster.
2. PABCO.
3. Premier – Pyroscat.
4. Or approved equal.

G. Acceptable Manufacturers for Piping Safety Covers, Molded Closed Cell Vinyl:
1. Brocar Products, Inc.
2. Truebro.
3. Or approved equal.

H. Substitutions: Permitted and subject to approval.

2.2 COMMON INSULATION CHARACTERISTICS

A. Specified insulation thickness based on R-values ranging from 4.0 to 4.6 per inch at 75 degrees F. mean temperature.
1. If insulation R-value is less than 4.0, increase indicated insulation thickness by ratio of 4.0/R-value.
2. If insulation R-value is greater than 4.6, decrease indicated insulation thickness by ratio of 4.6/R-value.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency

acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

2.3 INSULATION TYPES

A. Type 1: Fiberglass (molded for pipe).
   1. Material: 1 or 2 piece fiberglass molded to pipe size and conforming to ASTM C547 Type I; rigid molded, noncombustible.
   2. Jacket: Laminated aluminum foil and glass reinforced vinyl coated kraft paper.
   3. 'K' ('ksi') Value: 0.23 at 75 degrees F Mean Temperature.
   4. Maximum Service Temperature: 0 degrees F to 850 degrees F.

B. Type 2: Closed Cell Elastomeric or Polyolefin (molded for pipe).
   1. Material: Expanded, flexible, molded to pipe size and conforming to ASTM C534.
   2. Pre-slit and pre-glued longitudinal seam.
   3. 'K' ('ksi') Value: 0.30 at 75 degrees F Mean Temperature.
   4. Maximum Service Temperature of 220 degrees F.
   5. Adhesive: As recommended by insulation material manufacturer.
   6. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

C. Type 3: Contoured Fiberglass Board (with vapor barrier).
   1. Material: Semi-rigid, contoured, 3 pound density fiberglass board conforming to ASTM C612.
   2. Jacket (liner): 20 mil laminated jacket with tedlar latex bound felt, reinforced with glass fabric and metallized mylar vapor barrier.

D. Type 4: Plain Fiberglass Board.
   1. Material: 3 pound density rigid fiberglass board conforming to ASTM C612.
   2. Jacket: None.
   3. Maximum Service Temperature: 450 degrees F.

E. Type 5: Calcium Silicate Block.
   1. Material: Calcium Silicate Insulation: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C 533, Type I. Non-combustible as determined by test following ASTM E 136.
   2. For Piping: K' ('ksi') Value: 0.42 at 300 degrees F Mean Temperature as tested in accordance with ASTM C 335
   3. Maximum Service Temperature: 1200 degrees F.
   4. Compressive Strength (block): Minimum of 100 psi to produce 5 percent compression at 1 ½-inch thickness.
   5. Securement: Insulation shall be securely banded in place, tightly butted, joints staggered and secured with tie wire: 16 gauge stainless steel with twisted ends on maximum 12-inch centers.

F. Type 6: Fiberglass Blanket (for Ductwork).
1. Material: 0.75 pound density fiberglass blanket conforming to ASTM C553.
2. 'K' ('ksi') Value: 0.27 at 75 degrees F Mean Temperature.
3. Operating Service Temperature Limits: 40 degrees F to 250 degrees F
4. Jacket:
   a. Laminated aluminum foil and glass reinforced vinyl coated kraft paper.
   b. 1-1/2 inch wide adhesive tab.

G. Type 6A: Rectangular Duct Liner: Permacote Linacostic meeting ASTM C 1071 with air surface coated with acrylic coating treated with EPA register anti-microbial agent proven to resist microbial growth as determined by ASTM G 21 and ASTM G 22.
1. 'K' ('ksi') Value: Per ASTM C 518, 0.25 at 75 degrees F Mean Temperature.
2. Noise Reduction Coefficient: .70 or higher based on "Type A mounting" and tested in accordance to ASTM C 423.
3. Maximum Velocity: 6,000 ft/min.
4. Adhesive: Meeting ASTM C 919.
5. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
6. Edge Coating and Repairs: Superseal.

H. Type 6B: Round Duct Liner: Permacote Spiracoustic, rigid performed round liner, or Spiracoustic Plus with air surface coated with acrylic coating treated with EPA register anti-microbial agent proven to resist microbial growth as determined by ASTM G 21 and ASTM G 22.
1. 'K' ('ksi') Value: ASTM C 518, 0.23 at 75 degrees F Mean Temperature.
2. Noise Reduction Coefficient of .70 as per ASTM C 423. (Type A mounting).
3. Maximum Velocity: 6,000 ft/min.

I. Type 6C: Fiberglass Blanket (for Equipment).
1. Material: 1.5 pound density fiberglass blanket conforming to ASTM C553.
2. Operating Service Temperature Limits: 40 degrees F to 250 degrees F
3. 'K' ('ksi') Value: 0.24 at 75 degrees F Mean Temperature
4. Jacket:
   a. Laminated aluminum foil and glass reinforced vinyl coated kraft paper.
   b. 1-1/2 inch wide adhesive tab.
   c. Secured with UL listed pressure sensitive tape and/or outward clinch expanding staples and vapor barrier mastic.

J. Type 7: Fiberglass Board (for Equipment and Ductwork).
1. Material: 3 pound density rigid fiberglass board conforming to ASTM C612.
2. 'K' ('ksi') Value: 0.23 at 75 degrees F Mean Temperature.
3. Operating Service Temperature Limits: 0 degrees F to 450 degrees F, Kraft Jacket.
4. Operating Service Temperature Limits: 40 degrees F to 450 degrees F, aluminum Jacket
5. Jacket:
   a. Bleached kraft paper bonded to aluminum foil, reinforced with fiber glass yarn.
   b. Aluminum foil reinforced with fiber glass yarn and laminated to fire-resistant kraft.
   c. 1-1/2 inch wide adhesive tab.

d. Secured with UL listed pressure sensitive tape and/or outward clinch expanding staples and vapor barrier mastic.

K. Type 7A: High Temperature Fiberglass Board (for Equipment).
1. Material: 3 pound density rigid fiberglass board conforming to ASTM C612.
2. 'K' ('ksi') Value: 0.23 at 75 degrees F Mean Temperature.
3. Maximum Service Temperature: 850 degrees F
4. Facing: 1-inch galvanized hexagonal wire mesh stitched on one face of insulation.

L. Type 8: Closed Cell Elastomeric or Polyolefin Sheet.
1. Material: Expanded, flexible, closed cell elastomeric or polyolefin sheet conforming to ASTM C534.
2. 'K' ('ksi') Value: 0.30 at 75 degrees F Mean Temperature.
3. Maximum Service Temperature of 220 degrees F.
4. Adhesive: As recommended by insulation material manufacturer.
5. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

M. Type 9: Weatherproof Fiberglass (for outdoor piping):
1. Material: 1 or 2 piece fiberglass molded to pipe size conforming to ASTM C547.
2. Jacket:
a. 0.010 inch thick galvanized steel with 3/16" corrugations.
b. Fused weatherproof vinyl top coat.
c. Factory-attached moisture barrier laminated across full width.

N. Type 10: Calcium Silicate Block (with protective metal jacket):
1. Material: Hydrous calcium silicate block conforming to ASTM C533.
2. Jacket:
a. .016 inch aluminum with integral polykraft moisture barrier coating over entire surface in contact with insulation.
b. Stainless steel bands.

O. Type 11: Fireproofing Insulation:
1. Material: Non-combustible.
2. 2-hour fire rated. UL labeled.

P. Type 12: Piping Safety Covers, Molded Closed Cell Vinyl:
1. Material: Molded closed cell vinyl.
2. Meets requirements of the Americans with Disabilities Act (ADA).
3. Maximum Thermal Conductivity (ASTM C177): 1.17 (Btu-in)/(hr-sqft-degF)
4. Burning Characteristics (ASTM D635): Self-extinguishing.
5. Each piece to integrally connect with other pieces and fasten with fasteners.
6. Fasteners: Nylon.
7. Color: White or Taupe.:

2.4 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. Canvas Jacket: UL listed fabric, 6 oz/sq yd (220 g/sq m), plain weave cotton treated with dilute fire retardant lagging adhesive.

C. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

D. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils (0.5 mm) thick; roll stock ready for shop or field cutting and forming.
   1. Connections: Tacks, pressure sensitive color matching vinyl tape or permaweld solvent weld adhesive: As recommended by insulation material manufacturer.
   2. PVC Jacket Color: Color-code to match connected piping jackets based on materials contained within the piping system.

E. Aluminum Jacket: Sheets manufactured from aluminum alloy complying with ASTM B209, and having an integrally bonded moisture barrier over entire surface in contact with insulation, 0.016 inch thick No. 5005 tempered aluminum secured with machine drawn 0.020-inch stainless steel bands.
   1. Finish: Smooth finish or Factory-painted finish.
   2. Moisture Barrier: 1-mil hick, heat-bonded polyethylene and kraft paper.

F. Stainless-Steel Jacket: Sheets of stainless steel complying with ASTM A 666, Type 304 or 316; 0.10 inch thick; and roll stock ready for shop or field cutting and forming to indicated sizes.
   1. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and kraft paper.
   2. Jacket Bands: Stainless steel, Type 304, 3/4 inch wide.

2.5 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd.
   1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
   1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
   2. Aluminum: 0.007 inch thick.

C. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.
   1. Welded Pin Holding Capacity: 100 lb (45 kg) for direct pull perpendicular to the attached surface.

D. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length and washers of proper dimensions for insulation type and thickness indicated.
   1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb (45 kg) for direct pull perpendicular to the adhered surface.

2.6 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 EXECUTION

3.1 EXAMINATION

A. Refer to other Divisions of this Specification for additional information.

B. Verify piping, equipment and ductwork has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Exposed Piping: Locate insulation and cover seams in least visible locations.

B. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

C. Man made mineral fiber insulated pipes conveying fluids below ambient temperature:
1. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

E. Man made mineral fiber insulated pipes conveying fluids above ambient temperature:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

F. Inserts and Shields:
1. Application: Piping or Equipment 2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between support shield and piping and under finish jacket.
4. Insert configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.

5. Insert material: Compression resistant insulating material suitable for planned temperature range and service.

G. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to section for penetrations of assemblies with fire resistance rating greater than one hour.

H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces less than 10 feet above finished floor: Finish with PVC jacket and fitting cover.

I. Exterior Applications: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal equipment.

J. Factory Insulated Equipment: Do not insulate.

K. Exposed Equipment: Locate insulation and cover seams in least visible locations.

L. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

M. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

N. Insulated equipment containing fluids below ambient temperature: Insulate entire system.

O. Mineral fiber insulated equipment containing fluids below ambient temperature: Provide vapor retarder jackets, factory-applied or field-applied. Finish with glass-cloth and vapor barrier adhesive.

P. Mineral fiber insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor retarder, factory-applied or field-applied. Finish with glass cloth and adhesive.

Q. Finish insulation at supports, protrusions, and interruptions.

R. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with aluminum jacket.

S. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

T. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

U. Insulated ductwork conveying air below ambient temperature:
1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.

3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

V. Insulated ductwork conveying air above ambient temperature:
1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

W. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces below 10 feet above finished floor Finish with aluminum jacket

X. Exterior Applications: Provide insulation with vapor retarder jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section

Y. External Duct Insulation Application:
1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping

3.3 SCHEDULES

COLD PIPING			
Application	Size	Type	Thickness/R Value
Refrigeration suction	2" and smaller pipe size	2	½-inch
Cooling coil condensate drains	2" and smaller pipe size	2	½-inch
Chilled Water	2” and smaller pipe size	1	1-Inch
Chilled Water	2-1/2” and larger pipe size	1	1-1/2”

HOT PIPING			
Application	Size	Type	Thickness/R Value
Hot water heating.	2" and smaller pipe size	1	1-inch
Hot water heating.	2-1/2" and larger pipe size	1	1-1/2 inch

DUCTWORK AND FANS			
Application	Size	Type	Thickness/R Value

Round supply ducts	All	6	1-1/2-inch
Concealed rectangular supply ducts	All	6	1-1/2-inch
Concealed rectangular return ducts	All	6	1-1/2-inch
Concealed outside air and mixed air ducts	All	6	1-1/2-inch
Exposed rectangular supply ducts	All	7	1-inch
Exposed rectangular return ducts	All	7	1-inch
Exposed outside air and mixed air ducts	All	7	1-inch
Single inlet supply fans	All	3	1-1/2-inch
Single inlet exhaust fans	All	3	1-1/2-inch

END OF SECTION

SECTION 23 23 00 – REFRIGERANT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Related Sections:
1. Section 23 05 00 – Common Work Results for HVAC

1.2 SUMMARY

A. Section Includes:
1. Refrigerant piping.
2. Unions, flanges, and couplings.

1.3 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
1. ARI 750 - Thermostatic Refrigerant Expansion Valves.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. American Society of Mechanical Engineers:
1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
2. ASME B31.5 - Refrigeration Piping.

D. ASTM International:
1. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
2. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

F. Underwriters Laboratories Inc.:
1. UL 429 - Electrically Operated Valves.

1.4 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.

C. Refer to Section 23 05 29 for Hangers and Supports.

D. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

A. Refer to other Divisions of this Specification for additional information.

B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.

C. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories.
   2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
   3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
   4. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
      a. Refrigerant moisture and liquid indicators.
      b. Refrigerant strainers.
      c. Refrigerant pressure regulators.
      d. Refrigerant pressure relief valves.
      e. Refrigerant filter-driers.
      f. Refrigerant solenoid valves.
      g. Refrigerant expansion valves.
      h. Electronic expansion valves.

D. Test Reports: Indicate results of refrigerant leak test.

E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.6 CLOSEOUT SUBMITTALS

A. Refer to other Divisions of this Specification for additional information.

B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

B. Perform Work in accordance with applicable code for welding hanger and support attachments to building structure.

C. Perform Work in accordance with State standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to other Divisions of this Specification for additional information.

B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.

C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Furnish five year manufacturer warranty for valves excluding packing.

1.12 MAINTENANCE MATERIALS

A. Furnish two refrigerant oil test kits each containing everything required for conducting one test.

PART 2 PRODUCTS

2.1 REFRIGERANT PIPING

A. Copper Tubing to 7/8 inch OD: ASTM B88, Type K, annealed.
   1. Fittings: ASME B16.26 cast copper, compression type.
   2. Joints: Flared.
   3. Refrigerant piping supply and return; maximum operating pressure of 200 psig, and maximum operating temperature of 200 degrees F.

2.2 UNIONS, FLANGES, AND COUPLINGS

A. 2 inches and Smaller:
   1. Ferrous Piping: 150 psig malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.

B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Refer to other Divisions of this Specification for additional information.

B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment with flanges or unions.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Route piping parallel to building structure and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.

E. Install pipe identification in accordance with Section 23 05 53.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide access where valves and fittings are not exposed.

H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Flood refrigerant piping system with nitrogen when brazing.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

L. Install valves with stems upright or horizontal, not inverted.

M. Insulate piping and equipment.

N. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

O. Fully charge completed system with refrigerant after testing.

P. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

Q. Install refrigerant piping in accordance with ASME B31.5.

3.4 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test refrigeration system with dry nitrogen to 200 psig.

C. Repair leaks.

D. Retest until no leaks are detected.

END OF SECTION

SECTION 26 05 00 - COMMON RESULTS FOR ELECTRICAL WORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details dated 2001, including all revisions up to the date of advertisement, apply to this section.

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

C. Related Sections:

1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
2. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
3. Section 26 05 28 – Hangers and Supports for Electrical Systems.
4. Section 26 05 33.13 - Conduit and Backboxes for Electrical Systems.
5. Section 26 05 33.19 - Wireways for Electrical Systems.
6. Section 26 05 36 – Cable Trays for Electrical Systems.
7. Section 26 05 53 – Identification for Electrical Systems
8. Section 26 05 63 – Acceptance Testing of Electrical Systems
9. Section 26 22 00 - Low Voltage Transformers
10. Section 26 24 16 - Panelboards
11. Section 26 27 26 - Wiring Devices.
12. Section 26 28 16.13 - Low Voltage Enclosed Switches
13. Section 26 28 16.19- Low Voltage Enclosed Circuit Breakers
14. Section 26 29 13 - Enclosed Controllers
15. Section 26 32 13.13 - Diesel Engine Driven Generators
16. Section 26 33 53 - Static Uninterruptible Power Supply
17. Section 26 36 00 - Transfer Switches
18. Section 26 41 13 - Lightning Protection for Structures
19. Section 26 43 13 - Surge Protective Devices
20. Section 26 50 00 - Lighting

1.2 SUMMARY

A. Section Includes:

1. The Work specified in this Section consists of basic requirement for electrical work to be performed as part of this contract.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers/ American National Standards Institute (IEEE/ANSI)

1. IEEE/ANSI C2- National Electrical Safety Code

B. InterNational Electrical Testing Association, Inc. (NETA):

1. ANSI/NETA ATS - Acceptance Testing Specification

C. National Fire Protection Association (NFPA):

1. NFPA 70, National Electrical Code (NEC)
2. NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.04 SCOPE

A. The work to be accomplished includes providing all labor, materials, equipment, hangers and supports, consumable items, supervision, administrative tasks, cleaning, setting and adjusting, testing and documentation for fully operational electrical systems as describe herein and shown on the Contract Drawings.

B. The work shall be complete from point of service to all equipment or devices with all accessory construction and material required to make each item of equipment or system complete and ready for operation.

C. Prior to installation of any electrical equipment, the contractor shall prepare coordination shop drawings showing the proposed layout of equipment in each electrical room and ETC equipment room. Coordination drawings shall be to scale and be dimensioned showing actual equipment sizing as indicated on the approved equipment submittals and indicate proper clearances.

D. Where electrical disconnect switches, motor starters, variable frequency drives and the like are identified on the Contract Drawings as ‘Furnished With Equipment’ (FWE) the contractor shall install (mount and wire) these devices.

E. The Contractor shall set and adjust all circuit breakers and protective relaying in accordance with the approved Short Circuit, Protective Device Coordination and Arc Flash Study prepared in accordance with this specification section. All work shall be performed by certified technicians.

F. The Contractor shall install all arc flash hazard warning labels prepared in accordance with the approved Short Circuit, Protective Device Coordination and Arc Flash Study prepared in accordance with this specification section.

G. The Contractor shall provide all software, software licenses and all programming to make all systems fully operational.

H. The Contractor shall file plans, obtain permits and licenses, pay fees and obtain the necessary inspections and approvals from authorities having jurisdiction as needed to perform work in accordance with all legal requirements.

I. The Contract Drawings are diagrammatic and indicate the general arrangement of systems and work included. Information shown on riser diagrams or called for in the specifications but not shown on the plans shall apply as though required expressly by both. It is not intended to show every offset, fitting or component on the drawings however the work of this contract includes all necessary components and ancillary items for complete and operable electrical systems.

J. The Contractor shall to refer to architectural, structural, plumbing, mechanical, process and instrumentation and other drawings and sections that indicate the type of construction and equipment with which the work of this section must be coordinate.

1.5 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 01 33 00, Submittal Procedures:

1. Product Data: Submit Product Data, including catalog cuts, for all products provided for the electrical work of this Contract and as specified in each Section.
   1) Clearly indicate the products being provided and the intended usage of each product on the submittals.

2. Shop Drawings: Submit shop drawings for the electrical work of this Contract as specified in each Section.

3. Coordination Drawings: Submit coordination drawings for the electrical work of this Contract as specified in paragraph 1.04.C of this Section.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Testing Agency Qualifications:

   a. Use a NETA accredited testing agency, or approved equal, that is accredited for the region in which the Contract work is performed.

   b. Submit the testing agency's qualifications to the Engineer for approval.

B. Regulatory Requirements:

1. Perform all electrical work in conformance with the requirements of NFPA 70, the National Electrical Code as adopted and amended by the Authority Having Jurisdiction (AHJ).

2. The CONTRACTOR shall file plans, obtain permits and licenses, pay fees and obtain the necessary inspections and approvals from authorities having jurisdiction (AHJ) as needed to perform work in accordance with all legal requirements.

C. Certifications:

1. Submit evidence with all Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements. Products shall be listed and labeled by Underwriter's Laboratory (UL), approved by Factory Mutual (FM) or certified as meeting the listing standards by the Electrical Testing Laboratory (ETL). Such evidence may consist of either a printed mark on the data sheet or a separate listing card.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and equipment to the work site in accordance with the requirements of Section 01 60 00.

1. Deliver materials and equipment in a clean condition.
   a. Provide packaging that plugs, caps, or otherwise seals openings both during shipping and temporary storage.
2. Provide equipment needed for unloading operations, and have such equipment on the work site to perform unloading work when the material and equipment is delivered.
   a. If possible, clearly identify pick-points or lift-points on electrical equipment crating and packaging.
   b. In the absence pick-points or lift-points on equipment crating and packaging, identify pick-points or lift-points on the equipment itself.

B. Handle materials and equipment in accordance with the requirements of Section 01 60 00.
   1. Handle materials and equipment in accordance with manufacturer's written instructions.
   2. When unloading materials and equipment, provide special lifting harnesses or apparatus as required by manufacturers.

C. Store electrical materials and equipment, whether on-site or off-site, in accordance with Section 01 60 00 and the following:
   1. Follow the manufacturer's written instructions for storing the items.
   2. Store electrical equipment and products under cover.
      a. Except for electrical conduit, store electrical equipment and products in heated warehouses or enclosed buildings with auxiliary heat and that provide protection from the weather on all sides.

1.8 MAINTENANCE MANUALS

A. Operation and Maintenance Manuals:
   1. Prepare Operation and Maintenance Manuals in conformance with the requirements of Division 1
      a. Organize Operation and Maintenance Manuals by Specification Section and equipment number as designated on the Contract Drawings.
      b. Include suppliers, supplier addresses, and supplier telephone numbers for the equipment and products furnished

1.9 SHORT CIRCUIT, PROTECTIVE DEVICE COORDINATION AND ARC FLASH STUDY

1. The contractor shall prepare and submit for review electrical short circuit, protective device coordination and arc flash studies.
2. The studies shall be performed the by the protective relay manufacturer under the supervision of a New Jersey registered professional engineer using computer software by SKM Systems Analysis Power Tools, ETAP or approved equal.
3. The studies shall be made in accordance with ANSI/IEEE C37.10, ANSI/IEEE C37.13, IEEE 141, IEEE 242, IEEE 399 and IEEE 1584 and conform to the most current edition of NFPA 70E, Electrical Safety in the Workplace.
4. The coordination study shall provide recommended settings for all adjustable overcurrent devices to achieve best possible coordination while minimizing the arc flash incident energy/level. Where arc flash levels exceed 8 cal/cm^2, recommendations shall be made to reduce the arc flash level.

5. Where power is provided by multiple sources, or standby generators are present, or buses can be reconfigured (ie.-main-tie-main) multiple scenarios shall be examined to determine the worst case arc flash hazard.
6. A complete set of coordination curves shall be provided.
7. The arc flash analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E, Informative Annex D.
8. The arc flash analysis shall consider minimum and maximum sources, including motor contribution, to determine minimum and maximum short circuit currents and arcing currents that will determine worst-case scenarios for arc flash incident energy.
9. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
10. The selection of arc flash personal protective equipment (PPE) shall be done using Incident Energy Analysis Method and Table H.3(b) as provided in NFPA 70E, Informative Annex H.
11. The contractor shall submit a report which includes the following, at a minimum:
    a. Executive Summary
    b. Description of results and recommendations
    c. Input data including, but not limited to the following:
        (1) Feeder input data including feeder type (cable or bus), size, number per phase, conduit type (magnetic or non-magnetic), conductor material (copper or aluminum) and length.
        (2) Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
        (3) Reactor data, including voltage rating, and impedance.
        (4) Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X”d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
        (5) Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
    d. Tabular data for short circuit study results including, but not limited to the following:
        (1) Equipment name
        (2) Nominal Voltage
        (3) Equipment KAIC rating
        (4) Available 3-phase short circuit current with respective X/R ratio
        (5) Available single-line-to-ground short circuit current with respective X/R ratio
    e. Recommended protective device settings table including, but not limited to the following:
        (1) Phase and ground relays:
            a. Current transformer ratio
            b. Current setting
            c. Time setting
            d. Instantaneous setting

(2) Circuit breakers:
   a. Adjustable pickups and time delays (long time, short time, ground)
   b. Adjustable time-current characteristic
   c. Adjustable instantaneous pickup

f. Time current coordination (TCC) curves including:
   (1) Associated system one-line diagram
   (2) Protective device coordination curves for each device
   (3) Minimum melting, and clearing curves for fuses
   (4) Cable damage curves
   (5) Transformer 3-phase & single-line-to-ground ANSI damage curves with inrush points
   (6) Motor starting locked rotor curves

g. Tabular data for incident energy and arc flash protection boundary calculations including:
   (1) Equipment name
   (2) Upstream protective device name
   (3) Equipment voltage
   (4) Bolted fault (kA)
   (5) Protective device arcing fault (kA)
   (6) Trip/Time delay (sec.)
   (7) Breaker opening time (sec.)
   (8) Equipment type
   (9) Arc flash boundary (ft.)
   (10) Ground (Yes/No)
   (11) Working distance (ft.)
   (12) Gap (mm)
   (13) Incident energy (cal/cm^2)
   (14) Site specific PPE Level

h. Single line and impedance diagrams showing:
   (1) Input data for each circuit element as required by 10.c.(1) through (5)
   (2) Nominal voltage, worst-case 3-ph and single-line-to-ground fault currents and worst-case arc flash incident energy/levels for each equipment bus

12. Reports shall be submitted in both hard copy and electronically.
13. The contractor shall present a sample arc flash label in compliance with NFPA 70E, Section 130.5 (D) for approval. The label shall also include the issue date.

Upon acceptance of the report and label, the contractor shall prepare and install 4 in. X 6 in. thermal transfer type arc flash labels of high adhesion polyester for each equipment analyzed.

1.10 MAINTENANCE MANUALS

A. Operation and Maintenance Manuals:

1. Prepare Operation and Maintenance Manuals in conformance with the requirements of Division 1

a. Organize Operation and Maintenance Manuals by Specification Section and equipment number as designated on the Contract Drawings.
b. Include suppliers, supplier addresses, and supplier telephone numbers for the equipment and products furnished.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials and equipment shall be new and of the quality specified. All materials shall be free of defects at the time of installation. Materials or equipment damaged in shipment or at the jobsite shall be replaced with new material.

B. No equipment shall be installed in such a manner as to void a manufacturer's warranty.

C. Equipment and materials shall be listed, labeled and approved for intended service for all equipment and materials for which such standards exist.

2.2 SHOP FINISHING

A. For electrical equipment, factory-apply paint and coating systems that at a minimum meet the requirements of the NEMA ICS 6 corrosion-resistance test and the additional requirements specified in individual Specification Sections.

PART 3 EXECUTION

3.1 INSTALLATION

A. All work shall be completed in a neat and workman like manner. Equipment shall be level, plumb and true with the structure and other equipment. All equipment and materials shall be firmly secured and adequately supported. All equipment and materials shall be suitable for their environment.

B. Install all equipment in accordance with manufacturer's instructions and the product listing requirements.

C. Locate all equipment that must be serviced, operated or maintained in fully accessible positions.

D. Maintain minimum working clearances in front of and around all electrical equipment as required by applicable codes.

E. Provide nameplates, tags and other identifying materials.

3.2 FIELD QUALITY CONTROL

A. Perform electrical testing as detailed in Section 26 05 63 and in each Specification Section.

B. Have electrical work inspected as required by the local Authority Having Jurisdiction (AHJ).

1. Submit a copy of the certification of inspection with the final project closeout documents, and post the original in the electrical room on-site protected by a metal frame with a protective plate glass cover.

3.3 MANUFACTURERS' FIELD SERVICES

A. Provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the Final Project Report of the power system study.

3.4 TRAINING

A. Where indicated in specific sections of the Specifications, provide the services of a manufacture's authorized representative to instruct the Owner in the operation and maintenance of the equipment.

3.5 PROJECT CLOSEOUT

A. Provide Record Drawings, Operations and Maintenance Manuals and closeout documents as described in Division 1.

END OF SECTION - 260500

SECTION 26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 Related Documents

A. Division 100 General Provisions of the Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details”, dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.02 SUMMARY

A. Section Includes: The work specified in this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting low voltage cable and accessories.

1.03 REFERENCES

A. American National Standards Institute (ANSI)
   1. ANSI C-119.1 Electrical Connectors- Sealed Insulated Underground Systems Rated 600 Volts.

B. American Society for Testing Materials (ASTM):
   1. ASTM B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft.

C. National Electrical Manufacturer’s Association (NEMA):
   1. WC 7 Cross Linked Thermosetting Polyethylene Wire and Cable.
   2. WC 26 Packaging of Wire and cable

D. National Fire Protection Association (NFPA):
   1. NFPA 70 National Electrical Code (NEC).

E. Underwriter’s Laboratories, Inc. (UL):
   1. UL 44 Thermoset-Insulated Wires and Cables.
   2. UL 83 Thermoplastic-Insulated Wires and Cables
   3. UL 486 A/B Wire Connectors
   4. UL 510 Standard for Insulating Tape
   5. UL 1277 Standard for Electrical Power and Control Tray Cables with optional Optical Fiber Members.
   6. UL 1569 Standard for Metal-Clad Cables
   7. UL 1581 Electrical Wires, Cables, and Flexible Cords.

1.04 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:

1. Product Data and Catalog Cuts: Submit product data for all products provided; indicate clearly the usage of each product.
   1. All wires and cables.
   2. All lugs.
   3. All connectors.
   4. Tapes.
   5. Splices

1.05 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

1.06 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.01 LOW VOLTAGE CONDUCTORS

A. All conductors shall be annealed copper in accordance with ASTM B3.

B. All wire and cable shall be UL listed and labeled.

C. Imprint insulated conductors with the manufacturer, insulation type, conductor size, maximum voltage and UL label. Wire and cable manufactured more than 12 months before delivery to the job site shall not be used.

D. Conductors for power and branch feeders shall be solid or stranded copper in sizes up to and including No. 10 AWG. For sizes No. 8 AWG and larger conductors shall be Class B stranded copper in accordance with ASTM B8.

E. Provide conductors of proper size and ampacity ratings as indicated on the Contract Drawings. Unless otherwise indicated on the contract drawings, minimum wire sizes shall be as follows:
   1. Minimum Conductor Size:
      a. No. 12 AWG in power and branch feeder circuits.
      b. No. 14 AWG in control circuits.
      c. No. 14 AWG in alarm and status circuits.

F. 600 Volt Single Conductor Power Wire:
   1. Single conductor power wire shall be copper conductors with 600 volt insulation rated for 90 degree C conductor temperature in wet and dry locations. All power wiring No. 8 AWG and larger shall be Class B strand.

a. Type RHW-2: Ethylene Propylene Rubber with overall chlorinated poly-ethylene or cross-linked polyolefin jacket
b. Type XHHW-2: Cross-linked polyethylene (XLP) insulation.
c. Type THHN/THWN-2: Thermo-plastic (PVC) insulation with nylon jacket.

2. Service lateral conductors, service entrance conductors, feeders in duct banks to building disconnecting switches and generator main leads shall be Type RHW-2.
3. All three phase power wiring to panels, transformers and equipment in the building shall be Type XHHW-2.
4. Interior lighting and general purpose receptacle branch circuits shall be Type THHN/THWN-2.
5. Acceptable Manufacturers:
   a. Cablec Continental Co.
   b. SouthWire.
   c. Okonite Co.
   d. Or Approved Equal.

G. Control Wiring
   1. Control wiring shall be Type THHN/THWN-2.

2.02 WIRE AND CABLE CONNECTIONS

A. Connectors for Power Conductors
   a. Provide tin plated high conductivity copper compression type terminal lugs and splices.
   b. Terminal lug for conductors No. 3/0 AWG and large shall be long barrel NEMA two hole type.

B. Splices
   a. Splices shall be compression type, long barrel butt type with center stop.
   b. Splices in underground cables shall be waterproof and suitable for submergence in manholes and underground duct and meet the requirements of ANSI C-119.1.
   c. Splices shall be kits by 3M or approved equal.

C. Lighting and Branch Circuits
   a. Provide pre-insulated, UL-listed, solderless connectors of the spring-lock or compression type that can be installed by hand, 3M Scotchlok, Ideal Industries or approved equal.
   b. For site lighting, provide Scotchlok Connector Sealing Packs or approved equal.

D. Control Wiring and Instrumentation Connections:
   1. For control and instrumentation wiring connections at terminal boards, provide crimped nylon-insulated ring terminals.

   2. Manufacturers:
      a. Thomas & Betts Corp.
      b. AMP Inc.
      c. Ilsco Corp.
      d. Ideal Industries, Inc.
      e. Approved Equal

2.03 TAPE

1. Vinyl Insulating Tape:
   a. Provide UL-listed flexible polyvinyl chloride (PVC) backed insulating tape with a pressure sensitive adhesive. Provide tape that is resistant to abrasion, acids, alkalis, and copper corrosion; resistant to hot, cold and wet weather; and resistant to damage from UV sunlight exposure.
2. Manufacturers:
   a. 3M, Scotch-Super 33+
   b. Plymouth-Premium
   c. Permacel (Nitto)
   d. Approved Equal

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all conduits, junction boxes, electrical vaults and handholes for cleanliness, lack of burrs, conduits alignment, completeness, and correct deficiencies.

B. Ensure that two locknuts are installed on all conduits without threaded hubs, that bushings are installed in all conduits with wires larger than No. 10, that grounding bushings and fittings are installed.

3.02 PREPARATION

A. Swab all conduits with a nylon brush and steel mandrel.

B. Ascertain that pulling calculations have been made and are available for long runs and pulls as indicated in this Section. Ascertain that a means of controlling pulling tension is installed on mechanical assist devices for pulling cable.

C. Pre-lubricate all conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.

3.03 INSTALLATION

A. General:
   1. Conductors shall be carefully handled during installation to avoid damage. They shall be unreeled or uncoiled slowly in order to prevent to the insulation due to sudden bending.
   2. Suitable precautions shall be taken to protect installed wiring against damage due to construction activities.

B. Equipment Ground Conductors: Include a green equipment ground conductor with all circuits.

C. Cable Pulling:
   1. Comply with the manufacturer’s recommendations for the inspection, handling, storage, temperature conditioning prior to installation, bending and training limits, pulling limits, and calculation parameters for installation of all cable. Use quadrant blocks located properly along

the cable run. Remove from the job-site and replace all cables that were subjected to excessive bending and tension and all cables that are cracked or have damaged or nicked outer jackets.

2. Lubricate all cables during pulling with lubricants specifically recommended by the cable manufacturer.
3. Limit cable pulling tensions to the maximum pulling tensions recommended by the cable manufacturer. Use dynameter to measure pulling tensions on all runs where calculations are required to be submitted. If pulling tension is exceeding during pulling, cables shall be removed and marked and not reused.
4. Installation of cables in manholes: Install cable along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls so as not to interfere with duct entrances. Support cable on brackets and insulators spaced at a maximum of two feet apart. Lubricants must be used and most be approved by the cable manufacturer.

3.04 WIRING IDENTIFICATION

A. Color-code all feeders wires and cables as specified in Section 26 05 53.

Phase	480/277 Volts	208/120 Volts
A	Brown	Black
B	Orange	Red
C	Yellow	Blue
N	Gray	White
EGC	Green	Green

B. Identify all control wiring with wire numbers corresponding to record drawings.

C. Identify all power wiring by circuit and panelboard, switchboard, and motor control center number.

3.05 CABLE TERMINATING

1. All power and control conductors shall be continuous and shall not be spliced unless otherwise indicated on the Contract Documents.
2. Bolts, nuts and hardware used for terminations shall be silicone bronze. All terminations shall be properly torque.
3. Where terminations are made on insulated busses, the terminations shall be insulated using the proper tape(s) and filler materials for the voltage level of the cable.

3.06 WIRE AND CABLE SPLICES

A. Splice cables only in accessible location.

B. Locate splices in underground systems in accessible locations. Make below-grade splices using a compression connector on the conductor. Insulate and waterproof below-grade splices by methods suitable for continuous submersion in water using either method that follows:

1. Gravity Poured Method: Employ materials and equipment contained in an approved commercial splicing kit with a mold suitable for the cables to be spliced. When the mold is in place around the joined conductors, prepare and pour the resin mix into the mold.
2. Cast-Type Splice Insulation: Employ materials and equipment contained in an approved commercial splicing kit employing a thermosetting epoxy resin insulating material applied by a gravity poured method or by a pressure injected method. Fix cables in place to be moved until the splicing materials have completely set.

3.07 TESTING

A. Electrical Testing: Field test prior to energizing wire and cable as specified in Section 26 05 63 of these Specifications.

END OF SECTION 260519

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes:
   1. Requirements for installing, connecting, testing, cleaning, and protecting grounding and bonding systems.

1.3 REFERENCES

A. American Society for Testing Materials (ASTM):
   1. ASTM B 1; Standard Specification for Hard-Drawn Copper Wire.
   2. ASTM B 8; Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

B. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).

C. Underwriter's Laboratories, Inc. (UL):
   1. UL 467, Standard for Grounding and Bonding Equipment.
   2. UL 486A-486B, Wire Connectors.
   3. UL 486C, Standard for Splicing Wire Connections.
   4. UL 486D, Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
   5. UL 486E, Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.

1.4 GROUNDING SYSTEM REQUIREMENTS

A. Provide a complete grounding and bonding system including all grounding electrodes, grounding electrode conductors, equipment grounding conductors, bonding jumpers, grounding bushings, connections and other materials that may be required.

B. All raceway, cable tray and non-current carrying metal equipment and enclosures shall be electrically continuous and bonded to the grounding system.

1. Ground all metal conduits, wiring channels, and armored cables continuously from outlet to outlet, and from outlets to cabinets, junction boxes, or pull boxes.
    a. Bond each run of raceways to form a continuous path for ground faults from end to end.
2. Grounding Bushings:
    a. Provide all 1-1/2-inch or larger metallic conduits with grounding bushings unless they enter metallic enclosures via integral threaded hubs.
    b. Provide grounding bushings for conduits entering the bottom of freestanding equipment.
    c. Bond wire from every grounding bushing to the equipment ground stud or ground bus in the enclosure.
    d. Bond the grounding bushings to ground studs or ground buses in the enclosures.
3. Provide insulated equipment grounding conductor in all conduits.
    a. Bond the equipment grounding conductor to all pull boxes, junction boxes, equipment enclosures, and other enclosures as required by NFPA 70.

C. Bond building ground electrode systems to the building lightning protection cable(s) as indicated on the Contract Drawings and as specified in Section 26 41 13, Lightning Protection for Structures.

1.5 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:
1. Product Data: Submit product data for all products provided. Clearly indicate the usage of each product.
    a. Ground rods
    b. Ground wire
    c. Connectors
    d. Exothermic welds
    e. Ground bus

B. Project Record Documents:
1. Prepare and submit record drawings showing the actual locations of grounding cables and rods for both concealed and exposed work provided under this Contract.

1.6 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.1 MATERIALS

A. Wire:
   1. Bare Ground Wire:
      a. Bare grounding conductors shall be soft drawn copper, Class B strand sized in accordance with the Contract Documents.
   2. Insulated Ground Wire:
      a. Insulated grounding conductors shall be Class B stranded copper conductors.
      b. Equipment grounding conductors installed with 600 volt insulated feeders or branch circuits shall be provided with green insulation of the same type as the current carrying conductors.
      c. Equipment grounding conductors installed with medium voltage circuits shall be provided with green 600 volt type XHHW-2 insulation.

B. Non-Welded Connections:
   1. Lugs shall be tin plated high conductivity copper compression type. For conductors No. 2/0 and larger provide two-hole long barrel type. For conductors No. 1/0 and smaller provide one-hole short barrel type.
   2. Nuts, bolts washers and other hardware used for grounding connections shall be high copper alloy, silicon bronze or 316 stainless steel.
   3. Pipe clamps shall be brass or high strength silicon bronze with bronze or stainless steel hardware.
   4. Acceptable Manufacturers
      a. Ilsco
      b. Thomas & Betts
      c. Ideal Industries
      d. Approved equal

C. Exothermic Welding Kits:
   1. Provide molds, thermite packages, and other material for exothermic welds that are rated to carry 100 percent of the cable ratings. All materials shall be from a single manufacturer.
   2. Provide all items such as tees, crosses, splices, and cable connections necessary for connecting ground and bonding cables to the following items:
      a. Ground rods.
      b. Reinforcing steel bars.
      c. Structural steel
      d. Buried connections.
      e. Concrete encased connections.
   3. Acceptable Manufacturers:
      a. Erico, Cadweld®.
      b. Continental Industries, Inc., Thermoweld®.
      c. Alltec.
      d. Approved Equal

D. Ground Rods:
   1. Provide UL listed sectional ground rods.
   2. Unless otherwise indicated on the Drawings, provide ground rods fabricated using a molten weld casting process to copper clad medium carbon steel core.
   3. Diameter: Unless otherwise noted on the Contract Drawings-3/4 inch.
   4. Length: 10 feet.
      a. To obtain longer length rods, join rod sections using rod couplers.
   5. Acceptable Manufacturers:
      a. Erico International Corp.
      b. Galvan Industries, Inc.
      c. South Atlantic, LLC
      d. Approved Equal

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions:
   1. The Contract Drawings are generally indicative of the Work, but due to their small scale, it is not possible to indicate some offsets and fittings required nor the minor structural obstructions that may be encountered.
      a. Perform field measurements to discover offsets and fitting requirements not shown.
      b. Locate all on-site utilities and other obstructions in the area of construction, and verify that interferences will not occur.

3.2 PREPARATION

A. Layout electrical work to suit actual field conditions and in accordance with accepted standard practice.

3.3 INSTALLATION

A. Perform required earthwork including excavation, backfill, and compaction, as specified in Section 31 23 33, Trenching and Backfilling.

B. Construct each ground system and connection so it is mechanically secure and electrically continuous.
   1. Secure grounds to boxes in such a manner that each system is electrically continuous from the point of service to each outlet.
   2. Terminate conduits using double locknuts and bushings.
   3. Clean paint, grease and such other insulating materials from the contact points of grounds.

C. Ground Grids:
   1. Installing Ground Rods:
      a. Ground rods shall be driven vertically with the upper end of the rod not less than 24 inches below finished grade. When rock is encountered, the rod may be driven at an angel not to exceed 45 degrees from the vertical. Where a ground test well is provided, the ground rod shall extend six (6) inches into the test well.

2. Installing Ground Wires:
    a. Excavate the trenches for the ground grid cables, and lay the ground cable in the trenches from ground rod to ground rod without splice, and from one side of the grid to the other as shown on the Contract Drawings.
        1) Lay the ground grid cables cable allowing 10 percent slack.
        2) Form 12-inch minimum radius bends at changes in direction.
        3) At intersections, place cables so they diverge 60 degrees or more from other cables at the intersection.
        4) Connect service entrance grounds directly to the ground grids without splices in the cable.
    b. Route connecting cables from the ground grid in the trenches to the building structure.
        1) Route exposed cables parallel to the building lines, except for bends; form all bends with a 12-inch minimum radius.
        2) Wherever the cable breaks grade, provide schedule 80 PVC conduit from 2-feet below for protection; and provide conduit at other points where the cable may be subject to damage.
    c. Remove any damaged or kinked cable.
3. Welding ground wires to the ground rods and equipment connections.
    a. All underground and concreted encased connections shall be exothermic weld. Mechanical connections will not be permitted.
    b. Follow the procedures of the exothermic welding kits manufacturer.
    c. Prior to welding ground wires to the ground rods and equipment connections perform the following:
        1) Clean paint, grease, and other similar insulating materials from contact points.
        2) Inspect the molds for damage; and discard any faulty mold or any molds used over 40 times.
    d. Exothermically weld the ground wires to the ground rods as shown on the Contract Drawings, including to ground rods at grid crossings, to ground rods at grid intersections on the sides of the ground grid, and at all equipment connections.
4. Make all connections to electrical equipment and ground buses with compression, two-hole lugs and studs.
    a. Clean paint, grease, and other similar insulating materials from the contact points for the ground lugs and studs.
    b. Clean all wires to a bright finish prior to construction the connections.

D. Equipment Ground Buses:
1. Wherever 5 or more conduits enter a box or enclosure, provide an equipment ground bus.
    a. Connect all equipment grounding conductors and conduit bond wires within the box or enclosure to a single ground stud or single common ground bus.
2. Size ground buses to carry 100 percent of the rating or setting of the largest over current device in the circuit(s) ahead of the equipment, conduit, or other item, and as indicated on the Contract Drawings.

E. Equipment Grounding Conductors (EGC)
   1. Provide an insulated equipment grounding conductor in all raceway with every feeder and branch circuit and control circuit. All equipment grounding conductors shall be terminated on ground busses or grounding studs at both ends.
   2. Grounding Lighting Fixtures:
      a. All luminaires shall be grounded in accordance with NEC Article 410.
   3. Grounding Motors:
      a. Install an equipment grounding conductor within each conduit supplying power to motors. Terminate equipment grounding conductor in the motor connection box on ground stud or with dedicated bolted connection.

F. Separately Derived Systems
   1. Provide grounding electrode conductors, supply-side and system bonding jumpers sized in accordance with the Contract Documents for the neutral connections of all separately derived systems.
   2. Metal water piping and building structural steel shall be bonded in accordance with NEC Article 250.104(D), Separately Derived Systems.

G. Lightning Protection System
   1. The lightning protection system ground terminals shall be bonded to the building or structure grounding electrode system in accordance with NEC Article 250.106.

H. Bonding for Other Systems
   1. Provide an intersystem bonding termination in accordance with NEC Article 250.94.

I. Concrete Encased Electrodes
   1. Where indicated on the Contract Drawings provide concrete encased electrodes in accordance with NEC Article 250.52(3)(1) or 250.52(3)(2) as shown on the drawings. Provide conductor sizes as shown on the Contract Drawings. Connections to rebar shall be exothermic weld

3.4 REPAIR/RESTORATION

A. Replace any finished exothermic welded splice connections that inspections find to be defective.
   1. Refer to Subparagraph 3.05.B.2 for types of defective exothermic welded splice connections.

B. After inspection by the Owner's representative, backfill the direct buried cables.

3.5 FIELD QUALITY CONTROL

A. Site Testing:
   1. Prior to energizing any system, test the resistance to ground for the system in accordance with Section 26 05 63, Acceptance Testing for Electrical Systems.
      a. Perform a continuity test from all utilization and distribution equipment to the ground grid on a run-by-run basis.

B. Inspection:
   1. Prior to completion of the Work of this Section, inspect the items provided for conformity to the Contract Drawings and Specifications.

   2. Inspect finished exothermic welded connections for the following defects:
      a. Conductors appear within the splice area.
      b. Top of splice risers are below conductors.
      c. Surfaces exhibiting more than 20 percent slag material.
      d. Surfaces with over slag material that has flowed into conductors.
      e. Mold blowouts.
      f. Excessive porosity.
         1) Small pores less than 1/32 inch are permitted.

3.6 PROTECTION

A. Protect finished insulated wires from being painted.

B. Protect all ground grid wells from damage during paving and landscaping.

C. Protect all ground grid installations and ground wires from damage during the work of other Sections.

END OF SECTION 26 05 26

SECTION 26 05 28 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: The work specified in this Section consists of material for furnishing, installing, cleaning and protecting hanger and support systems for electrical wiring, conduit boxes, and equipment.

1.3 REFERENCES

A. American Society for Testing Materials (ASTM)

1. ASTM A36 Specification for structural steel.
2. ASTM A53 Specification for pipe, steel, and hot-dipped, zinc-coated, welded and seamless.
3. ASTM A153 Specification for zinc coating (hot-dip) on iron and steel hardware.
4. ASTM A283 Specification for Mild Steel Plates.
5. ASTM A325 Specification for carbon steel externally threaded standard fasteners.
6. ASTM A500 Specification for cold-formed welded and seamless carbon steel structural steel tubing in rounds and shapes.
7. ASTM A525 Specification for plain-end and seamless pipe.
8. ASTM A563 Specification for carbon and alloy steel nuts.
9. ASTM A570 Specification for steel, sheet and strip, carbon, hot-rolled, structural quality.
10. ASTM A575 Specification for steel bars, carbon, merchant quality, hot wrought.
11. ASTM A576 Specification for steel bars, carbon, structural quality, hot wrought.
12. ASTM A633 Specification for normalized, high-strength, low-alloy structural steel plates.
13. ASTM A635 Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled
14. ASTM E84 Specification for fire resistance of building materials.

B. Federal Specifications:

1. Fed. Spec. FF-S-107C(2) Screws, tapping and drive
2. Fed. Spec. FF-S-325 Shield, expansion nail, & drive screw Group II, Type 4, Class 1

C. National Fire Protection Association (NFPA):
   1. NFPA 70 National Electrical Code (NEC)

D. American Welding Society:
   1. AWS D1.1 Structural Welding Code-Steel

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00, Common Results for Electrical Work:
   1. Product Data: Submit product data for all products provided. Clearly indicate usage of each produce

B. Shop Drawings: Submit Shop Drawings for the following items:
   1. Equipment supports.
   2. Trapeze conduit and cable tray supports.

C. Structural Calculations: Provide structural calculations for the items for which Shop Drawings are required

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

1.6 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.1 MATERIALS - STEEL

A. Provide steel shapes in sizes as indicated and as follows:
   1. Steel Sections: A STM A36/A, A36M
   2. Steel Tubing: ASTM A500, Grade B
   3. Plates: ASTM A283
   4. Sheets: ASTM A570
   5. Pipe: ASTM A53, Grade B Schedule 40, hot-dipped, zinc-coated

2.2 U-CHANNEL SUPPORT FRAMING SYSTEMS

A. Acceptable Manufacturers:
   1. Provide products of a single manufacturer for metal framing systems and fittings for metal framing systems. Acceptable manufacturers are:
      a. Unistrut.
      b. Kindorf.

c. B-Line.
d. Approved equal

B. For aboveground noncorrosive interior locations:
1. Provide U-channel supports, 1-5/8-inch nominal, fabricated from 12 gauge ASTM A570, grade 33 structural and electrolytically zinc-coated to conform to ASTM B633, Type II, SC1. Provide combination members where required that are spot-welded on 3-inch centers. Provide depths of 1-3/8-inch or larger, however, when supports are mounted directly to walls provide depths of 13/16-inch or larger.
2. Conforming to ASTM A575, A576, A635, or A36 with electro-galvanized finish conforming to ASTM B633, Type III, SC1.

C. Provide 316 stainless steel U-channel supports, fittings, threaded rod and hardware for exterior locations.

2.3 CONDUIT SUPPORTS

A. Conduit straps for use with rigid conduit shall be malleable iron and shall be provided with conduit spacers. When installed with PVC coated conduit, the conduit straps shall be PVC coated.

B. Conduit straps for use with EMT shall be stamped steel or malleable iron.

2.4 ANCHORS AND FASTENERS

A. Drive (Deep-Pitch) Screws: Self-tapping type, 316 stainless steel, Fed. Spec. FF-S-107C(2).

B. Drilled-In Anchors and Fasteners: Fed. Spec. FF-S-107C (2).
1. Applications in Masonry (and Precast Concrete Hollow-Core Structural Elements):
a. Anchors: Provide anchors designed to accept both machine bolts and threaded rods. Provide anchors consisting of an expansion shield and expander nut contained inside the shield. Provide expander nut fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches and bears against the shield bottom.
b. Shield Body: Provide shield body consisting of four legs, the inside of each tapered toward shield bottom (or not end). The end of one leg shall be elongated and turned across shield bottom. Outer surface of shield body shall be ribbed for grip-action.
c. Expander Nut: Provide square design with sides tapered inward from bottom to top.
d. Material: Provide die cast Zamac No. 3 zinc alloy of 43,000 psi minimum tensile strength.
e. Fasteners: Provide 316 stainless steel machine bolts conforming to S.A.E. Grade 2 for use with above anchors: nuts and washers to conform to ASTM A 563.
f. Acceptable Manufacturers:
1) U.S.E. Diamond, Inc.; FORWAY System.; or approved equal.
2. Applications in Cast-in-Place Concrete (and Solid Precast Concrete Structural Elements):
a. Anchor/Fastener: Provide UL listed and one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1.

b. Stainless Steel Anchor/Fastener: Provide one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1. Stud of AISI Type 303 or 304 stainless and nut and washer of AISI Type 316 stainless.
c. Acceptable Manufacturers:
   1) U.S.E. Diamond, Inc.; SUP-R-STUD.
   2) Hilti Fastening Systems; KWIK-BOLT.
   3) Molly Fastener Group; PARABOLT.
   4) Or Approved equal.

C. Note: Hammer drive-type explosive charge drive-type anchors and fastener systems are not acceptable. Lead shields, plastic-inserts, fiber-inserts, and drilled-in plastic sleeve/nail drive systems also not acceptable. Adhesive fasteners are not acceptable.

2.5 PRODUCTS

A. Provide bolts, nuts, and washers smaller than 1/4-inch trade size 316 stainless steel: ASTM A 325 galvanized to ASTM A 153/A 153M for galvanized components.

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

C. Touch-up primer: SSPC-Paint 15, Type 1, red oxide.

D. Touch-up primer for galvanized surfaces: SSPC-Paint 20, Type I, inorganic zinc.

PART 3 EXECUTION

3.1 EXAMINATION

A. Carefully investigate the structural and finish condition, as well as other construction work which, may affect the work of this Section. Arrange Electrical Work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment, rooms, areas, etc.

B. Prior to performance of work described above, make detailed drawings of proposed departures from original design due to field conditions or other cause, and submit for Engineer's approval.

3.2 PREPARATION

A. Field Measurement: The Drawings are generally indicative of the work, but due to their small scale, it is not possible to indicate some offsets, fittings, and apparatus required nor the minor structural obstructions that may be encountered.

B. Obtain roughing-in dimensions of electrically operated equipment being installed in other construction work. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.

C. Layout electrical work to suit actual field measurements and according to accepted Trade standard practice. Provide electrical installations conforming to NEC 300 for wiring methods general requirements, and to other applicable Articles of the NEC governing methods of wiring.

3.3 INSTALLATION

A. Anchor And Fastener Installations:
   1. Threaded Bolts: Draw threaded bolted connections up tight using 316 stainless steel lock washers to prevent bolt or nut loosening.
   2. Drilled-In Expansion Anchor Installation:
      a. General: Install expansion anchors in strict accordance with manufacturer's instructions and in accordance with the following.
      b. Drilling Holes: Make drill holes to the required diameter and depth in accordance with anchor manufacturer's instructions for size of anchors being installed.
      c. Minimum Embedment: Embed expansion anchors to four and one-half bolt diameters unless otherwise indicated on drawings.

3.4 FABRICATION

A. Fit and shop assemble items in largest practical Sections for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline.

D. Ease exposed edges to small uniform radius. Cut all backboard corners to 1-inch radius.

E. Exposed mechanical fastenings: Provide flush countersunk screws or bolts; unobtrusively located, consistent with design of component except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication except where specifically noted otherwise.

G. Drill or punch holes accurately as required for attachment of work and for bolted connections. Burned holes are not acceptable. Holes shall be no more than 3/32-inch larger than fasteners.

H. Perform welding of assemblies in accordance with AWS D1.1. Dress welds smooth and free of sharp edges and corners.

I. Fabrication Tolerances:
   1. Squareness: 1/8 inch (3 mm), maximum difference in diagonal measurements.
   2. Maximum offset between faces: 1/16 inch (1.5 mm).
   3. Maximum misalignment of adjacent members: 1/16 inch (1.5 mm).
   4. Maximum bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
   5. Maximum deviation from plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m)

3.5 FINISHES-STEEL

A. Prime paint the non-galvanized steel items.
   1. Prepare surfaces to be primed in accordance with SSPC-SP2.
   2. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
   3. Prime Painting: One coat.

B. Galvanizing of items specified above as galvanized: Galvanize after fabrication to ASTM A 123. Provide minimum 1.25 oz/sq ft (380 g/sq m) galvanized coating.

3.6 FIELD QUALITY CONTROL

A. Inspect the items for the following and correct any discrepancies:
   1. Adequacy of coating, damage to coatings. Touch up damaged coating surfaces; use specified primer for primed steel surfaces, use zinc-rich primer for galvanized steel surfaces.
   2. Adherence to fabrication tolerances:
      a. Squareness: 1/8 inch (3 mm), maximum difference in diagonal measurements.
      b. Maximum offset between faces: 1/16 inch (1.5 mm).
      c. Maximum misalignment of adjacent members: 1/16 inch (1.5 mm).
      d. Maximum bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
      e. Maximum deviation from plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

3.7 PROTECTION

A. Protect the items during work of other trades.

END OF SECTION 26 05 28

SECTION 26 05 33.13 - CONDUITS AND BACKBOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes:
   1. Requirements for furnishing and installing electrical conduit, tubing, boxes and fittings for electrical wiring.

1.3 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).
   2. ANSI C80.1, Rigid Steel Conduit - Zinc-Coated (GCR).
   3. ANSI C80.3, Electrical Metallic Tubing - Zinc Coated (EMT).
   4. ANSI C80.6, Intermediate Metal Conduit - Zinc Coated (IMC).

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 568/A 568M, Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold Rolled, General Requirements for.
   2. ASTM D1784, Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   3. ASTM D 2564, Specification for Solvent Cements for PVC Plastic Piping Systems

C. National Electric Manufacturer's Association (NEMA):
   1. NEMA RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   2. NEMA TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
   3. NEMA 250, Enclosures.
   4. NEMA FB 1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
   5. NEMA OS 2, Sheet Steel Outlet Boxes, Device Boxes Covers and Box Supports.
   6. NEMA OS 3, Nonmetallic Outlet Boxes, Device Boxes Covers and Box Supports.

D. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).

E. Underwriters Laboratory, Inc. (UL):
   1. UL 1, Standard for Flexible Metal Conduit
   2. UL 6, Standard for Rigid Metal Conduit-Steel
   3. UL 360, Standard for Liquid-Tight Flexible Steel Conduit.
   4. UL 514A, Metallic Outlet Boxes.
   5. UL 651, Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
   6. UL 797, Electric Metallic Tubing - Steel.

1.4 DESIGN REQUIREMENTS

A. Conduit Systems:
   1. Provide conduit of the type and material as indicated on the Contract Drawings

1.5 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:
   1. Product Data: Submit product data for all products provided. Clearly indicate the usage of each product.

1.6 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.1 NON-METALLIC CONDUIT

A. Electrical Plastic Tubing and Conduit:
   1. Rigid Polyvinyl Chloride (PVC) Conduit:
      a. Provide high impact PVC conduit conforming to the requirements of NEC Article 352, NEMA TC 2 and UL 651 at 90 degrees Celsius, and made from compounds conforming to the requirements of ASTM D 1784.
         1) For encasement in concrete, provide Schedule 40.
      b. Provide PVC conduits that are UL listed, labeled, and approved for both underground and above ground use.
   2. Acceptable Manufacturers:
      a. Lamson & Sessions, Carlon®.
      b. Queen City Plastics, Inc.
      c. PW Eagle
      d. Cantex
      e. Or approved equal.

B. Non-Metallic Conduit Solvent
   1. Provide solvent for non-metallic conduit joints from the same manufacturer as the conduit and conforming to the requirements of ASTM D2564.

2.2 METALLIC CONDUIT

A. Electrical Metallic Tubing (EMT):
   1. Provide electrical metallic tubing (EMT) conforming to the requirements of NEC Article 358 for materials and uses, ANSI C80.3 and UL 797.
   2. Provide galvanized steel tubing conduit lengths bearing the manufacturer's trademark.
   3. Acceptable Manufacturers:
      a. Tyco/Allied Tube and Conduit.
      b. Wheatland Tube Company, Division of John Maneely Company.
      c. Western Tube & Conduit Corporation
      d. Approved equal.
   4. Couplings shall be double set screw type.

B. Plastic Coated Rigid Galvanized Steel Conduit:
   1. Provide UL listed plastic coated rigid galvanized steel conduit conforming to the requirements of NEMA RN 1 and UL 6.
   2. Provide base conduit of rigid hot-dip galvanized steel (RMC) conduit.
   3. Apply plastic coating in accordance with the following:
      a. Apply a 40-mil thick PVC coating on the outside and a 2-mil thick fusion-urethane coating on the inside.
      b. Provide plastic coating of one uniform color on all plastic coated rigid galvanized steel conduit provided for the Contract. Plastic coating color shall be blue or gray.
   4. Provide 40-mil thick plastic sleeves to protect internally threaded conduit openings.
      a. Provide sleeves with an inside diameter equal to the outside diameter of the conduit/pipe protected by it and extending either one pipe diameter or 2-inches, whichever is less, beyond the opening.
   5. Manufacturers:
      a. OCAL
      b. Perma-Cote
      c. Plasti-Bond
      d. Approved Equal

C. Flexible Metal Conduit (FMC):
   1. Provide UL Listed steel flexible metal conduit conforming to the requirements of NEC Article 348 and UL 1.
   2. Provide conduit with interlocking spiral galvanized steel strip construction capable of bending to a minimum radius of five times its diameter without deforming the spiral strips both inside and outside of the conduit.
   3. Finish the interior and exterior of flexible conduit smooth and free from burrs, sharp edges, and other defects that may injure wires; and place the manufacturer's trademark on each length.
   4. Acceptable Manufacturers
      a. Electri-Flex Company, Type BR
      b. Eastern Wire, Greenfield

c. Southwire, Type Galflex
d. Approved equal.

D. Liquid Tight Flexible Metal Conduit (LFMC):
1. Provide UL Listed PVC coated flexible metal conduit conforming to the requirements of NEC Article 350 and UL 360.
2. Provide conduit with interlocking spiral strip construction capable of bending to a minimum radius of five times its diameter without deforming the spiral strips both inside and outside of the conduit.
a. Provide conduit with a flexible, galvanized, interlocking spiral strip steel core jacketed with smooth, liquid-tight polyvinyl chloride designed to withstand temperatures from minus 40 degrees Celsius to plus 60 degrees Celsius.
3. Finish the interior and exterior of flexible conduit smooth and free from burrs, sharp edges, and other defects that may injure wires and place the manufacturer's trademark on each length.
4. Furnish an integral continuous copper ground in ½-inch through 1-1/4-inch PVC coated flexible metal conduit.
5. Acceptable Manufacturers
a. Electri-Flex Company, Liquatite Type LA
b. ANAMET Electrical, Inc, Sealtite Type UA
c. Southwire, Titan Type UL
d. Approved equal.

E. Rigid Galvanized Steel Conduit (RMC):
1. Provide UL Listed rigid galvanized steel conduit (RMC) conforming to the requirements of NEC Article 344, ANSI C80.1 and UL 6.
2. Fabricate the RMC from mild steel piping, hot dipped galvanized inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating.
3. Provide defect free conduit bearing the UL label, and furnished in 10-foot minimum lengths with both ends threaded and one end fitted with a coupling and the opposite end fitted with a thread protector.
a. Provide tapered NTP ¾ inch per foot threads complying with ANSI/ASME B1.20.1.
4. Acceptable Manufacturers:
a. Tyco/Allied Tube and Conduit
b. Wheatland Tube Company
c. Western Tube & Conduit Corporation
d. Approved equal.

2.3 CONDUIT FITTINGS

A. Fittings for Non-Metallic Conduit Systems:
1. Provide high impact non-metallic fittings conforming to same requirements as for the non-metallic conduit.
2. Non-Metallic Conduit Expansion Fittings:
a. Provide a two-piece nonmetallic, noncorrosive, nonconductive, UL listed expansion fitting.

3. Acceptable Manufacturers:
   a. Carlon
   b. Cantex
   c. PW Eagle
   d. Approved equal.

B. Fittings for Metallic Conduit Systems:
1. Construct conduit bodies/fittings of malleable iron or cast aluminum.
2. For PVC coated raceway systems, provide PVC coated fittings of cast malleable iron or cast steel from the same manufacturer that provides the uncoated conduit bodies/fittings.
3. Conduit Bodies:
   a. Provide threaded entry type conduit outlet bodies with neoprene gaskets and cast covers with stainless steel screws
   b. Acceptable Manufacturers:
      1) Appleton Electric
      2) O-Z/Gedney
      3) Crouse Hinds
      4) Approved equal.
4. Conduit Unions:
   a. Provide conduit unions capable of completing a conduit run with threaded connections when neither conduit end can be turned.
   b. Acceptable Manufacturers:
      1) Appleton Electric, UNF and UNY Unions,
      2) Thomas and Betts Company, Erickson® Coupling.,
      3) OZ Gedney
      4) Approved equal.
5. Conduit Outlet Boxes:
   a. Provide cast iron or aluminum conduit outlet boxes with threaded hubs and gasketed cover to keep out moisture.
   b. Acceptable Manufacturers:
      1) Appleton Electric, GRF outlets and covers
      2) O-Z Gedney
      3) Crouse Hinds
      4) Approved equal.
6. Conduit Device Boxes:
   a. Provide malleable iron or aluminum conduit device boxes with threaded hubs, internal grounding screws and conforming to the requirements UL 514A.
   b. Acceptable Manufacturers:
      1) EGS/Appleton Electric
      2) EGS/O-Z Gedney
      3) Crouse Hinds
      4) Approved equal.

C. Fittings for Electrical Metallic Tubing (EMT)
1. EMT couplings and fittings shall set screw type.
2. EMT couplings shall be stamped steel.
3. EMT fittings shall be provided with insulated throats.

D. Bushings
   1. Insulated bushings for conduits 1-1/4 inches trade size and larger shall have metal bodies and threads, with molded high impact thermosetting insulation to prevent conductor damage. Bushings shall be O.Z. Gedney Type IBC or approved equal. Insulated bushings for conduit trades size 1-inch and smaller may be plastic, O.Z.Gedney Type A, or Approved Equal
   2. Insulated grounding bushings shall be similar to the bushings described above, except provided with set screws to lock the bushing on the conduit and shall have mechanical type lugs for attachment of the bonding jumper, O.Z. Gedney Type BLG or approved equal.

E. Hubs
   1. Water tight conduit connections for NEMA 3R, 4 and 4X enclosures shall be stainless steel Myers 'Scru-Tite,' Thomas & Betts or approved equal.

F. Conduit Straps
   1. Conduit straps for use with rigid conduit shall be malleable iron and provided with conduit spacers. When installed with PVC coated conduit, the conduit straps shall be PVC coated.
   2. Conduit straps for use with EMT shall be stamped steel or malleable iron.

2.4 CONDUIT SPACERS

A. For underground conduit installation provide non-metallic, interlocking type conduit spacers which snap together to join any combination of intermediate and base units together, both vertically and horizontally.

B. Manufacturers:
   1. Underground Devices Inc.
   2. The George-Ingraham Corp.
   3. IPEX Electrical
   4. Approved equal.

2.5 SMALL CAST OUTLET BOXES

A. For Steel Conduit Systems:
   1. Provide cast steel or cast malleable iron boxes with threaded hubs and with a zinc electroplate finish followed by dichromatic prime and aluminum polymer finish conforming to NEMA FB-1.
   2. Where covers are indicated or specified, provide cast steel or cast malleable iron with neoprene gaskets with a zinc electroplate finish followed by dichromatic prime and aluminum polymer finish and captive 316 stainless steel mounting screws.
   3. Where fixture hangers are indicated or specified, provide ball type cast steel or cast malleable iron with neoprene gaskets with a zinc electroplate finish followed by dichromatic prime and aluminum polymer finish and captive 316 stainless steel mounting screws.
   4. Acceptable Manufacturers:
      a. Appleton
      b. OZ Gedney
      c. Approved Equal

B. For Coated Systems: When coated conduit systems are indicated or specified boxes shall be coated as specified in Section 16131.
   1. Provide 40 mils thick PVC coating outside and 2 mils fusion-bonded blue, red or green urethane coating inside. Providing coating of uniform color throughout job. Conform coating to NEMA RN 1.
   2. Provide internally threaded opening with a 40 mil thick plastic sleeve extending one pipe diameter or 2 inches whichever is less beyond opening with an inside diameter of sleeve equal to the outside diameter of conduit/pipe used.
   3. Acceptable Manufacturers:
      a. Occidental Coating Company.
      b. Robroy Industries.
      c. Approved Equal

2.6 SMALL SHEET METAL BOXES

A. Pull and terminal boxes for general purpose dry locations:
   1. Provide sheet steel boxes with continuously welded seams, ground smooth and no holes or knockouts.
   2. Provide overlapping sheet steel screw cover with captivated screws.
   3. Provide ANSI No. 61 gray polyester powder coating over phosphatized surfaces.
   4. Conform to NEMA 250 Type 1 unless otherwise shown on the Contract Drawings.

B. Outlet Boxes (Concealed- stud wall and above ceilings)
   1. Stamped steel, Raco or approved equal

C. Enclosures for Outdoor Locations:
   1. Provide stainless steel boxes with continuously welded seams, ground smooth, no holes or knockouts for use with steel conduit.
   2. Provide aluminum boxes with continuously welded seams, ground smooth, no holes or knockouts for use with aluminum conduit.
   3. Provide seamless drip-shield on top.
   4. Provide slip-on cover with stainless steel captivated screws.
   5. Provide oil resistant gasket.
   6. Conform to NEMA 250 for Type 4X enclosures.

D. Boxes for use with fire alarm system wiring shall be factory or shop painted red.

E. Manufacturers
   1. Hoffman
   2. Rittal
   3. Milbank Manufacturing
   4. Approved Equal

PART 3 EXECUTION

3.1 INSPECTION

A. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
   1. Due to the small scale of the Contract Drawings it is not possible to indicate all offsets, fittings, and apparatus required or the minor structural obstructions that may be encountered during the Work.

B. Inspect the condition of existing conduit that is required for the Work of this Section.

3.2 PREPARATION

A. After carefully investigating structural and finish conditions and other in-place construction work, make detailed Shop Drawings showing proposed departures from the original design due to field conditions or other causes.
   1. Layout the electrical work according to accepted standard electrical trade practice to suit actual field measurements.
   2. Arrange the electrical work to consider existing conditions and to preserve access to other equipment, rooms, areas, and similar features of the construction.
   3. Submit Shop Drawings with plan and profile views of duct banks.
   4. Indicate the location and details of conflicting utility construction and slopes.

B. Obtain roughing-in dimensions of electrically operated equipment, including equipment being installed by both electrical and other construction trades.
   1. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.

3.3 INSTALLATION

A. Fabricate and install conduit and wireway systems in accordance with accepted electrical trade standard practice.
   1. Layout the electrical work of this Section to suit actual field measurements.
   2. Install the electrical Work of this Section in conformance to the wiring methods general requirements of NEC 300, and to all other applicable Articles of the NEC governing wiring methods.
   3. Cut conduit and wireway square, and ream the cut ends per NEC requirements to deburr the openings so that they are not restricted more than cuts made by the material manufacturer.
   4. Avoid bending conduits as much as possible and practical; but if bends are made, use an approved conduit bending tool or machine to make the bends.
   5. Provide flexible metal conduit or liquid tight flexible metal conduit for final connection to all rotating and vibrating equipment including transformers, motors, solenoid valves, instruments, limit switches and gantry mounted devices.
      1) For motor connections, do not use a flexible conduit length exceeding 18 inches.
      2) For equipment connections, do not use a flexible conduit length exceeding 36 inches.

6. Provide fittings and apparatus as required to construct the approved electrical design.
   a. Running threads on conduit are not permitted.
      1) Where couplings and connectors are required for metal conduits, use approved threaded couplings and connectors.
   b. Provide conduit unions where necessary to complete a conduit run when neither conduit end can be turned.
   c. Where conduit and raceway runs cross building expansion joints, make provision for expansion in the conduit and raceway runs.
   d. Provide sealing covers for junction boxes where required.
   e. Provide weatherproof conduit hubs on all conduit connections exterior to the building, and on instruments, process equipment, and pump motors.
7. Installing RGS and PVC Coated Conduit:
   a. Install RGS and PVC coated conduit using methods and techniques recommended by the conduit manufacturer.
   b. Threading Conduit:
      1) Field thread the conduits per the manufacturer's instructions.
         a) For PVC coated conduit, first use a cylindrical guide, oversized to fit over the plastic coating, to neatly cut the coating off at the proposed end of the threads.
         b) Do not damage or remove the coating beyond the proposed end of the threads.
      2) Once the threading operation is complete, protect the newly cut threads against corrosion by applying a "sealing" compound as recommended by the manufacturer.
   c. Assembling RGS and PVC Coated Conduit Fittings:
      1) Use PVC coated conduit bodies, clamps, supports, accessories, and fittings with coated conduit systems.
      2) Just prior to assembling each conduit joint, apply the conduit manufacturer's touch-up compound to the end of the conduit in the area normally covered by the fitting sleeve.
      3) Use cloth or other material over strap type wrenches to protect the coating while tightening conduits.

B. Concealed Work:
   1. Conceal all conduits and raceways in the structure's construction unless otherwise indicated on the Contract Drawings or required by the Engineer.
      a. Group conduit and raceway runs in concealed work as much as practical to avoid congesting the concealed spaces.
      b. Do not weaken the structure by excessive or unnecessary cutting.
   2. Conduits and Raceways Embedded in Concrete Slabs:
      a. Separate multiple conduits encased together by not less than two inches of concrete.
      b. Locate conduit installed in floor slabs within the reinforced area of the slab.
      c. Where conduit crosses expansion joints, provide weather tight expansion and defection fittings and bonding jumpers.

C. Exposed Work:
   1. In exposed work, run conduit and raceway parallel to centerlines and structure surfaces; or perpendicular to centerlines where required, with right angle turns consisting of symmetrical bends or fittings.
   2. Maintain at least 6 inches clearance between conduit and raceway runs and pipes, ducts, and flues of mechanical systems.

3. If a portion of a metallic conduit run, whether plastic-coated or not, extends above grade or is otherwise exposed to personnel, ensure that the conduit is properly bonded to an equipment grounding conductor at both ends.
   a. Install the equipment, grounding conductor either inside or outside the box.

D. Hangers and Supports:
   1. Install auxiliary support structures, anchors, and fasteners as specified in Section 26 05 28.
      a. Mount or suspend conduit and wireway systems directly on structural members of the structures and walls.
      b. Do not attach conduit or raceway systems to suspended ceiling members or to the suspending mediums.
      c. Securely attach anchors into walls.
   2. At all conduit attachments, allow space between the mounting surfaces and the conduit by providing U-channel supports, clamp-backs, or spacers.
      a. Attach wall-mounted conduit runs close to the walls following the contour of the walls, parallel to the walls and other building lines except at bends.

E. Structure Penetrations:
   1. Make penetrations in existing concrete structures by core-drilling.
      a. Drill the penetrations true, clean, and free from spalling.
   2. At penetrations through fire rated floors, walls, and similar assemblies, provide firestopping..
   3. Install a wall penetration seal at all wall penetrations.
      a. Size wall penetrations to accommodate the conduit outside diameter, plus either 1/4 inch or a whole allowance to allow the installation of the wall penetration seal.

F. Boxes for outlets and devices:
   1. Install boxes to be level and plumb. Mount all adjacent boxes in alignment at the same mounting height.
   2. Install device boxes at a uniform height as indicated on the drawings. Mount outlet boxes for equipment within 18-inches of equipment power connection.
   3. Do not install flush mounting box back-to-back in walls. Provide minimum 6- inches (150 mm) separation. Provide minimum 24-inches (600 mm) separation in acoustic rated walls.
   4. Use cast boxes outside and with exposed conduit in unfinished areas. Mount on spacers to be 1/8-inch from wall unless box has built-in raised pads to perform the same function.
   5. In other finished walls for single devices and two devices and wall outlets, install 4-inch square boxes with appropriate plaster ring. Space boxes on opposite sides of the wall 6-inches apart. Set plaster ring flush or to protrude less than 1/16-inch from wall. Openings for boxes in finished walls must be within 1/16-inch of box. Correct all oversize openings in accordance with specifications for wall material.

3.4 FIELD QUALITY CONTROL

A. Inspect installed conduit runs for obstructions, proper support, proper grounding, and completeness.

B. Test all boxes for proper connection to grounding system.

C. Inspect flush boxes:

1. Opening between box and wall finish is less than 1/16-inch.
2. Box is flush with wall or protrudes less than 1/16-inch and is not set behind wall surface.

D. Inspect surface mounted boxes for level and plumb within 1/16-inch.

3.5 PROTECTION

A. Mask all boxes and conduit during painting except surfaces to be painted.

B. Protect against damage from other work.

END OF SECTION 26 05 33.13

SECTION 26 05 33.19 - WIREWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: The work specified in this Section consists of constructing the metallic wireway systems for the project.

1.3 REFERENCES

A. Federal Specifications:
   1. Fed. Spec W-C-582 Conduit, Raceway, Metal, and Fittings, Surface.

B. Underwriters Laboratories (UL)
   1. UL 870 Standard for Wireways, Auxiliary Gutters and Associated Fittings

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:
   1. Product Data: Submit product data for all products provided. Clearly indicate usage of each product.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.1 WIREWAY SYSTEM MATERIALS

A. Wireway (General Purpose, NEMA Type 1): Lengths, connectors and fittings UL Listed and constructed in accordance with Underwriters Laboratories Standard UL 870 for Wireways, Auxiliary Gutters and Associated Fittings.
   1. Screw cover design. Covers held firmly in place with captivated screw fasteners.

2. Wireway shall be constructed without knockouts.
3. Fabricate from code gauge steel finished with corrosion resistant gray polyester powder coat finish.
4. Acceptable Manufacturers:
    a. Hoffman Engineering Company.
    b. B-Line
    c. Wiegmann.
    d. Approved Equal.

B. Wireway (Raintight, NEMA Type 3R): Lengths, connectors and fittings UL listed and constructed in accordance with Underwriters Laboratories Standard UL 870 for Raintight Wireways, Auxiliary Gutters and Associated Fittings.
1. Wireway shall be constructed without knockouts.
2. Provide gasketing that cannot rip or tear during installation and maintain its raintight capability during the life of the wireway.
3. Fabricate from code gauge steel finished with corrosion resistant gray polyester powder coat finish.
4. Acceptable Manufacturers:
    a. Hoffman Engineering Company.
    b. B-Line
    c. Wiegmann.
    d. Approved Equal.

C. Wireway (NEMA 4X)
1. Provide UL 870 listed wireway for use in areas designated NEMA 4X or as indicated on the Drawings.
2. Type 304- 16 gauge stainless steel bodies and covers.
3. Stainless steel flanges- 10 gauge
4. Provide covers with butt hinges and external screw clamps.
5. Oil resistant gasket.
6. No holes or knockouts
7. Seams continuously welded.
8. Acceptable Manufacturers
    a. Hoffman
    b. C & I Enclosures
    c. Austin Enclosures
    d. Approved Equal

PART 3 EXECUTION

3.1 INSPECTION

A. Carefully investigate the structural and finish condition, as well as other construction work, which may affect the work of this Section. Arrange Electrical Work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment, rooms, areas, etc.

B. Prior to performance of work described above, make detailed drawings of proposed departures from original design due to field conditions or other cause, and submit for Engineer's approval.

3.2 PREPARATION

A. Field Measurement: The Drawings are generally indicative of the work, but due to their small scale, it is not possible to indicate all offsets, fittings, and apparatus required nor the minor structural obstructions that may be encountered.

B. Obtain roughing-in dimensions of electrically operated equipment being installed in other construction work. Set wireway only after receiving approved dimensions and checking such equipment locations.

C. Layout electrical work to suit actual field measurements and according to accepted Trade standard practice. However, electrical installations shall conform to NEC 300 for wiring methods general requirements, and to all other applicable Articles of the NEC governing methods of wiring.

3.3 INSTALLATION

A. In general fabricate wireway systems in accordance with accepted trade practice and in accordance with product listing requirements and the requirements of NEC Article 300 and 376.
   1. Do not attach wireway to suspended ceiling members or to the suspending mediums.
   2. Cut wireway square and deburr cuts to the same degree as cuts made by the material manufacturer.
   3. Mount or suspend raceway systems directly on structural members or structural elements of the building. Space supports in accordance with NEC requirements.
   4. Do not weaken the structure by excessive or unnecessary cutting.

END OF SECTION 26 05 33.19

SECTION 26 05 36 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: The work specified in this Section consists of material for furnishing, installing, connecting, testing, cleaning and protecting cable trays and fittings.

1.3 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. NEMA VE-1 Metal Cable Tray Systems
   2. NEMA VE-2 Metal Cable Tray Installation Guidelines

B. National Fire Protection Association (NFPA):
   1. NFPA 70 National Electrical Code (NEC).

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work.

B. Product Data and Catalog Cuts: Submit product data for all products provided. Indicate clearly the usage of each product.

C. Shop drawings: Submit shop drawings for the following items:
   1. Overall plan of cable tray installation drawn to a scale of 1/4 inch or larger.
   2. Bill of materials: Provide list indicating manufacturer and catalog number for all items other than standard hardware.
   3. Structural calculations: Provide structural calculations for all supports.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

1.6 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 26 05 00, Common Results for Electrical Work

PART 2 PRODUCTS

2.1 METALLIC CABLE TRAY SYSTEMS

A. Acceptable Manufacturers:
   1. Provide products of a single manufacturer for metal framing systems and fittings for metal framing systems. Acceptable manufacturers:
      a. B – Line.
      b. M.P. Husky.
      c. T. J. Cope
      d. Or approved equal.

B. General:
   1. Cable trays, covers, fittings, splice plates, and all items shall be aluminum alloy 6063T-T6 finished in its natural state.
   2. Cable trays shall be UL listed for use as a grounding means.
   3. Cable trays shall conform to NEMA Standard VE-1 and NFPA 70 Article 392.
   4. Furnish all items to provide a complete cable tray system. Include all straight run trays, elbows, tees, vertical curves, fittings, splice plates, bonding material, related support items, and related accessory items required for a complete installation.
   5. Provide smooth edges and radius on side rails and rungs to protect cables from damage.
   6. Provide tray splice plates of sufficient high strength to carry the same bending moments and shear loads as the cable tray. Provide spliced shoulder bolts to both fully engage the splice plate and the side rail. Provided locknut shall be of the serrated flange type allowing for one-wrench installation.
   7. Strength: The cable tray shall be capable of carrying a uniformly distributed cable load specified in NEMA VE-1 for the class of cable tray indicated.
   8. Provide elbows, tees, and cross fittings without tangents beyond the point of curvature. Provide fittings with minimum radius that exceeds the minimum cable bending radius.
   9. Accessories: Cable tray system shall include all related accessory items such as dropouts, end plates, and barrier strips to separate services in the trays. Covers shall be furnished where indicated on the Contract Drawings.

C. Ladder Type Cable Tray
   1. Ladder cable tray shall consist of two longitudinal members (side rails) with transverse members (rungs) welded or swaged to the side rails. No portion of the rails shall protrude below the bottom plane of the side rails.
   2. Provide ladder type cable of class, types and sizes as indicated.
      a. Rail Height……...As shown on Contract Drawings
      b. Loading Depth……..…As shown on Contract Drawings
      c. Rung Spacing……..As shown on Contract Drawings
      d. Loading……..…As shown on Contract Drawings
      e. Support Spacing…….As shown on Contract Drawings
      f. Tray Width……...As shown on Contract Drawings
      g. Midspan Defection……1/200 of span

PART 3 EXECUTION

3.1 PREPARATION

A. Carefully investigate the structural and finish condition as well as other construction work, which may affect the work of this Section.

B. Arrange electrical work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment, rooms, areas, etc.

C. Field Measurement: The Drawings are generally indicative of the work but due to their small scale it is not possible to indicate all offsets, fittings, and apparatus required nor the minor structural obstructions that may be encountered. Make field measurements of the areas in which cable tray is to be installed.

D. Layout cable tray to suit actual field measurements.

3.2 INSPECTION

A. Carefully investigate the structural and finish condition as well as other construction work, which may affect the work of this Section. Arrange electrical work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment.

3.3 INSTALLATION

A. In general, fabricate cable tray systems in accordance with accepted Trade standard practice and NEMA VE-2.

B. Provide supports at a maximum of eight feet.

C. Make all field cuts using power hacksaw equipped with both a table for supporting the cable tray and a means of holding the tray rigidly in place and making a clean square cut. Drill all holes using a drill press and templates to accurately locate splice plate holes. Equivalent means and methods, which produce accurate clean cuts and holes, are acceptable. Ends must be square to within 1/16-inch and holes located to within 1/32-inch of nominal. Center punch all hole locations. Use pilot holes as necessary. File off all burrs and rough edges.

D. Install all items in strict accordance with manufacturer’s instructions; in conformity with any product listing and labeling restrictions and instructions; in conformity with NEMA Standard VE-2. Provide continuous supplemental grounding conductors bonded to each piece of cable tray and sized in accordance with the Contract Drawings.

E. Do not weaken the structure by excessive or unnecessary cutting.

F. Provide expansion plates in each straight run and at each building expansion joint.

G. Make conduit drops from cable tray with approved fittings.

H. Construct in exposed work parallel and perpendicular to building lines and structure and level and plumb with right angle turns consisting of symmetrical bends or fittings, except as indicated and as follows. Construct changes in vertical elevation at 45 degrees to the horizontal and construct offsets of less than two medium radius with 30 degree or 45 degree bends. Maintain at least 6-inches clearance between cable tray runs and mechanical systems pipes, ducts, flues.

I. Provide structural supports of adequate strength to conform to dead, live and seismic loads to be encountered.

3.4 FIELD QUALITY CONTROL

A. Inspect all items for the following and correct any discrepancies.
   1. Adherence to Fabrication Tolerances:
      a. Squareness: 1/8 inch (3 mm) maximum difference in diagonal measurements.
      b. Maximum Offset Between Faces: 1/16 inch (1.5 mm).
      c. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).
      d. Maximum Bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
      e. Maximum Deviation From Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

END OF SECTION 26 05 36

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, and protecting identification signs and labels for electrical systems.

1.3 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI Z535.4, Product Safety Signs and Labels.

B. National Electrical Manufacturer's Association (NEMA):
   1. NEMA 250, Enclosures for Electrical Equipment.

C. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).
   2. NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

D. U. S. Government:
   1. Code of Federal Regulations (CFR)
      a. 29 CFR 1910 Occupational Safety and Health Standards

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:
   1. Product Data: Submit product data for all products provided. Clearly indicate the usage of each product.
   2. Shop Drawings:
      a. Provide a schedule depicting all nametag legends.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

1.6 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide products meeting the specified requirements from one of the following manufacturers, unless otherwise indicated:
   1. Brady Corporation.
   2. Seton Identification Products.
   3. LEM Products, Inc.
   4. Approved Equal

2.2 MATERIALS

A. Laminated Phenolic or Plastic:
   1. Provide rigid, thermosetting resin or polymer material that is heat- and fire-resistant, abrasion resistant, electronically non-conductive, and non-corroding.
   2. Extrude the thermosetting resin or polymer into sheets, and laminate the sheets together so that colored top and bottom layers sandwich a contrasting color core in the middle.

B. Mounting Hardware:
   1. Provide number10 hex-head machine screws and lock-washers, or hex-head bolts, lock-washers, and nuts for mounting identification nameplates onto electrical equipment.
   2. Provide either type 316 stainless steel or brass fasteners; however, all fasteners used on the same nameplate must be of the same material.

2.3 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Provide laminated phenolic or plastic equipment identification nameplates having beveled edges and engraved lettering.
   1. Drill holes in NEMA 1 enclosures for mounting hardware in the equipment identification nameplates as follows:
      a. For nameplates that are more than 2 inches wide, drill four holes.
      b. For nameplates that are more than 1-1/2 inches high, drill four mounting holes.
      c. For smaller nameplates, drill holes for two fasteners.
   2. Provide equipment identification nameplates long enough to ensure that the heads of fastening hardware do not extend beyond the nameplate material, and come no closer than 1/16-inch to the nearest letter of the nameplate legend and no closer than 1/16-inch to the nearest edge.

B. Nameplates for NEMA 3R or 4X enclosures shall be adhesive backed.

C. Provide nameplates for all electrical equipment including switchboards, panelboards, transformers, safety switches, cabinets, contactors and UPS equipment. Engrave the following information on

each equipment identification nameplate, similar to that shown in Example 1 below except as appropriate for the specific equipment being identified:

1. In the first line, indicate the equipment name and identification number.
2. In the second line, indicate the equipment Voltage, the phase, and the number of wires.
3. Source of power

EXAMPLE 1:

PANELBOARD PPB-2
208/120 VOLTS, 3-PHASE, 4-WIRE
FED FROM MDP-1

D. Engrave equipment identification nameplates with all capital, Helvetica Medium font, or equal, lettering.
   1. Provide white nameplate lettering centered on black backgrounds, except for warning nameplates provide white lettering centered on red backgrounds.
   2. Provide a minimum 1/8-inch border between the nameplate lettering and the tops and bottoms of the nameplates.
   3. Use 3/8-inch high letters for the first line, and 1/4-inch letters for succeeding lines; except, in cases where the tag will not fit because the equipment is too small, use 3/16-inch letters for the first line and 1/8-inch letters for succeeding lines.

2.4 CONDUIT AND RACEWAY LABELS

A. Provide permanent labels marking all pull and junction boxes with the panel and circuit number of the conductors contained in the enclosure.

2.5 ARC-FLASH WARNING LABELS:

A. Provide Arc-Flash Warning labels in accordance with the requirements of NFPA 70, NFPA 70E, and ANSI Z535.4 listing the Hazard Category, Arc Flash Boundary, and associated Incident Energy range.

2.6 DANGER WARNING LABELS:

A. Provide danger signage in accordance with the requirements of 29 CFR 1910.145 and NFPA 70E.
   1. For enclosures, provide signs with the caption “DANGER HIGH VOLTAGE KEEP OUT”
   2. For fences, provide signs similar to the signs for enclosures, except provide dual language sign captions in both Spanish and English and add Mister Ouch symbols.

3. For poles, provide dual language signs similar to the signs for fences, except add the words "KEEP OFF".

B. Product Examples:
1. Enclosure danger signs: Brady Worldwide, Inc Product Number 84083.
2. Fence Danger signs: Brady Worldwide, Inc Product Number 69737.
3. Pole danger signs: Brady Worldwide, Inc Custom markers.

2.7 MULTIPLE SERVICES WARNING LABELS:

A. Where multiple service or building disconnecting means are installed a sign shall be provided at each location indicating the number and location of the other disconnecting means in accordance with NEC Article 230.2(E).

B. Where an engine generator is provided a sign shall be placed at the service entrance equipment or building disconnecting means that indicates the type and location of the onsite emergency and standby power sources in accordance with NEC Article 700.7, NEC Article 701.7 and NEC Article 702.7.

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to installing electrical identification items, verify with the Engineer that the data on each is correct.

3.2 INSTALLATION

A. Wiring Identification:
1. Refer to Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.

B. Convenience Receptacles
1. Provide self adhesive vinyl labels indicating the panel and circuit number serving the device.

C. Electrical Box Identification:
1. For each pull box and junction box, identify its source of power; for example, indicate the panelboard and circuit number supplying power to a box with an identification label.

D. Electrical Equipment Identification:
1. Provide identification nameplates on the front all electrical equipment including but not limited to the following:
a. Diesel electric generators.
b. Dry Type Transformers.
c. Surge Protective Devices
d. Enclosed circuit breakers.
e. Low-voltage enclosed switches.
f. Low-voltage enclosed transfer switches.
g. Low-voltage motor starter switches.

h. Low voltage motor control centers.
i. Low-voltage variable frequency controllers.
j. AC distribution switchboards.
k. Panelboards.

2. Install nameplates in the top center of the front face of the electrical equipment in a visible location.
   a. For NEMA 1 enclosures constructed as specified in NEMA 250, fasten the nameplate to the enclosure using 316 stainless steel screws or an approved equal.
   b. For NEMA 3R or 4X enclosures, fasten the nameplate to the enclosure using Seton number15660 adhesive or an approved equal.

END OF SECTION 26 05 53

SECTION 26 05 63 ACCEPTANCE TESTING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section

B. Section 26 05 00- Common Results for Electrical Work with all referenced related Sections.

1.2 SUMMARY

A. Section Includes: This Specification Section includes the field inspection, mechanical completeness, and electrical acceptance tests required for electrical apparatus, wire, cable and other miscellaneous equipment and material installed and wired by Contractor.

1.3 REFERENCES

A. Applicable Documents and Testing Requirements of:
   1. International Electrical Testing Association (NETA)
      a. ATS-2013 Acceptance Testing Specifications for Electric Power Equipment and Systems
      b. ETT-2010 Standard for Certification of Electrical Testing Personnel
   2. National Electrical Manufacturer's Association (NEMA)
      a. NEMA ICS 7.1 - Safety Standards for Construction and Guide for selection, Installation, and Operation of Adjustable Speed Drive Systems.
      b. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
      c. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
   3. National Fire Protection Association (NFPA)
      a. NFPA-110 Standard for Emergency and Standby Power Systems

1.4 SUBMITTALS

A. Submit documentation as required by this Section of the Contract in accordance with the provisions of Section 25 05 00, Common Results for Electrical Work.

B. The Contractor shall prepare written procedures for the performance of all testing. The procedures shall include an itemization of all equipment, devices, cable and material requiring field testing, setting, adjustment or calibration and shall describe the required set points.

C. Test Reports: The Contractor shall maintain records for all tests and inspections with complete data on all measurements and observations and prepare and submit reports for all testing.
   1. Each test report shall include:

a. Summary of project
b. Description of equipment tested
c. Description of test
d. Test data
e. Analysis and recommendations

2. Test data records shall include
   a. Identification of Testing Organization
   b. Equipment Identification
   c. Ambient conditions
   d. Dates of inspections and tests
   e. Identification of the testing technician
   f. Indication of inspections, tests and calibrations to be performed and recorded
   g. Indication of expected results of calibrations
   h. Indication of as-found and as-left results, as applicable
3. Submit completed report no later than 30 days after completion of each test.
4. Provide five (5) copies of final test reports assembled in binders for record.

1.5 QUALITY ASSURANCE

A. Testing Organization: The Testing Organization shall be a NETA Accredited Company and technicians shall be certified in accordance with ANSI/NETA ETT-2010, Standard for Certification of Electrical Testing Personnel.

1.6 GENERAL REQUIREMENTS

A. Upon completion of the installation, the Contractor shall perform inspections and field tests on all equipment, materials and systems to insure that the entire installation is sound and that all circuits, including power, control, relaying, instrumentation and metering will function properly and as intended.

B. The Contractor shall furnish and maintain all tools, instruments, materials, test equipment, consumables, test connections and personnel, including supervision and labor required for testing, setting and adjusting of all electrical equipment.

C. All tests shall be performed with proper regard for the protection of equipment and the Contractor shall be responsible for adequate protection of all personnel during such tests.

D. No equipment shall be installed, operated or tested in such a manner as to void the manufacturer's warranty or guarantee. Should any test values or procedures as indicated in this Specification exceed the values or overrule the procedures recommended by the manufacturer for the equipment involved, the manufacturer's recommendation, shall take precedence.

E. Prior to energizing or placing in service any electrical equipment, testing and checking shall be completed.

F. The witnessing or waiving of witnessing of any test shall not relieve the Contractor of its guarantees for material, equipment and workmanship.

G. Equipment shall meet the test values and tolerances in NETA ATS-2013.

H. The Contractor shall promptly advise the Engineer in writing concerning the failure of any equipment or material to pass the tests performed, or to properly function as intended, or to meet calibration accuracy required. After the defects have been corrected, the test(s) shall be repeated.

I. The testing described in this Specification is the minimum requirement and not intended to limit the Contractor's ability to perform additional tests if deemed necessary by the Contractor.

1.7 WITNESSING OF TESTING

A. The Owner reserves the right to for the Owner, Owner's Representative or Engineer to witness any testing at no additional cost to the Owner. The Contractor shall provide 30 day notice prior to commencing tests.

1.8 SCHEDULING

A. Schedule all testing with work of other contractors to ensure an orderly sequence of startup and completion of work. All functional tests shall be scheduled with the Owner's Representative.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 TEST INSTRUMENT CALIBRATION

A. The Testing Organization shall have a calibration program in accordance with NETA ATS-2013 and shall maintain the appropriate records.

3.2 TESTING TO BE PERFORMED BY THE TESTING ORGANIZATION

A. 600 Volt Wire
   1. Testing to be performed on 480 volt 3-phase service conductors, generator main leads, panel feeders, building feeders, 3-phase motor branch circuits and 208 volt feeders:
   2. Visual and Mechanical Inspection (NETA 7.3.2.1)
      a. Perform all standard visual and mechanical inspections
      b. Bolted electrical connections shall be verified by use of a torque wrench
   3. Electrical Tests (NETA 7.3.2.2)
      a. Insulation Resistance Tests
      b. Continuity tests to insure correct cable connections

B. Panelboards
   1. Visual and Mechanical Inspection (NETA 7.1.1)
      a. Perform all standard visual and mechanical inspections
      b. Bolted electrical connections shall be verified by use of a torque wrench

2. Electrical Tests (NETA 7.1.2)
    a. Insulation Resistance Tests

C. Transformer (Small Dry Type, Low Voltage)
1. Visual and Mechanical Inspection (NETA 7.2.1.1.1)
    a. Perform all standard visual and mechanical inspections
    b. Bolted electrical connections shall be verified by use of a torque wrench
2. Electrical Tests (NETA 7.2.1.1.2)
    a. Insulation Resistance Tests
    b. Measure Secondary Voltage

D. Low Voltage Molded Case Circuit Breaker
1. Visual and Mechanical Inspection (NETA 7.6.1.1.1)
    a. Perform all standard visual and mechanical inspections
    b. Bolted electrical connections shall be verified by use of a torque wrench
2. Electrical Tests (NETA 7.6.1.1.2) 400 ampere trip and larger only
    a. Measure contact resistance
    b. Insulation Resistance Test
    c. Determine Long Time Pickup and delay by primary current injection
    d. Determine Short Time Pickup and delay by primary current injection

E. Grounding Electrode System
1. Visual and Mechanical Inspection (NETA 7.13.1)
    a. Perform all standard visual and mechanical inspections
    b. Bolted electrical connections shall be verified by use of a torque wrench
2. Electrical Tests (NETA 7.13.2)
    a. Perform fall-of-potential on grounding electrode system.

F. Thermographic Inspection
1. Perform thermographic inspection on electrical equipment listed below in accordance with NETA ATS Section 9.0
    a. Switchboard
    b. Service Entrance Equipment
    c. Distribution Panels
    d. Panelboards
    e. Dry Type Transformers
    f. Enclosed Circuit Breakers
    g. Enclosed Automatic Transfer Switch
    h. Motor Controllers

3.3 TESTING TO BE PERFORMED BY THE CONTRACTOR

A. Emergency Lighting Tests
1. Open lighting panel main circuit breaker to verify proper operation of all emergency lighting battery units. Adjust position of lighting heads as required and replace defective equipment. Operate battery systems for emergency lighting without power for 90 minutes.

B. Voltage Adjustment:
   1. Measure the plant voltage with the plant operated at both no load and at nominal load at the following locations:
      a. Main Distribution Switchboard
      b. Each panelboard bus
   2. Adjust all transformer taps to bring the no-load voltage to nominal voltage
   3. After all adjustments have been made, re-measure all voltages.

C. Functional Testing
   1. Unless otherwise noted, the Contractor shall energize and operate all alarm and control circuits under simulated or actual system conditions to verify the correctness of wiring. All control circuits shall be checked in their entirety.

3.4 TESTING TO BE PERFORMED WITH A MANUFACTURER'S REPRESENTATIVE

A. The following equipment shall inspected, adjusted, energized and operated with the assistance of a service technician who is trained and authorized by the equipment manufacturer.

B. Upon completion of startup, provide the manufacturer's written certification that the equipment is installed, inspected, tested, adjusted and approved satisfactory by equipment manufacturer's service technician.

C. Equipment acceptance testing shall be scheduled with the Owner's representative. The Owner and Engineer reserve the right to witness all testing.

D. Emergency Generator and Automatic Transfer Switch
   1. On site acceptance testing shall be performed in accordance with NFPA 110, Standard for Emergency and Standby Power Systems.
   2. Prior to startup, the Contractor shall complete all visual and mechanical inspections recommended by NETA ATS-2013 7.22.1 and 7.22.3.
   3. Tests shall be performed at 100 % generator kW rating. The Contractor shall provide all necessary load banks and fuel to conduct acceptance tests.
   4. All protective devices and control functions shall be set and adjusted.

E. Uninterruptible Power Supplies (UPS)
   1. Prior to start up, the Contractor shall complete all visual and mechanical inspections recommended by NETA ATS-2009 7.22.2
   2. All Startup and Acceptance tests recommended by the manufacturer shall be performed by a factory authorized technician.

END OF SECTION 26 05 63

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: The work specified in this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting transformers.

1.3 REFERENCES

A. National Electric Manufacturer's Association (NEMA):
   1. NEMA ST 20 — Dry Type Transformers for General Applications.
   2. NEMA TR 1 — Transformers, Regulators, and Reactors.

B. National Fire Protection Association (NFPA):
   1. NFPA 70 — National Electrical Code (NEC).

C. Underwriter's Laboratory, Inc. (UL):
   1. UL 1561 — Transformers, Dry-Type General Purpose and Power.

D. United States Department of Energy (DOE)
   1. DOE 10 CFR Part 431 — Energy Conservation Program for Commercial Equipment: Distribution Transformer Energy Conservation Standards; *DOE 2016 Efficiency*

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:
   1. Product Data:
      a. List of transformers and accessories to be furnished and installed.
      b. Catalog cuts of all transformers and accessories.
   2. Shop Drawings: Provide shop drawings for the following:
      a. Complete outline drawing, showing overall length, width, and height and including ratings of equipment, impedance, and installation restrictions.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.1 DRY-TYPE DISTRIBUTION TRANSFORMERS

A. Provide transformers of the general purpose, indoor or outdoor, two-winding, ventilated, dry-type designed and tested in accordance with the referenced NEMA and UL standards of capacities and mounting arrangements as indicated on the Contract Drawings. Provide wall-mounted transformers with a wall bracket that are adequate for the supporting weight.

B. Design transformers for continuous operation at rated KVA.

C. Provide 220 degree C. insulation systems. Unless otherwise indicated on the Contract Drawings, transformers shall be 115 degree C rise.

D. Coils shall be copper.

E. The core and coil assembly shall be impregnated with non-hygroscopic thermosetting varnish.

F. Construct transformers core with high grade, non-aging, silicone steel with high magnetic permeability and low hysteresis and eddy current losses.

G. The core and coil assembly shall be installed on vibration-absorbing pads.

H. Transformer average sound levels shall not exceed the maximum sound levels stipulated in NEMA ST-20 and IEEE C57.12.01.

I. Enclosures shall be heavy gauge steel with removable front and rear covers to provide access to terminal compartments. Enclosures for transformers installed indoors shall be rated NEMA 2. Enclosures for transformers installed outdoors shall be rated NEMA 3R.

J. Provide single phase transformers 2 kVA and below without taps. Provide single phase transformers 3 KVA through 7.5 kVA with 2-5 percent below normal full capacity (BNFC) taps. Provide single phase transformers 15 kVA and above and three phase transformers 15 kVA and above with two (2)-2 ½ percent above normal full capacity (ANFC) taps and four (4)-2 ½ percent below normal full capacity (BNFC) taps.

K. Transformers shall meet the efficiency requirements of ‘DOE 2016 Efficiency’ when operated at 35% of full load capacity.

2.2 TRANSFORMER FOR NON-LINEAR LOADS

A. Provide transformers for non-linear loads conforming to requirements for distribution dry type transformers except as noted herein.

B. The transformers shall be specifically designed to supply circuits with a harmonic profile equal to or less than a K-factor indicated on the Contract Drawings. The core design shall withstand voltage distortion and high frequency harmonic currents with the magnetic flux density designed to reduce eddy currents and prevent saturation or overheating of the core.

C. The transformer shall include an electrostatic shield between the primary and secondary windings.

D. The neutral conductor shall be rated to carry 200 percent of normal phase current.

E. The transformer nameplate shall be marked with the transformer K-Rating.

2.3 MANUFACTURERS

A. Subject to compliance with Specification requirements:
   1. Square D/ Schneider Electric
   2. Eaton/Cutler Hammer
   3. Siemens
   4. General Electric
   5. Acme Electrical Corporation
   6. Approved Equal

PART 3 EXECUTION

3.1 INSTALLATION

A. Install transformers in accordance with the manufacturer's instructions and with the product listing requirements. Provide adequate clearance for proper ventilation.

B. Protect the equipment against foreign matter and moisture during installation.

C. Install flexible metal conduit between transformer and conduit.

D. Ground all secondary derived systems in accordance with the National Electrical Code. Provide bonding conductors to system electrodes.

E. Perform testing in accordance with Section 16080, Acceptance Testing of Electrical Systems.

END OF SECTION 26 22 00

SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: The work specified in this Section consists of all materials for furnishing, installing connecting, energizing, testing, cleaning and protecting panelboards.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM B164 Nickel-Copper Alloy, Bar and Wire.
2. ASTM B187 Standard Specifications for Copper Bus, Bus Bar, Rod and Shapes

B. National Electrical Manufacturers Association (NEMA):
1. NEMA 250 Electrical Enclosures.
2. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches.
3. NEMA AB 2 Molded Case Circuit Breakers and their Application.
4. NEMA PB 1 Panelboards.
5. NEMA PB 1.1 General Instructions for Proper installation, Operation, and Maintenance of Panelboards.

C. National Fire Protection Association (NFPA):
1. NFPA 70 National Electrical Code (NEC).

D. Underwriters Laboratories (UL):
1. UL 50 Cabinets and Boxes
2. UL 67 Panelboards
3. UL 489 Molded Case Circuit Breakers and Circuit Breaker Enclosures

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:

B. Product Data and Catalog Cuts: Submit product data for all products provided. Indicate clearly the usage and designation of each product.

C. Shop Drawings: Submit shop drawings for all panelboards including bill of materials, dimensioned outline diagrams, circuit breaker schedules and accessories.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.1 PANELBOARDS

A. Provide UL Listed dead-front panelboards as follows:
   1. Bolt-on molded case circuit breakers as specified below.
   2. Conform to NEMA PB 1 and NFPA 70, NEC Article 408.
   3. Provide interiors, matching enclosures and covers of a single manufacturer as specified below.
   4. Provide circuit breakers of frame sizes, trip ratings, number of poles, and types as scheduled, indicated and noted.
   5. Provide branch circuits phased in sequence vertically and numbered uniformly left to right, top to bottom.

B. Provide panelboards that are fully rated for a short circuit capacity as scheduled, indicated and noted on the Contract Drawings.

C. Interiors: Provide interiors, as follows:
   1. Provide tin plated main, ground and neutral copper buses conforming to ASTM B187 having not less than 98 percent conductivity.
   2. Mount interiors on galvanized steel backplate.
   3. Make provisions for future breakers and for circuit breakers in all future spaces as indicated, scheduled or noted and so that additional breakers can be mounted without additional connectors or extension of busses.

D. Provide solderless type main, sub-feed, and through feed lugs rated for copper and aluminum conductors of size, number and type, as indicated, scheduled and noted on the Drawings.

E. Enclosures:
   1. Provide enclosures conforming to NEMA 250 for the types as indicated, scheduled, noted, and specified. Provide NEMA 1 enclosures unless otherwise indicated on the Drawings.
   2. Fabricate from galvanized steel without knockouts.
   3. Provide door-in-door enclosures.
   4. Provide metal frame circuit directory of sufficient size to allow 40-characters per circuit. Mount the directory in metal frame with plastic covers.

F. Doors: Provide doors as follows:
   1. Provide concealed hinges and trim clamps.
   2. Provide door-in-door enclosure.
   3. Provide combination catch and master keyed, flat key lock with two keys for each lock and common keying throughout each building of the facility.

G. Finishes:
   1. Factory finish enclosure cover completely using an electro-deposition process that deposits a complete finish coat of paint on all interior and exterior surfaces as well as bolted joints.

2. Include in the paint process cleaning, rinsing, phosphatizing, prepaint and post paint rinses, bake-cure and cool down steps.

H. Molded case circuit breakers:
1. Main circuit breakers shall be individually mounted and bolted to the bus assembly. Back-feed branch circuit breakers are prohibited.
2. Provide trip ratings, frame sizes, and number of poles as scheduled on the Contract Drawings.
3. Provide fully rated circuit breakers with short circuit ratings as scheduled on the Drawings.
4. Provide molded case circuit breakers conforming to NEMA AB 1, and UL 489.
5. Provide circuit breakers of the same manufacture and type as the panelboard installed.
6. All connections shall be rated for 75 degrees C wiring.

I. Trip Units
1. Panelboards
a. Provide trip free thermal-magnetic, bolt-on circuit breakers

2.2 MANUFACTURERS

A. Subject to compliance with the specifications:
1. Square D/ Schneider Electric
2. General Electric.
3. Eaton/Cutler-Hammer.
4. Approved Equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Space enclosures out from surfaces mounted on 1/4-inch spacers or U-channel supports.

B. Install all panelboards and circuit-breakers in accordance with the product listing requirements, manufacturer’s instructions and NEMA PB 1.1.

C. Punch holes for conduit entries in the enclosures.

D. In all areas except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.

E. Identification
1. Provide nameplates in accordance with Section 16075, Identification for Electrical Systems.
2. At the end of the project update the circuit directories to reflect as-built conditions. Circuit directions shall be typed.

3.2 CLEANING

A. After wiring, vacuum out interior and wipe clean of all foreign material.

B. After painting in areas, remove all over paint, drips and splashes.

3.3 PROTECTION

A. During painting, mask all nameplates, all plastic parts, and all items not to be painted.

B. Protect all items during work of other trades including welding and cutting.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: The work of this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting wiring devices and cover plates.

1.3 REFERENCES

A. National Electric Manufacturer's Association (NEMA):
1. NEMA WD 1 General Requirements for Wiring Devices
2. NEMA WD 6 Dimensional Requirements for Wiring Devices

B. National Fire Protection Association (NFPA):
1. NFPA 70 National Electrical Code (NEC).

C. Underwriters Laboratories, Inc. (UL):
1. UL 20 General-Use Snap Switches
2. UL 231 Power Outlets
3. UL 498 Standard for Safety for Attachment Plugs and Receptacles
4. UL 943 Ground Fault Circuit Interrupters
5. UL 1681 Standard for Safety for Wiring Device Configurations

D. Federal Specifications (FS):
1. W-C-596/40 Connector, Receptacle, Electrical, General Purpose, Duplex, Hospital Grade, Grounding, 2 Pole, 3 Wire, 20 Amperes, 125 Volts, 50/60 Hertz
2. W-C-596/41 Connector, Receptacle, Electrical, General Purpose, Single, Hospital Grade, Grounding, 2 Pole, 3 Wire, 20 Amperes, 125 Volts, 50/60 Hertz
3. W-C-596/107 Connectors, Receptacle, Electrical, Special Purpose, Single, Grounding, 2 Pole, 3 Wire, 20 Amperes, 277 Volts, 50/60 Hertz
4. W-S-896E Switches, toggle (Toggle and Lock), Flush Mounted (General Specification

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:

B. Product Data: Submit product data for all products proposed. Clearly indicate usage of each procuct.
   1. List of all products and accessories.
   2. Catalog cuts of all products and accessories to be furnished and installed.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work

1.6 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.1 SWITCHES AND RECEPTACLES

A. Provide UL listed specification grade switches meeting Fed. Spec. W-S-896 and NEMA Standard WD 1, and WD 6; and UL listed specification grade receptacles meeting Fed. Spec. W-C-596 and NEMA Standard WD-1 and WD-6 for voltage and current indicated. Provide switches and receptacles with screw terminals or clamp and screw for side wiring. Push-in back wiring and plug-tails will not be permitted. A mixture of manufacturer's products is not permitted. Unless otherwise noted all devices shall be colored gray; receptacles on UPS branch circuits shall be red.

B. Toggle Handle Snap Switches: Provide 20 amp, 120/277 volt, side wired, single pole, 3-way or 4-way as indicated, quiet design.
   1. Extra Heavy Duty Industrial Grade: Legrand/Pass & Seymour PS20AC1 or approved equal.

C. Standard Face Design Receptacles:
   1. Hard-Use Specification Grade: Duplex, 125 volts AC, 20 amperes, side wired 2-pole, 3-wire, grounding, Legrand/Pass & Seymour 5362 or approved equal. Receptacles installed on uninterruptible power supply (UPS) branch circuits shall be colored red.

D. Weather-Resistant Receptacles:
   1. Heavy Duty Specification Grade: Duplex, 125 VAC, 20 amperes, side wired, 2-pole, 3 wire grounding, Legrand/Pass & Seymour WR5362 or approved equal.

E. Ground Fault Circuit Interrupter (GFCI) Receptacles:
   1. Specification Grade: Self-testing, tamper resistant duplex, 125 volts AC, 20 amperes, 2-pole, 3-wire, grounding, UL943, solid state circuitry, Legrand/Pass & Seymour 2097TR or approved equal.

F. Weather-Resistant Ground Fault Circuit Interrupter (GFCI) Receptacles:
   1. Specification Grade: Self-testing, weather and tamper resistant duplex, 125 volts AC, 20 amperes, 2-pole, 3-wire, grounding, UL943, solid state circuitry, Legrand/Pass & Seymour 2097TRWR or approved equal.

G. Power Outlet Receptacles: Single type, heavy duty design, at rated voltage and amperage with NEMA configuration indicated on the Drawings.

H. Acceptable Manufacturers:
   1. Legrand/Pass & Seymour
   2. Leviton
   3. Hubbell
   4. Cooper/Arrow Hart
   5. Approved Equal

2.2 WALL PLATES

A. Provide a wall plate for each switch, receptacle and special purpose outlet. Do not use sectional gang plates. Use multi-gang outlet plates for multi-gang boxes. Use wall plates of AISI 302 stainless steel (.040 inches thick) (1mm) with satin finish in finished areas.

B. Provide device plates of heavy cadmium plated steel for use with exposed stamped steel boxes, edges of device plates flush with edges of boxes.

C. Provide device plates of heavy cadmium plated steel for use with cast FD type boxes, edges of device plates flush with edges of boxes.

D. Use wall plates for pushbutton and buzzer outlets that have openings to suit the pushbuttons and buzzers. Use plates having the same finish mentioned above.

E. Provide wet location device covers for use at locations subject to wet or rain conditions. Provide receptacles covers marked “Suitable for Wet Locations While In Use”.

F. Use AISI 316 stainless steel type screws for the installation of wiring devices and wall plates.

G. Acceptable Manufacturers:
   1. Legrand/Pass & Seymour
   2. Leviton
   3. Hubbell
   4. Cooper/Arrow Hart
   5. Approved Equal

2.3 WET AREAS

A. Weather proof enclosures and cover identified as “Extra-Duty” and shall be “in-use” type which is weather proof whether or not an attachment plug is inserted.

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect area to insure all surfaces are concrete foundation for completeness, correct number, type, and location of anchors, size and levelness. Check for spalled concrete, honeycombs, and other concrete defects.

B. Check pull and junction box for correct type, size and location.
   1. Flush boxes should be plumb and level to 1/8-inches and flush or protrude no more than 1/16-inch from the finish surface.
   2. Surface mounted boxes should be plumb and level to 1/16-inch.
   3. Size of box should conform to NFPA 70 Article 370.

C. Check wiring pigtails for sufficient length to re-terminate wiring.

D. Check ground wires for correct type, size and location.

E. Correct any and all defects.

3.2 PREPARATION

A. Remove any over sprayed paint from interior of boxes and from wiring.

B. Clean interior of box of dirt and debris.

3.3 INSTALLATION

A. Install all equipment and material in accordance with their product listing requirements.

B. Where 2 or more switches or receptacles are shown on the Drawings at the same location, they shall be ganged and covered with one coverplate.

C. Provide red receptacles for circuits on UPS Power Panels.

D. Use stainless steel hardware in all locations other than dry locations and except for hardware fixed to wiring devices, use nylon screws to affix all plastic wallplates and plated screws to affix all metal wall plates.

E. Adjust final switch and devices to be plumb and level and wall plates of flush boxes to be set flush to wall.

F. Mounting Heights: Refer to Contract Drawings.

3.4 TESTING

A. Test each receptacle with a plug-in tester that checks for reversed wiring line and neutral wiring, reversed ground and neutral wiring, open, ground wiring, and open neutral wiring.

Test all ground fault circuit interrupters (GFCI) with plug in tester that simulates ground fault.

3.5 PROTECTION

Mask all items during painting operation.

Protect items against damage during other work.

END OF SECTION 26 27 26

SECTION 26 28 16.13 - LOW-VOLTAGE ENCLOSED SWITCHES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details", dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections

1.2 SUMMARY

A. Section Includes: The Work specified in this Section includes furnishing, installing and testing low voltage enclosed switches.

1.3 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   A. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
   B. NEMA KS 1 Heavy Duty Enclosed and Dead Front Switches

B. National Fire Protection Association (NFPA):
   A. NFPA 70 National Electrical Code (NEC).

C. Underwriter's Laboratories, Inc. (UL):
   A. UL 98 Enclosed and Dead-Front Switches.

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:

B. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
   A. Low voltage enclosed switches
   B. Accessories

C. Shop Drawings
   A. Bill of Materials
   B. Dimensioned outline drawings with equipment ratings of low voltage enclosed switches.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

PART 2 PRODUCTS

2.1 ENCLOSED SWITCHES

A. Provide low voltage enclosed switches (safety switches) that meet the requirements of NEMA KS l and are UL Listed:
   a. Types:
      1) Heavy duty fusible type.
         a) Provide positive pressure fuse clips.
         b) Provide fuses as specified
      2) Heavy duty non-fusible type.
   b. Provide 600 volt enclosed heavy duty disconnect switches rated for the horsepower, voltage, and amperage as indicated on the Contract Drawings.
   c. Provide enclosed disconnect switches with the number of poles and of the type indicated on the Contract Drawings.

B. Enclosure:
   a. Provide enclosures consisting of a box and cover conforming to the requirements of NEMA 250 and of the type indicated or scheduled on the Contract Drawings.
      1) If not otherwise specified provide Type 1 for dry locations and NEMA 4X for outdoor or wet locations.
      2) Unless otherwise indicated on the Contract Drawings, NEMA 4X enclosures shall be stainless steel.
   b. Material:
      1) Construct enclosures of code gauge sheet steel per the requirements of UL 98.
   c. Finish:
      1) Apply a rust-inhibiting phosphate coating to the enclosure's sheet steel, and then finish the enclosure in gray baked enamel.
   d. Provide a permanent label with the manufacturer's switch type, catalog number, and horsepower rating on the enclosure.

C. Switch Mechanism:
   a. Provide a visible blade quick-make, quick-break operating handle and switch mechanism integral to the box or body and not the cover. The handle shall travel a least 90 degrees between OFF and ON positions to clearly distinguish and indicate the handle position.
   b. Provide a means to padlock the switch in the OFF position.
   c. Provide a switch designed so that the switch blades are visible in the OFF position when door is open.
   d. Provide a dual cover interlock to prevent unintentional opening of the switch cover when the switch is in the ON position and prevent turning the switch ON when the cover is opened. The interlock shall have an externally operated override.

D. Line Terminal Shields
   a. Provide clear line terminal shields to prevent accidental contact with live parts. Terminal shields shall include probe holes to allow voltage testing without removal of the shield.

E. Lugs
   a. Provide UL-listed copper lugs for rated 75 degree C for use with copper cables.
   b. Lugs for switches rated 800 amperes and larger shall be compression type.

F. Grounding
   a. The manufacturer shall provide ground kits which may be field or factory installed.

G. Fuses:
   a. Provide fuses rated for the voltage and amperage as indicated on the Contract Drawings.
   b. For non-motor loads, provide UL Class RK1 single element, fast-acting type fuses.
   c. For motor, welder, and transformer loads, provide UL Class RK5 dual element, time-delay type fuses.

H. Acceptable Manufacturers:
   a. Cooper Bussman
      1) UL Class RK1: Limitron®.
      2) UL Class RK5: Fusetron®.
   b. Gould-Shawmut.
   c. Approved Equal.

I. Provide one set of spare fuses for each point of use.

2.2 ACCEPTABLE MANUFACTURES

A. Subject to compliance with Specification requirements:
   A. Square D/ Schneider Electric
   B. Eaton/Cutler Hammer
   C. Siemens
   D. General Electric
   E. Approved equa;

PART 3 EXECUTION

1.1 INSTALLATION

A. Install equipment in accordance with the manufacturer’s instructions and the product listing requirements.

B. Mount enclosures on channel framing or spacers to provide minimum ¼ inch space between enclosures and mounting surfaces.

C. Provide nameplates in accordance with Section 260553, Identification for Electrical Systems

END OF SECTION 26 28 16.13

SECTION 26 28 16.19 LOW-VOLTAGE ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, connecting, energizing, testing, cleaning, and protecting enclosed, low-voltage, individually mounted molded-case circuit breakers.

1.3 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250; Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA AB 1; Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.

B. National Fire Protection Association (NFPA):
   1. NFPA 70; National Electrical Code (NEC).

C. Underwriter's Laboratories, Inc. (UL):
   1. UL 489; Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Works:
   1. Product Data:
      a. Circuit Breakers
      b. Circuit breaker enclosures
      c. Circuit Breaker Accessories
   2. Shop Drawings:
      a. Enclosed molded-case circuit breakers

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide circuit-breaker enclosures from the same manufacturer as the circuit-breaker.

B. Acceptable Manufacturers:
   1. Subject to the requirements of the specification:
      a. Square D Company.
      b. Eaton/ Cutler Hammer.
      c. General Electric.
      d. Siemens.
      e. Approved equal.

2.2 MANUFACTURED UNITS

A. Enclosed Molded-Case Circuit-Breakers:
   1. Provide quick make-quick break, molded-case circuit breakers conforming to NEMA AB 1 and UL 489.
   2. Provide circuit breakers with the voltage rating, interrupting ratings, poles and trip setting as indicated on the Contract Drawings.
   3. Provide factory-installed accessories as indicated and specified.
   4. All terminals shall be suitable for copper conductors and shall be rated 75 degrees C.

B. Trip Units
   1. Circuit breakers with 225 ampere trip and less shall be provided with trip free thermal magnetic trip units.
   2. Circuit breakers with 250 ampere trip and greater shall be provided with true RMS electronic digital trip units with the following adjustments:
      a. Long time pick up
      b. Long time delay
      c. Short time pick up
      d. Short time delay
      e. Instantaneous pick up
   3. Solid state digital trip units shall be provided with energy monitoring functions.
   4. Ground fault trip elements shall be provided for 480 volt circuit breakers rated at 800 amperes or more or where otherwise indicated on the Contract Drawings.

C. Enclosures:
   1. Provide enclosures conforming to the requirements of NEMA 250.
      a. Enclosures shall be NEMA Type 1 unless otherwise shown on the Contract Drawings.
   2. Provide enclosures sized to contain the circuit breaker and all other required items.
      a. Provide an interlock that prevents opening the enclosure door when the circuit breaker is in the “ON” position. The interlock shall have an externally operated override.
      b. Provide a copper ground-bus or ground-stud.
   3. The enclosure shall be sized to meet the wire bending space requirements of NEC Article 312.

4. Provide each enclosure with an external operator that positively indicates the “ON”, “OFF”, and “TRIPPED” positions of the enclosed circuit breaker.
5. Provide the capability to pad-lock the circuit breaker in the “ON” and the “OFF” positions by using three padlocks.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install circuit breakers in accordance with the circuit breaker manufacturer’s instructions and the product listing requirements:
   1. Mount enclosures on 1/4-inch (6mm) spacers or U-channel supports to provide a space between enclosures and mounting surfaces.

B. Identify circuit breakers in accordance with Section 26 05 53, Electrical Identification.

3.2 FIELD QUALITY CONTROL

A. Site Testing: Perform testing in accordance with Section 26 05 63.

3.3 PROTECTION

A. Protect the items provided under this Section during the performance of work provided under other Sections, especially during welding and cutting operations.

END OF SECTION 26 28 16.19

SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: The work specified in this Section consists of materials for furnishing; installing, connecting, energizing, testing, cleaning and protecting enclosed low-voltage individually mounted enclosed starters and contactors, and related accessories.

1.3 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
1. NEMA 250 Electrical Enclosures
2. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches
3. NEMA FU 1 Low Voltage Cartridge Fuses
4. NEMA ICS 1 Industrial Control and Systems: General Requirements
5. NEMA ICS 2 Industrial Control and Systems: Contractors and starters
6. NEMA ICS 4 Industrial Control and Systems: Terminal Blocks
7. NEMA ICS 5 Industrial Control and Systems: Control Circuit and Pilot devices
8. NEMA ICS 6 Industrial Control and Systems: Enclosures
9. NEMA ST 1 Specialty Transformers

B. National Fire Protection Association (NFPA):
1. NFPA 70 National Electrical Code (NEC)

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:

B. Product Data and Catalog Cuts: Provide product data for all products provided. Indicate clearly the usage of each product.

C. Shop Drawings: Submit shop drawings of all enclosed low voltage starters.

D. Provide manufacturer's instructions for all enclosed starters and contactors.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work

PART 2 PRODUCTS

2.1 MOTOR STARTERS

A. Manual Motor Starters: Provide starters in NEMA Standard 250 Type 1 enclosure, unless indicated otherwise on the Drawings, and having the correct number of poles and horsepower rating to operate the connected motors.
   1. Fractional Horsepower Manual Starters: Starter consisting of a manually operated quick-make, quick-break toggle switch equipped with melting alloy type thermal overload relay. Thermal unit sized to suit imposed load and of one-piece construction and interchangeable. Starter rendered inoperative when thermal unit is removed. Starter contacts of double break silver alloy type in a trip-free switch mechanism.
   2. Acceptable Manufacturers:
      a. Square D Company.
      b. General Electric.
      c. Eaton/Cutler-Hammer.
      d. Siemens
      e. Approved Equal.

B. Manual Motor Switches: Provide switches in NEMA Standard 250 Type 1 enclosure, unless indicated otherwise on the Drawings, and having the correct number of poles and horsepower, or horsepower rating to operate the connected motors.
   1. Fractional Horsepower Manual Switches: Switch consisting of a manually operated quick-make, quick-break toggle switch without thermal overload relay. Starter contacts of double break silver alloy type in a trip-free switch mechanism.
   2. Acceptable Manufacturers:
      a. Square D Company.
      b. General Electric.
      c. Eaton/Cutler-Hammer
      d. Siemens
      e. Approved Equal.

C. Combination Motor Starter (Full Voltage): Provide starter units as indicated on the Drawings and meeting the following requirements:
   1. Combination motor starters shall consist of a controller disconnecting means, motor starter, control power transformer and control pilot devices installed in a single enclosure
   2. Magnetically held, electrically operated, three pole assemblies with arc extinguishing characteristics and double break silver-alloy renewable contacts meeting NEMA ICS 2. Provide Full Voltage Non-Reversing, Full Voltage Reversing or Full Voltage 2-Speed starters as shown on Contract Drawings. Starters shall accommodate overload relay thermal units properly sized and installed on each phase of the respective motor to be controlled. Thermal unit must be in position to operate starter.
   3. Provisions to add a minimum of four normally open, or normally closed, electrical interlocks.

4. Three pole melting-alloy-element block-type overload relays, trip-free hand reset. Furnish thermal units.
5. Circuit breakers of the magnetic trip type meeting NEMA AB 1. Provide adjustment screw to simultaneously set the magnetic trip level of each individual pole with a single magnetic adjustment, with adjustment continuous throughout the trip range. Provide clear indication of whether the breakers are in the ON, OFF or TRIPPED position by the position of the external operating handle. Mechanically interlock handle with the unit door to prevent access unless the breaker is in the OFF position. Provide padlocking facilities to positively lock the breaker in the OFF position with from one to three padlocks with the door open or closed.
6. UL Listed short circuit rating not less 42,000 amperes or as indicated on the Drawings
7. Operating and Indicating Devices: Unless otherwise shown on drawings, provide starters with Hand-Off-Auto selector switch and Red and Green run LED type pilot lights.
8. Terminal Boards: Provide each starter with an individual terminal board within the unit, completely accessible from the front, and so arranged that connection to starter can be made from the front when unit frame and starter are in place. Provide clearly marked studs for line, load and control connections. Clearly mark terminals and indicate on the manufacturer's supplied interconnection diagrams.
9. Voltage:
    a. Control Voltage: 120 volts, using individual control transformers. Control transformers having a capacity of 100VA more than the capacity required to operate external solenoids, relays, alarms, and such other control voltage components, as indicated on the Drawings. Provide primary and secondary fuses.
    b. Service Voltage: As indicated on the Drawings.
10. Enclosure: NEMA Standard 250 Type 1, unless indicated otherwise on the Drawings. Construct enclosures of code gauge (UL 98) sheet steel treated with a rust-inhibiting phosphate and finished in gray baked enamel.
11. Acceptable Manufacturers:
    a. Square D Company.
    b. General Electric.
    c. Eaton/Cutler-Hammer.
    d. Siemens
    e. Approved Equal.

2.2 CONTACTORS

A. Provide contactors which meet the following:
1. Multipole, electrically operated, mechanically or magnetically held type as indicated on Contract Drawings.
2. Continuous duty for each type of load.
3. Number of poles per contactor, amperages and load voltages as indicated on Drawings.
4. Construction: Flush dead back design with arc shields and barriers to prevent pole-to-pole flashover. Parts accessible for inspection and maintenance. Contacts readily replaceable from front. Contactors suited for tungsten and ballast lighting and resistance heating loads. Interrupting capacity 150 percent of rating with no derating for high inrush loads.
5. Enclosure: NEMA 1 surface type, unless indicated otherwise on Drawings, with provision for padlocking.

B. Acceptable Manufacturers:
   1. Square D Company.
   2. General Electric.
   3. Eaton/Cutler-Hammer.
   4. ASCO
   5. Approved Equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Space enclosures out from surfaces mounted on 1/4-inch spacers or U-Channel supports.

B. Install all starters in accordance with the product listing requirements and the manufacturer's instructions.

C. Provide nameplates in accordance with Section 26 05 53, Identification of Electrical Equipment.

END OF SECTION 26 29 13

SECTION 26 32 13.13 - DIESEL ENGINE DRIVEN GENERATOR SETS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: The work specified in this Section consists of furnishing, installing, testing startup and training for NFPA 110, Level 2, Type 10, Class 24 standby power diesel generator sets.

1.3 MANUFACTURERS QUALIFICATIONS

A. Provide generating sets built, tested and shipped by one manufacturer to insure single source of supply and responsibility. Consideration shall be given only to manufacturers meetings the following qualifications:
   1. Maintain a Prototype Test Support system which verifies the performance integrity of the generator set design and meets the prototype test requirements of NFPA 110.
   2. Maintain a service facility with complete spare parts stock within 100 miles of Project Site, with technicians available for calls 24 hours/day, 365 days per year.
   3. Service capability to provide routine maintenance to the engine, generator and transfer switches.

B. Acceptable manufacturers for the diesel engine generator sets:
   a. Cummins Power Generation
   b. Kohler Power Systems
   c. Caterpillar
   d. MTU
   e. Approved Equal.

1.4 DESIGN CRITERIA

A. The power requirements specified herein or shown on the Contract Drawings for each unit shall be provided from a single engine generator set. Multiple parallel units will not be considered to meet the requirements of a single unit.

B. Generator sets shall be rated for standby operation and shall supply power in the event of the loss of the utility source with no run time limitation while the utility source is unavailable:
   1. Generator Rating specified at 0.8 power factor.

2. Generator Characteristics:
   a. Power Ratings (kVA/kW) as indicated on the Contract Drawings
   b. All units shall conform to:
      1) Voltage (Grounded Wye) 480Y/277
      2) Phase 3
      3) No. Of Service Wires 4
      4) Solid Ground
      5) 105 degree C rise alternator

C. Load Starting Requirements: The generator shall be capable of starting the loads as indicated in the one line distribution schematic on the Contract Drawings as well as 10% of additional load on each transfer switch. Maximum starting transient voltage shall not exceed 15%.

D. The engine generator sets shall conform to the requirements of NFPA 110 for Level 2 systems and shall start and accept load in 10 seconds.

E. The engine generator set shall be UL listed in accordance with UL 2200.

1.5 REFERENCES

A. American Society of Civil Engineers
   1. ASCE-7 Minimum Design Loads for Buildings and Structures

B. National Fire Protection Association (NFPA)
   1. NFPA 70 National Electrical Code
   2. NFPA 110 Standard for Emergency and Standby Power Systems

C. National Electric Manufacturer's Association (NEMA)
   1. NEMA MG-1 Motors and Generators

D. State of Delaware-Division of Air Quality
   1. Regulation No. 1144 Control of Stationary Generator Emissions

E. Underwriters Laboratory (UL)
   1. UL 142 Above Ground Tanks for Flammable and Combustible Liquids
   2. UL 2200 Stationary Engine Generator Assemblies

F. United States Department of Environmental Protection (USEPA)
   1. USEPA 40 CRR 89 Control of Emissions from New and In-Use Non-Road Compression-Ignition Engines

1.6 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work

B. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
   1. Engine-Generator
   2. Alternator
   3. Gen-Set Controller
   4. Circuit Breakers
   5. Batteries
   6. Battery Charger
   7. Exhaust System
   8. Voltage Regulator
   9. PMG
   10. Governor
   11. Remote Annunciator
   12. Other Accessories

C. Shop Drawings
   1. Bill of Materials
   2. Engine-Generator dimensioned outline drawing, showing overall length, width, and height and weight.
   3. Enclosure assembly drawings complete with bill of materials
   4. Dimensioned outline of sub-base fuel tank
   5. Circuit breaker time-current curves.
   6. Generator thermal damage curve
   7. Wiring Diagrams

D. Certifications
   1. Submit a statement of compliance which states the proposed products are certified to the emissions standards required by the location and application of this Project.

E. Test Reports
   1. Certified test reports documenting factory tests

F. Operations and Maintenance Manuals

   Operation and Maintenance Manual Contents: shall include spare parts lists, fuel types, lubricating oils, special tools, maintenance requirements and schedule, equipment/systems operation for the following:
   1. Engine.
   2. Generator.
   3. Cooling system.
   4. Air intake and discharge system.
   5. Fuel system.
   6. Fuel tank.
   7. Control panel/control system.
   8. Main circuit breaker.
   9. Battery charger.
   10. Batteries.

11. Exhaust system.
12. Other auxiliaries as called out in this section.

1.7 FACTORY TESTING

A. The manufacture shall perform standard production tests on the completed unit at the manufacturer's facility prior to shipment. A certified test report shall be provided. The tests shall include but not be limited to:
   1. Operation at rated kW
   2. Operation at rated kVA
   3. Transient and steady state governing
   4. Transient and steady state voltage regulation
   5. Operation of all alarms and protective shutdown devices
   6. Single step load pickup at rated kW
   7. Over speed operation

1.8 TRAINING

A. Provide the on-site services of a manufacturer's authorized representative to demonstrate the operation and maintenance of the equipment.

B. Provide a minimum of two (2) eight hour days for on-site training.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Basic Electrical Materials: Those Products such as conduit, wireways, wire and connectors, cable, support devices, fasteners, and similar devices, as required for Work of this Section are as specified in other Sections of these Specifications.

B. Diesel Engine Generator Sets:
   1. Diesel Engine: Heavy duty industrial type, water-cooled, of four stroke cycle compression ignition operation, having solid-injection, and of either vertical in-line or V-type design.
      a. Engine designed to operate at 1800 RPM at normal full load operation.
      b. Provide engine capable of satisfactory performance when operating on commercial grade No. 2 Fuel Oil (ASTM D 396). Engines requiring premium or special fuels will not be considered.
   2. Electronic Governor: Provided an electronic solid state governing system for isochronous speed control of the prime mover. Provide a governor capable of operation in a droop or constant speed system with control at any set speed to be isochronous within plus or minus 0.25 percent.
      a. Governing system shall comprise an electronic control module, a speed setting potentiometer, a magnetic pick-up and a hydraulic actuator with fail-safe provisions for loss of power or speed. A sensor signal is incorporated in control module to shutdown the prime mover.
      b. Fail-safe features shall include a separate overspeed device to prevent prime mover run-away in the event of any failure, which might render the governor inoperative.

3. Diesel Fuel System Components:
   a. Fuel system equipped with a fuel filter having replaceable elements, which may be easily removed from their housing for replacement without breaking any fuel line connections, or disturbing the fuel pumps or any other part of the engine. No screens or filters requiring cleaning or replacement will permitted in the injection pump or injection valve assemblies.
   b. Provide fuel/water separator, Racor or equal.
   c. Provide a manual shut-off valve on the fuel line and any check valves, flexible fuel connections and such other items that may be required for proper operation of the engine.
4. Lubrication:
   a. Provided a gear-type lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, piston pins, timing gears, cam-shaft bearings and valve rocker arm mechanism.
   b. Provide a suitable water-cooled oil cooler.
   c. Threaded spin-on type oil filters provided and so located and connected that lubricating oil is continuously filtered and cleaned. Filters shall be conveniently located for servicing. Equip filters with a spring loaded bypass valve as an assurance against stoppage of lubricating oil circulation in the event filters become clogged.
   d. Provide a crankcase drain for complete gravity drainage.
5. Air Cleaners: Provided one or more dry type replaceable element air cleaners of sufficient capacity to effectively protect working parts of the engine from dust and grit.
6. Automatic Starting System:
   a. Provide an electric starting system with positive engagement drive and of sufficient capacity to crank the engine at a speed, which will allow full diesel starting of the engine. System shall be 24 volts or as recommended by engine manufacturer.
   b. Automatic Controls: Fully automatic start-stop controls provided in generator set control panel in accordance the requirements of NFPA 110.
   c. Batteries: Lead-acid storage battery set of heavy-duty diesel starting type. Battery voltage compatible with starting system. Provide battery rack, necessary cables, and clamps.
7. Heaters:
   a. Provide an engine mounted, thermostatically controlled immersion type engine water jacket heater to be provided to insure maintaining engine block coolant temperature in the range of 120 to 140 degrees F (49 to 60 degrees C).
      1) Heater shall be suitable for operation on 208 volt AC power.
      2) Heater shall include a lube oil pressure switch for automatic cut-out on engine start.
   b. Generator winding anti-condensation strip heater, 120 volts A.C. thermostatically controlled. Factory wired to the generator control panel. Wattage as per manufacturer's recommendations.
   c. Generator control panel heater, 120 volts A.C. thermostatically controlled. Factory wired to the generator control panel. Wattage as per manufacturer's recommendations.
   d. Battery heater, 120 volts A.C. thermostatically controlled. Factory wired to the generator control panel. Wattage as per manufacturer's recommendations.

8. Engine Cooling: The cooling system for each emergency standby unit shall have sufficient capacity for cooling the respective engine when the generator set is delivering full-rated load at the design ambient temperature.
   a. Engine Circulating System:
      1) Each engine shall be equipped with an engine driven, centrifugal-type water circulating pump for circulating water through engine jacket, cylinder heads and radiator;
      2) Thermostatic valve to maintain the engine at recommended temperature level under all load conditions.
      3) Each cooling system shall be equipped with one or more spin-on type engine water filters, which will treat the coolant and prevent corrosion and scale deposits from forming inside the cooling system.
      4) Provide a ball valve between engine and jacket water heater to facilitate maintenance on jacket water heater.
   b. Antifreeze: Cooling system shall be filled with a minimum concentration of 50 percent enthylene glycol.
9. Generator: Generator shall be a 4 pole revolving field synchronous type, brushless, with a permanent magnet exciter, coupled directly to the engine flywheel through a flexible coupling arrangement designed for positive alignment. The generator shall be of a single sealed bearing design, bearing being maintenance free and lifetime lubricated. The generator housing shall bolt directly to the engine flywheel housing. The rotor shall be dynamically balanced for operating speeds up to 125 percent of rated speed. The rotor shall be constructed using techniques such that shaft currents are negligible and an insulated bearing is not needed. The rotor shall be provided with full amortisseur windings.
   a. Generator construction shall comply with all applicable sections of NEMA Standard MG-1, including NEMA MG-1 - 78. Generator insulation shall be Class H protected with 100 percent epoxy impregnation and an overcoat of resilient insulating material on the stator and rotor to reduce possible fungus and/or abrasion deterioration. Alternator temperature rise shall be 105 degree C.
   b. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for a constant excitation power source independent of the load on the main stator terminals. The permanent magnet generator shall sustain main field excitation power for optimum motor starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices.
   c. The generator shall be capable of maintaining 300 percent of the standby current during short circuit conditions for a minimum of 10 seconds without the addition of external hardware such as a current boost system.
   d. Generator shall be provided with a solid state voltage regulator. The voltage regulator shall be mounted in the control panel on the generator. A built-in voltage adjusting rheostat shall provide five percent voltage adjustment. The voltage regulator shall have an adjustable maximum voltage dip. The voltage regulator shall also include over excitation protection that will turn the voltage regulator off to protect the generator in the event of extended operation in an overload condition. The generator shall be equipped with an overvoltage protection device as standard equipment to prevent damage to the generator and connected loads in the event that the generator goes into an overvoltage situation. The overvoltage device shall be factory set for 125 percent of rated voltage. The voltage regulator shall have been designed for use with a diesel

engine prime mover. The voltage regulator shall have been designed around the engine generator match for optimum load pick up.

e. Voltage Regulation: From no load to rated load maintained within a band of plus or minus 0.5 percent of rated voltage. The steady state voltage stability shall remain within a 0.5 percent band of rated voltage. Steady state voltage modulation shall not exceed one cycle per second.

f. One step load acceptance shall be 100 percent of nameplate KW rating to meet NFPA 110.

10. Frequency Regulation:
    a. Steady State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
    b. Steady State Frequency Stability: When the system is operating at any constant load within the rated load, there shall be no random speed variations outside of the steady state operational band and no hunting or surging of speed.
    c. Transient Frequency Performance: Less than 5 percent variation for 50 percent step load increase of decrease. Frequency shall recover and remain within steady state operating band within 5 seconds.
11. Output Wave Form
    a. At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total or 3 percent for any single harmonic. Telephone influence factor determined in accordance with NEMA MG-1 shall not exceed 50.
12. Circuit Breaker:
    a. A generator mounted main line molded case circuit breaker shall be provided for each unit. Each circuit breaker shall serve as a load circuit interrupting and protective device which shall operate both manually for normal switching functions and automatically during overloads and short circuit conditions.
    b. Circuit breaker shall be 100 percent rated, solid state trip type with true RMS electronic trip unit and the following adjustable trip unit functions:
        1) Long time pickup and delay
        2) Short time pickup and delay
        3) Instantaneous pickup
        4) Ground fault pre-alarm (No trip)
    c. All circuit breakers shall be provided with auxiliary contacts to indicate the position of the circuit breaker. The auxiliary contact shall be factory wired to provide a “Generator Circuit Breaker Opened” alarm at the control panel and at the remote annunciator.
13. Engine-Generator Set Control. A NEMA 1 enclosed control panel shall be mounted on the generator set with vibration isolators. The control shall be vibration isolated and prototype tested to verify the durability of all components under the vibration conditions encountered. The generator set mounted control shall include the following features and functions:
    a. Three position control switch labeled RUN/OFF/AUTO. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
    b. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

c. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power.

d. Generator Set AC Output Metering: The generator set shall be provided with a metering set with the following features and functions:
   1) Analog AC Voltmeter, dual range, 90 degree scale, 2% accuracy; Analog AC Ammeter, dual range, 90 degree scale, 2% accuracy; Analog Frequency/RPM meter, 45-65 Hz, 1350-1950 RPM, 90 degree scale, +/- 0.6 Hz accuracy.
   2) Seven position phase selector switch with OFF position to allow meter display of current and voltage in each generator phase. When supplied with reconnectable generators, the meter panel shall be reconnectable for the voltage specified.

e. Generator Set Alarm and Status Display: The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on the display panel:
   1) Low oil pressure (alarm)
   2) Low oil pressure (shutdown)
   3) Low coolant temperature (alarm)
   4) High coolant temperature (alarm)
   5) High coolant temperature (shutdown)
   6) Low coolant level (shutdown)
   7) High Battery Voltage (alarm)
   8) Low Battery Voltage (alarm)
   9) Battery Charger Loss of AC power (alarm)
   10) Emergency Stop Activated (alarm)
   11) Overcrank (shutdown)
   12) Overspeed (shutdown)
   13) Low fuel (alarm)
   14) Fuel leak (alarm)
   15) Ground fault (alarm)
   16) Not-In-Auto (alarm)
   17) Generator Circuit Breaker Opened (alarm)
   18) The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

f. Engine Status Monitoring: The following devices shall be provided on the generator set control :
   1) Engine oil pressure gauge
   2) Engine coolant temperature gauge
   3) Engine operation hour gauge
   4) Battery voltage (DC volts)

g. Engine Control Functions. The control system provided shall include a cycle cranking system, which shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods. Fail to start shall be indicated by operation of the overcrank alarm indication lamp. The control system shall also include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification.

h. Alternator Control Functions:
   1) The generator set shall include an automatic voltage regulation system, which is matched and prototype tested with the governing system provided. It shall be immune from mis-operation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ.
   2) Voltage adjusting rheostat, locking screwdriver type, to adjust voltage +/- 5% from rated value;

i. Control Interfaces for Remote Monitoring. Provide the following features in the control system:
   1) Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
   2) One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.

j. Provide an LED type remote alarm annunciator with horn, located as shown on the Drawings. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for fuel leak, high battery voltage, low battery voltage, and generator circuit breaker opened. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(s) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110.

k. Provide an emergency stop pushbutton station for installation remote from the generator. The pushbutton station shall be provided with a tamper proof cover, STI Universal Stopper, or approved equal and shall be suitable for indoor installation.

14. Battery Charger:
    a. UL listed certified 10 amp voltage regulated battery charger shall be provided for each engine-generator set. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
       1) Loss of AC power - red light
       2) Low battery voltage - red light
       3) High battery voltage - red light
       4) Power ON - green light (no relay contact)
    b. Charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses
15. Battery Charging Alternator
    a. Provide an engine driven battery charging alternator, minimum 35 amperes.
16. Exhaust System Components:
    a. Provide following as part of generator set:

1) Gas-proof seamles ASA steel turbo ell with petcock for bleeding off any condensation that might accumulate within the exhaust piping companion flange.
2) Critical Silencer.
3) Silencer and tailpipe shall be painted with a high temperature black enamel, corrosion resistant coating.
4) All necessary high temperature insulation required for the exhaust piping shall be furnished and installed under this Section of the Contract.

17. Base: The engine-generator set shall be mounted on a heavy, duty steel base to maintain alignment between components. The base shall include a battery tray with hold-down clamps within the rails.

C. Generator Set Sound Attenuating/Weatherproof Enclosure

1. Provide a weather-resistant, sound attenuated non- walk in type enclosure with base and built-in UL Listed base fuel tank with rupture tank. Enclosure shall conform to the following requirements.
2. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 70 dBA at any location 7 meters from the generator set in a free field environment. (Cummins Quiet Site II or equal).
3. Exterior: 14 gauge (1.6 mm) baked enamel aluminum.
4. Interior: sound absorber insulation.
5. Access: Solid doors with door handle keyed alike, stainless steel butt hinges, 3-point latch, stainless steel holder and rain gutter above door.
6. Air Intake: External fixed louvers with bird screen, internal sound absorber baffle system with motor operated damper.
7. Air Exhaust: External gravity louver with internal sound absorber system for radiator discharge.
8. Base and Rupture Tanks: UL Listed steel inner tank, with pickup and return piping and vent to outside of enclosure. Mechanical gauge, lockable fuel fill cap, drain coupling and high/low fuel alarm switch, and emergency vent. Outer rupture tank with leak alarm switch, drain coupling with plug, and emergency vent. The tank shall have venting and emergency venting per UL 142 and NFPA 30. The fuel tank shall be able to be filled from outside the enclosure, with a fuel level gauge provided at the fill port. The fuel tank shall be sized for 24 hours of continuous operation at 100% load.
9. Lifting provisions shall be provided at or near the enclosure roof, with capacity suitable for rigging the enclosure. Estimated enclosure weight shall be provided on submittal drawings.
10. A bolt-in-place removable wall panel shall be provided for maintenance and/or equipment installation.
11. The enclosure shall be provided with an exhaust silencer, which is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Include muffler brackets and straps; rain cap, collar and shield; flex pipe for muffler; and insulation for flex, muffler and exhaust pipe.
12. The enclosure shall be provided with a 2” (51mm) high environmental protection barrier placed around the electrical stub-up area and enclosure interior wall to help prevent liquid spill-over to the environment, a wall mounted aluminum document holder, radiator cap access, and oil, fume and water drains to outside of enclosure.
13. The following electrical package shall be provided with the enclosure:

a. Connections for battery charger, engine water jacket heater, generator anti-condensation strip heater, generator control panel heater and battery heater.
b. All electrical wiring shall be run in EMT conduit. Final connections to vibrating equipment shall be made with liquid tight flexible metallic conduit.

14. Acceptable Manufacturers:
    a. Acoustical Sheetmetal Inc.
    b. Pritchard Brown.
    c. Approved Equal.

2.2 SPARE PARTS

A. Filters:
    1. Provide three complete sets of filters for each unit as required for normal service and maintenance routines.

2.3 SAFETY PROTECTION EQUIPMENT

A. Earmuffs:
    1. Provide two pair of industrial type earmuffs for each engine generator set location having wide ear cushions that spread pressure over the entire area of the cushion and an adjustable padded headband for added stability.
    2. Acoustic fibers shall fill the extra deep cups to protect hearing from all noises, including low frequencies. Earmuffs shall be rated NRR 29db when worn overhead.
    3. Acceptable Manufacturer: Lab Safety Supply - UM-6898, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install equipment in accordance with manufacturer's instructions and product listing requirements. Provide such operations and work as may be necessary to provide a complete installation in accordance with these Specifications and/or Drawings, or as may be reasonably interpreted there from for a complete installation ready for service operation

B. Mounting:
    1. Provide spring-type vibration isolators between each engine-generator unit and the sound attenuating/weatherproof enclosure base. The number and size of isolators shall be as recommended by the engine-generator manufacturer.

3.2 FOUNDATION FOR GENERATOR SET

A. The top of slab shall be minimum 6-inches above finished grade. Provide conduit turn-ups and cable entrance spaces as required by the equipment.

B. Where conduits are to be turned up into the generator, the concrete encasement for the conduits shall be extended up to the top of the concrete pad and be provided with a ¾-inch chamfer around all exposed top edges. The concrete encasement for the conduits shall be completely isolated from the concrete pad for the transformer.

C. All conduits shall be provided with grounding type bushings

3.3 ACCEPTANCE TESTING

A. Field testing of the standby power system shall be performed after the installation of the engine generators, transfer switches and all accessory components are completed and the equipment is ready to be operated as a complete and fully functional system.

B. All acceptance tests specified in Section 26 05 63, Acceptance Testing of Electrical Systems shall be completed.

C. Engine generator field installation acceptance tests shall be performed in accordance with NFPA 110, Standard for Emergency and Standby Power Systems. Load tests shall be performed at 100 % kW load. The contractor shall provide portable load banks to achieve 100% resistive loading and shall provide all fuel required for acceptance testing.

D. A manufacture's authorized technician shall be present for all functional testing.

E. The Owner reserves the right for the Owner, Owner's Representative or Engineer to witness all testing at no additional cost to the Owner.

END OF SECTION 26 32 13.13

SECTION 26 33 53 - STATIC UNINTERRUPTIBLE POWER SUPPLIES

PART 1 GENERAL

1.1 Related Documents

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: Requirements for uninterruptible power supply systems, components and related installation.

1.3 REFERENCES

A. Institute of Electrical and Electronic Engineers (IEEE)/America National Standards Institute (ANSI):
   1. ANSI/IEEE C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturer's Association (NEMA):
   1. NEMA PE 1 - Uninterruptible Power Systems.

C. National Fire Protection Association (NFPA)
   1. NFPA 70 - National Electrical Code (NEC).

D. Underwriters Laboratories
   1. UL 1778 – Uninterruptible Power Supplies.

1.4 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

B. The UPS shall be UL or ETL Listed per UL Standard 1778.

1.5 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:

B. Shop drawings and manufacturers' literature shall be submitted and shall consist of single-line diagrams, assembly wiring diagrams, equipment drawings, breaker and fuse coordination curves, product description, and installation instructions. Shop drawings shall clearly indicate enclosure size, gutter space, breaker frame sizes and trips, main bus type and rating.

C. An Installation and Maintenance Manual shall be submitted and shall include equipment fabrications details, installation instructions and testing procedures.

1.6 MODES OF OPERATION

A. The UPS shall be designed to operate as double conversion transfer system in the following modes:
   1. Normal. The critical AC load is continuously supplied by the UPS inverter. The rectifier/charger derives power from a utility AC source and supplies DC power to the inverter while simultaneously float-charging a power reserve battery.
   2. Emergency. Upon failure of utility AC power, the critical AC load is supplied by the inverter, which without any switching, obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
   3. Recharge. Upon restoration of utility AC power, after a utility AC power outage, the rectifier/charge shall automatically restart, walk-in, and gradually assume the inverter and battery recharge loads.
   4. Bypass. If the UPS inverter overload capacity is exceeded or a fault occurs the static transfer switch shall perform a reverse transfer of the load from the inverter to the bypass source with no interruption in power to the critical AC load.

1.7 SYSTEM RATINGS

A. UPS Unit:
   1. Voltage. Input/output voltage specifications of the UPS shall be:
      a. UPS Unit:
         1) Input: 208Y/120 volts, three-phase, 4-wire, plus-ground.
         2) Output: 208Y/120 volts, three-phase, 4-wire, plus-ground.
   2. kVA/kW: As indicated on the Contract Drawings.

B. Batteries:
   1. Battery Cells: Sealed, valve-regulated lead-acid (VRLA), maintenance-free.
   2. Reserve Time:
      a. A minimum of 15 minutes at 80% load.

1.8 PERFORMANCE REQUIREMENTS

A. AC Input to UPS:
   1. Voltage Configuration: three-phase, 4-wire plus ground.
   2. Voltage Range: +10%, -20% of nominal.
   3. Frequency: Nominal frequency +/-5%.
   4. Power Factor: Up to 0.96 lagging at nominal input voltage and full rated UPS output load with input filter.
   5. Current Limit: 125% of nominal AC input current maximum.
   6. Current Distortion: 10% reflected THD maximum at full load with input filter.

B. AC Output, UPS Inverter:
   1. Voltage Configuration: three-phase, 4-wire plus ground.
   2.
   3. Voltage Regulation:
      a. ± 1.0% static phase to neutral

b. ± 2.0% static phase to phase
c. ± 5.0% dynamic at 100% resistive load change
d. Response time < 1ms

4. Frequency: Nominal frequency +/-0.1%.
5. Frequency slew rate: 0.1 through 5.0 hertz per second adjustable
6. Voltage Distortion:
   a. < 2% TDH linear load
   b. < 5% THD non-linear load
7. Synchronization Window: (+/-) 0.5 through (+/-) 3.0 Hz adjustable
8. Output Power Rating: Rated kVA at 0.8 lagging power factor.
9. Overload Capability:
   a. 110% for ten minutes
   b. 125% for one minute
   c. 149 % for 5 seconds
   d. > 150% for 300 ms

1.9 ENVIRONMENTAL RATINGS

A. Ambient Temperature Ranges:
   1. Operating Temperature:
      a. UPS: +10 to +40 degree C.

B. Relative Humidity: 5 to 95 percent, non-condensing.

C. Altitude:
   1. Operating: 0 to 1,000 meters without derating.

D. Audible Noise: Noise generated by the UPS under any condition of normal operation shall not exceed a sound pressure level of 65 dBA measured at 1 meter from the surface of the UPS.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Eaton 9355 UPS

B. Liebert eXM UPS

C. Approved Equal

2.2 FABRICATION

A. Materials:
   1. All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.
   2.

B. Wiring:

1. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70). All bolted connections of bus bars, lugs, and cables shall be in accordance with requirements of the National Electrical Code and other applicable standards. All electrical power connections are to be torqued to the required value and marked with a visual indicator.
2. Provision shall be made for power cables to enter or leave from the top or bottom of the UPS cabinet.

C. Construction and Mounting:
1. The UPS unit, comprised of a rectifier/charger with input filter, inverter and static transfer switch shall be housed in a single free-standing NEMA type 1 enclosure. Cabinet doors/covers shall require a tool for gaining access. Casters and stops shall be provided for ease of installation. The UPS cabinet shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling.

D. Cooling:
1. Cooling of the UPS shall be by forced air. Low-velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output.
2. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.

E. Grounding:
1. The AC output neutral shall be electrically isolated from the UPS chassis. The UPS chassis shall have an equipment ground terminal. Provisions for local bonding shall be provided.

2.3 COMPONENTS

A. Rectifier/Charger:
1. General: The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be a phase-controlled, solid-state SCR type with constant voltage/current limiting control circuitry.
2. AC Input Current Limiting: The rectifier/charger unit shall be provided with AC input current limiting whereby the maximum input current shall be limited to 125% of the full input current rating. The rectifier/charger shall operate at a reduced current limit mode whenever the critical load is powered from the UPS static bypass circuit such that the maximum UPS input current will not exceed 125% of full load input current.
3. Input Current Walk-In: The rectifier/charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 20-second time interval after input voltage is applied. Walk-in time shall be field selectable for 5 through 20 seconds.
4. Fuse Failure Protection: Power semiconductors in the rectifier/charger shall be fused with fast-acting fuses, so that loss of any one power semiconductor shall not cause cascading failures.
5. DC Filter: The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 1% RMS. The filter shall be adequate to insure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.

6. Automatic Rectifier Restart: Upon restoration of utility AC power, after a utility AC power outage and prior to a UPS automatic end-of-discharge shutdown, the rectifier/charger shall automatically restart, walk-in, and gradually assume the inverter and battery recharge loads.
7. Battery Recharge: In addition to supplying power for the inverter load, the rectifier/charger shall be capable of producing battery charging current sufficient to replace 80% of the battery discharge power within 3 hours. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

B. Inverter:
1. General: The term inverter shall denote the solid-state equipment and controls to convert DC power from the rectifier/charger or battery to regulated AC power for supporting the critical load. The inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.
2. Overload Capability: The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 150% of full load current. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.
3. Fuse Failure Protection: Power semiconductors in the inverter unit shall be fused with fast-acting fuses, so that loss of any one power semiconductor will not cause cascading failures.
4. Inverter Shutdown: For rapid removal of the inverter from the critical load, the inverter control electronics shall instantaneously turn off the inverter transistors. Simultaneously, the static transfer switch shall be turned on to maintain continuous power to the critical load.
5. Inverter DC Protection: The inverter shall be protected by the following disconnect levels:
   a. DC Overvoltage Shutdown.
   b. DC Undervoltage Warning (Low Battery Reserve), user adjustable from 1 to 99 minutes.
   c. DC Undervoltage Shutdown (End of Discharge)

C. Display and Controls:
1. Monitoring and Control: The UPS shall be provided with a backlit graphical LCD display and include the following.
   a. Menu-driven display with pushbutton navigation.
   b. Real time clock (time and date).
   c. Alarm history with time and date stamp.
   d. Battery backed-up memory.
2. Metering: The following parameters shall be displayed:
   a. Input AC voltage line-to-line and line-to-neutral.
   b. Input AC current for each phase.
   c. Input frequency.
   d. Battery voltage.
   e. Battery charge current.
   f. Battery run time
   g. Output AC voltage line-to-line and line-to-neutral.
   h. Output AC current for each phase.
   i. Output frequency.
   j. Output power
3. Status Messages: The following UPS status messages shall be displayed:
   a. Normal operation.
   b. UPS on Batteries
   c. UPS in bypass mode

d. UPS has an active alarm

4. Controls: UPS start-up, shutdown, and bypass operations shall be accomplished through the front-panel pushbutton controls. Menu-driven user prompts shall be provided to guide the operator through system operation without the use of additional manuals. Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms.
5. On-Line Battery Test:
   a. The UPS shall be provided with a menu-driven On-Line Battery Test feature. The test shall ensure the capability of the battery to supply power to the inverter while the load is supplied power in the normal mode.

D. Static Transfer Switch:
1. General:
   a. A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously.
   b. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.
2. Uninterrupted Transfer:
   a. The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:
      1) Inverter overload capacity exceeded.
      2) Critical AC load overvoltage or undervoltage.
      3) Battery protection period expired.
      4) UPS fault condition.
   b. The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:
      1) Inverter/bypass voltage difference exceeding preset limits.
      2) Bypass frequency out of limits.
      3) Bypass out-of-synchronization range with inverter output.
3. Uninterrupted Retransfer: Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:
   a. Bypass out of synchronization range with inverter output.
   b. Inverter/bypass voltage difference exceeding preset limits.
   c. Overload condition exists in excess of inverter full load rating.
   d. UPS fault condition present.

E. Battery Power Pack:
1. The battery power pack shall include sealed, lead-acid valve regulated battery cells. If a separate cabinet is required it shall match the UPS cabinet styling to form an integral system line-up. Battery cells shall be mounted on slide-out trays for ease of maintenance. A battery disconnect circuit breaker with undervoltage release (UVR) shall be included for isolation of the battery pack from the UPS module. The UPS shall automatically be disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level.

Casters and leveling feet shall also be provided with the battery power pack cabinet for ease of installation.

F. Accessories:
   1. Wall mounted 3-Breaker maintenance by-pass panel.
   2. Wall mounted remote EPO switch.
   3. Programmable Relay Board: Isolated Form C contacts shall be provided to indicate a change of status of any of the alarm conditions.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions and product listing requirements

B. Clearances and Protection: Maintain all clearances around UPS to adjacent electrical equipment and wall surfaces.

3.2 FIELD QUALITY CONTROL

A. Factory Testing: Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification. These tests shall include operational discharge and recharge tests on at least a one-minute battery plant to assure guaranteed rated performance.

B. Unit Start-Up and Site Testing: Site testing shall be provided by the manufacturer's field service personnel. Site testing shall consist of a complete test of the UPS system and the associated accessories supplied by the manufacturer in accordance with NETA ATS. A full load power test including a partial battery discharge test shall be provided as part of the standard start-up procedure. This shall be accomplished without disturbing user wiring and completed prior to operation of the site critical load from the UPS output. The test procedure shall be used to verify the capability of the UPS output waveform with its load. The engineer shall be informed immediately of any test failures.

END OF SECTION 26 33 53

SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: Requirements for 480 Volt automatic transfer switches and related installation.

1.3 REFERENCES

A. National Fire Protection Association (NFPA):
   1. NFPA 70: National Electrical Code (NEC).

B. Underwriters Laboratories (UL):
   1. UL 1008: Automatic Transfer Switches.

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:

B. Shop Drawings: All mechanical and electrical equipment and components specified herein must be included to be considered a complete shop drawing.
   1. Product Data: Provide manufacturers descriptive literature, product specifications, technical bulletins and catalogue data sheets.
   2. Equipment Drawings: Submit completely dimensioned plan, elevations, and cross-sections of system equipment and sub-assemblies. Shop drawings clearly indicate enclosure size, gutter space, and withstand current rating and continuous ampere rating of switch.
   3. Product List: Provide a list of equipment and components on all drawings with each product identified by legend reference. Include product name, manufacturer, and model number.
   4. Wiring Diagrams: Submit wiring diagrams for electrical apparatus showing numbered wiring terminals where applicable. In addition, submittal to contain detailed three- line diagrams and assembly wiring diagrams. Submit control diagrams indicating control devices mounted in automatic transfer switch, interconnecting wiring, and remote control devices, if any.

C. Submit Operation and Maintenance (O & M) Manuals, which shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures, and operating instructions.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

1.6 DESIGN CRITERIA

A. 480/277 volts, three-phase, four-wire, 60 Hertz, solidly grounded wye system voltage, unless indicated otherwise. All components in the system shall have adequate capacity, switching capability, withstand rating and bracing for the fault current indicated on the Drawings.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCHES

A. Provide automatic transfer switches rated for continuous duty in an unventilated NEMA 1 sheet metal enclosure. Enclosure shall be UL listed. The cabinet door shall be key-locking. Controls on cabinet door shall be key operated. Manual operating handles and all control switches (other than key operated switches) shall be accessible to authorized personnel only by opening the key locking cabinet door. Transfer switches with manual operating handles or non-key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

B. The transfer switch shall be open transition type and shall be provided with a Programmed (Delayed) Transition Transfer feature, adjustable from 0-60 seconds to disconnect the load from both sources in the neutral position to allow inductive load voltage to decay.

C. All poles of transfer switch shall be mechanically held in both normal and emergency positions. All switches shall be double throw having electrically operated normal-emergency positions, inherently interlocked both mechanically and electrically so that all main contacts move simultaneously on the same shaft, without the utilization of multiple snap-action devices.

D. The electrical operator shall be a single mechanism, comprised of a minimum number of operating parts, a service handle designed for one hand operation shall be provided for manual service operation. All main contacts shall be silver alloy wiping action type and be protected by separately removal arching contacts. Transfer switches with main and/or arcing contacts that weld in the event of a fault current as indicated by UL or independent test lab reports will not be acceptable.

E. All switch and relay contacts, coils, springs and control elements shall be conveniently removable from the front of the transfer switch without use of special tools, or removal of the switch panels from the enclosure and without major disassembly or disconnection of drive linkages or power conductors. Sensing and control relays shall be continuous duty industrial control type with minimum contact rating of 10 amperes. Sensing relays shall operate without contact chatter or false response when voltage is slowly varied to drop out and pick up levels.

F. The continuous duty rating of the automatic transfer switch shall be capable of handling all classes of loads on a make, carry and break basis per UL 1008. The switch must be capable of surviving in operable condition the maximum short circuit fault current available at the load side of the overcurrent device indicated on the Contract Drawings.

G. The transfer switches shall be specifically designed for 3 or 4 pole application as shown on the Contract Drawings. Transfer switches utilizing adapted devices such as molded case circuit breakers, or circuit breaker parts, disconnect switches, etc., which have not been intended to repeatedly open and close load currents are not acceptable.

H. The transfer switch shall obtain its operating voltage from the source to which it will transfer.

I. Failure of any coil or disarrangement of any part shall not permit the transfer switch to assume a neutral position.

J. Operation: The automatic transfer switch control panel shall utilize solid-state sensing on normal and emergency for automatic, positive operation. The following shall be provided:
   1. All phases of the normal source voltage shall be monitored line-to-line. Close differential voltage sensing shall be provided on all phases. The pickup voltage shall be adjustable from 85% to 100% of nominal and the dropout voltage shall be adjustable from 75% to 98% of the pickup value. The transfer to emergency will be initiated upon reduction of normal source to 85% of nominal voltage and retransfer to normal shall occur when normal source returns to 90% of nominal.
   2. A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. The time delay shall be field adjustable from 0.5 to 6 seconds and factory set at 1 second.
   3. A time delay on retransfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and factory set at 30 minutes.
   4. A programmed transition time delay adjustable from0-60 seconds.
   5. An unloaded running time delay for emergency generator cool down. The time delay shall be field adjustable from 0 to 5 minutes and factory set at 5 minutes.
   6. A time delay on transfer to emergency. Initially set at zero but field adjustable up to 1 minute for controlled timing of load transfer to emergency.
   7. Independent single phase voltage and frequency sensing of the emergency source. The pickup voltage shall be adjustable from 85% to 100% of nominal. Pickup frequency shall be adjustable from 90% to 100% of nominal. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal and frequency is 95% or more of nominal.

K. Auxiliary Contacts, Indicating Lights, Control Switches: The following shall be provided:
   1. A contact that closes when normal source fails for initiating engine starting, rated 10 amps, 32VDC. Contacts to be gold plated for low voltage service.
   2. Two auxiliary contacts that are closed when automatic transfer switch is connected to normal source and two auxiliary contacts that are closed when automatic transfer switch is connected to emergency source. Rated 10 amps, 480 VAC.
   3. One auxiliary contact that is closed when normal source is available and one auxiliary contact that is closed when emergency source is available. Rated 10 amps, 480 VAC.
   4. A green signal light to indicate when the automatic transfer switch is connected to the normal source. A red signal light to indicate when the automatic transfer switch is connected to the emergency source.
   5. A white signal light to indicate when the normal source is available. A white signal light to indicate when the emergency source is available.

6. A test switch to momentarily simulate normal source failure.
7. A key-operated switch with standby and normal positions to manually switch between the standby and normal source.
8. A solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. A with/without load selector switch for the exercise period.

L. Acceptable Manufacturers:
1. Onan
2. ASCO.
3. Russelectric
4. Approved Equal

PART 3 EXECUTION

3.1 INSTALLATION

A. Products shall be installed, connected, and interconnected, where indicated, and in accordance with the product listing requirements, manufacturer's printed instructions, as specified herein and as indicated on the Drawings. Connections shall be made in a manner, which will insure electrical continuity and operability of the products.

B. Protect the equipment against foreign matter and moisture during installation.

END OF SECTION 26 36 00

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes:
   1. Requirements for an exterior, building and gantry lightning protection system, including toll equipment and related installations.

1.3 REFERENCES

A. Lightning Protection Institute (LPI):
   1. LPI 175, Lightning Protection Institute Installation Code.

B. National Fire Protection Association (NFPA):
   1. NFPA 780, Lightning Protection Systems.

C. Underwriters Laboratories (UL):
   1. UL 96, Lightning Protection Components.
   2. UL 96A, Installation Requirements for Lightning Protection Systems.

1.4 SYSTEM DESCRIPTION

A. Provide a system consisting of a complete cable network on the roof and gantry structure including all air terminals, splices, and bonds; and with cable down leads, concealed either directly in the building construction or in conduit, routed to ground.

B. The Work of the Section shall be coordinated with the Work of the roofing and gantry installation. No work will be permitted which would void the roofing warranty.

C. The structures to be protected include each ETC equipment hut building and gantry.

D. The Work of this Section shall be coordinated with Section 26 05 26, Grounding and Bonding.

1.5 PERFORMANCE REQUIREMENTS

A. Provide a complete, functional, and unobtrusive lightning protection system as specified herein, shown on the Contract Drawings, and approved by the Engineer.

1. Provide the standard product of a manufacturer regularly engaged in the production of lightning protection systems.
   a. Provide the manufacturer's latest approved design.
2. Observe the limitations on areas of usage for aluminum cables and for copper and aluminum materials together as outlined in NFPA 780 and LPI 175.
3. Install all systems in conformance with UL 96A requirements.
4. Protect equipment on stacks and chimneys from corrosion, and size the equipment in accordance with LPI and UL requirements.

B. Install all equipment in a neat workmanlike manner in the most inconspicuous manner possible.

C. All work shall be concealed to the greatest extent possible. All down leads shall be concealed. No conduit or cable will be permitted to be installed on any vertical face of the building exterior. The locations of the down leads shall be identified, coordinated and submitted for approval prior to the construction of the building. Any work installed on the exterior face of the building face will be removed and relocated at the Contractor' expense.

D. A pre-installation conference shall be conducted for the work of this Specification Section.

1.6 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:
   1. Product data for the materials and equipment used as a part the work of this Section.
   2. Shop Drawings showing the type, size, and locations of all equipment, grounds, cable routings, and other items required to provide a complete and operational lightning protection system.
   3. Lightning protection system manufacturer's qualifications.
   4. Lightning protection system installer's qualifications.

B. Upon completion of the installation, submit the following information in accordance with the requirements of Section 01 78 00, Closeout Submittals:
   1. As-built Shop Drawings for the lightning protections system.
   2. UL Master Label Certificate

1.7 QUALITY ASSURANCE

A. The lightning protection installer shall be certified by the Lightning Protection Institute (LPI) as a Master Installer/Designer (MID)

B. Provide a lightning protection system that conforms to the requirements of the Lightning Protection Institute and Underwriter's Laboratories Standards for lightning protection systems.
   1. Provide LPI System Certification.
   2. Upon completion of the installation provide a Master Label from Underwriters Laboratory lightning protection certification program.
   3. The system manufacturer must be a UL listed and approved manufacturer.
   4. The system manufacturer must be a fully certified manufacturer member in good standing of the Lightning Protection Institute.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide lightning protection equipment manufactured by the one of the following manufacturers:
   1. Thompson Lightning Protection, Inc.,
   2. Harger Lightning Protection, Inc.,
   3. Heary Brothers Lightning Protection Co., Inc.,
   4. Ace Lightning Protection Co., Inc.,
   5. Larson Lightning Protection.
   6. Robbins Lighting, Inc.
   7. Approved equal.

2.2 MATERIALS

A. Provide copper or aluminum materials as described herein that conform to the requirements of UL 96; and of the size, weight, and construction to suit the application indicated in accordance with LPI and NFPA Code requirements.

B. Conductors:
   1. Roof Conductors: Provide UL listed conductors sized as required.
   2. Down Conductors from Roof to Ground: Provide conductors sized as required.

C. Air Terminals:
   1. Perimeter or Roof Ridge Air Terminals: 1/2 inch (13mm) by 18 inch (450mm) solid aluminum.
   2. Air Terminal Bases: Cast aluminum with bolt pressure cable connections.
      a. Crimp type connectors are not acceptable.
      b. Surface Contact Area: 18.5 square inches (120 square cm) minimum.

D. Ground Rods: Provide copper clad or stainless steel ground rods as indicated on the drawings, 3/4 inch diameter by 10’-0” long (minimum) conforming to the requirements of Specification Section 26 05 26, Grounding and Bonding.

E. Hardware:
   1. Conductor Fasteners: Provide an approved type of non-corrosive metal fasteners having ample strength to support the conductors.
   2. Bonding Devices, Cable Splicers, and Miscellaneous Connectors: Provide cast aluminum devices with bolt pressure connections to cable.
      a. Cast or stamped crimp fittings are not acceptable.
   3. Miscellaneous Fasteners: Provide stainless steel bolts, nuts and screws.

F. Conduit and Conduit Fittings: Provide Schedule 40 PVC conduit conforming to NEMA TC-2, with fittings conforming to NEMA TC-3, and both conforming to the requirements of Specification Section 26 05 33.13, Conduit and Boxes.

G. Exo-Thermic Welded Connectors:
   1. Provide molds, thermite packages, and other material for exo-thermic welds that are full-rated to carry 100 percent of cable rating and which are letter-coded exo-thermionic welded type.

a. Provide the molds, thermite packages, and other material from a single manufacturer throughout the project.
b. Acceptable manufacturers are as follows:
   1) Cadweld.
   2) Thermoweld.
   3) Alltec.
   4) Approved Equal

2. Provide items for connections of cable to ground-rod.

H. Provide additional materials to complete a functional system per the lightning protection system manufacturer's recommendations.

PART 3 EXECUTION

3.1 ACCEPTABLE INSTALLERS

A. Employ an experienced installer who is a Certified Master Installer recognized by UL and the LPI, or working under the direct supervision of an LPI manufacturer as listed above, or his authorized LPI Certified Master Installer representative.

3.2 INSTALLATION

A. Air Terminal Installation:
   1. Locate and space air terminals according to LPI and NFPA requirements.
      a. Do not space air terminals more than 20 feet (6m) apart around the outside perimeter or the ridge of the roof, and not over 50 feet (15m) apart through the center of flat roof areas unless approved by the Engineer.
   2. Extend air terminals at least 18 inches (450mm) above the object to be protected.
   3. Securely mount air terminal bases with stainless steel screws or bolts, except secure all air terminal bases in flat roof areas with adhesive in accordance with the roofing manufacturer's recommendations.

B. Conductor Installation:
   1. Install conductors in accordance with the UL Code.
   2. Install a perimeter cable around the entire main roof.
   3. Connect each perimeter cable to at least two down leads to provide a two way path to ground from each air terminal.
   4. Interconnect all center roof air terminals with conductors to the outside perimeter cable.
   5. Conductors on flat roof areas may be run exposed.
   6. Make ground connections both around the perimeter of each roof and to the main down conductor at 100'-0" (30m) on center, maximum.
   7. Install conductor fasteners spaced not to exceed 3 feet (91cm) on center.
   8. Conceal all down.
   9. Seal all conduit openings.
   10. Enclose single ground wires in conduit and conduit fittings without other circuit conductors:

C. Bond all metallic objects on the roof to the lightning protection system as required by NFPA 780.

D. Aluminum to Copper Downlead Connections:
   1. Provide an approved transition bimetal fitting at the roof level to transition from aluminum roof conductor to copper down lead cable.

E. Ground Terminal Installation:
   1. Locate grounding terminals at the base of the structure.
   2. Coordinate with building grounding electrode system.

F. Ground Wire to Ground Rod Connections:
   1. Exothermically weld ground wires to ground rods.
   2. Assure freedom from pin-holes and holidays in coating.

G. Ground Wire to Equipment Connections:
   1. Connect ground wires to equipment using two-hole compression type lugs.
   2. On ground lugs and studs, clean all paint, grease, and other similar insulating materials from contact points.
   3. Clean all wires to a bright finish prior to connection.

3.3 INTERFACE WITH OTHER WORK

A. Coordinate installation of the lightning protection with other trades to insure a correct, neat, and unobtrusive installation.

END OF SECTION 26 41 13

SECTION 26 43 13 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes: The work specified in this Section consists of materials for furnishing, installing, connecting and energizing enclosed surge protective devices (SPDs).

1.3 REFERENCES

A. National Fire Protection Association (NFPA)
   1. NFPA 70: National Electrical Code Article 285

B. Underwriters Laboratories (UL)
   1. ANSI/UL 1449-Third (3rd) Edition: UL Standard for Safety for Surge Protective Devices

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of Section 26 05 00 Common Results for Electrical Work:
   1. Manufacturer's product data sheets.
   2. Wiring and connection details.
   3. Verification the SPD complies with the listing requirements of ANSI/UL 1449-Third (3rd) edition.

1.5 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

1.6 WARRANTY

A. The Manufacturer shall provide a limited five-year warranty from date of shipment against failure when installed in compliance with manufacturer's written instructions.

PART 2 PRODUCTS

2.1 VOLTAGE SURGE SUPRESSION

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 125% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage.

6. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum VPR for the device shall not exceed the following:

MODES	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

B. SPD Design

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV.
3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.

4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
   a) Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
   b) Remote Status Monitor – Provide Form C dry contacts (one NO and one NC) for remote annunciation of its status.
   c) Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
   d) Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter.
6. Overcurrent Protection
   a) The unit shall contain thermally protected MOVs. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

2.2 SYSTEM APPLICATION

1. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown on the Contract Drawings.

2.3 ACCEPTABLE MANUFACTURERS

1. Advanced Protection Technologies (APT)
2. Eaton
3. Square D
4. Siemens
5. Approved Equal

PART 3 EXECUTION

3.1 INSTALLATION

A. The surge protective devices shall be installed in accordance their product listing requirements and with the manufacturer's instructions.

B. Contractor shall connect the surge protection device in parallel to the power source, keeping conductors as short and straight as practically possible.

C. When installed to an electrical distribution panelboard, the unit shall be close nippled to the panel and be supplied a circuit breaker as indicated on the Contract Drawings.

END OF SECTION 26 43 13

SECTION 26 50 00 - LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

B. Section 26 05 00- Common Results for Electrical Work with all referenced related sections.

1.2 SUMMARY

A. Section Includes:
   1. Requirements for normal and emergency egress lighting equipment, components, and related installation.

1.3 REFERENCES

A. American National Standards Institute (ANSI).
   1. ANSI C81.64, Guidelines and General Information for Electrical Lamp Bases, Lampholders and Gauges.
   2. ANSI C81.64a, Electric Lamp Bases and Holders - Guidelines and General Information for Electrical Lamp Bases, Lampholders and Gauges.
   3. ANSI C82.1, Specifications for Fluorescent Lamp Ballasts.
   4. ANSI C82.1d, Electric Lamps – Paragraphs 5.3.3 and 5.5.3: Compact Fluorescent Lamp Ballasts.
   5. ANSI C82.1e, Fluorescent Lamps – Specifications for Fluorescent Lamp Ballasts.
   6. ANSI C82.2, Fluorescent Lamp Ballasts, Methods of Measurement of.
   7. ANSI C82.2a, Fluorescent Lamps - Methods of Measurement.
   8. ANSI C82.3, Fluorescent Lamp Reference Ballasts, Specifications for.
   9. ANSI C82.11, High-Frequency Fluorescent Lamp Ballasts.
   10. ANSI C82.11b, Lamp Ballasts - Specifications for High-Frequency Fluorescent Lamp Ballasts - Line Transient Requirements.
   11. ANSI C82.12, Lamp Ballasts - Ballasted Adaptors.
   12. ANSI C82.13, Fluorescent Lamps and Ballasts - Definitions.
   13. ANSI C82.77, Lamp Ballasts - Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment.

B. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).

C. Underwriter's Laboratories, Inc. (UL):
   1. UL 496, Lampholders.
   2. UL 773, Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting.

3. UL 924, Standard for Emergency Lighting and Power Equipment.
4. UL 935, Standard for Fluorescent-Lamp Ballasts.
5. UL 1598, Luminaires.

1.4 DESIGN REQUIREMENTS

A. Design Criteria:
   1. The Lighting Fixture Schedule on the Contract Drawings constitutes the basis of the lighting design for this Contract, but may not indicate the special design details required.
      a. The Lighting Fixture Schedule includes the lighting fixture descriptions, fixture manufacturers, and corresponding model numbers.
      b. The lighting fixtures as scheduled meet the requirements of the lighting design for this Contract with respect to the visible style, number of lamps, and lenses desired.
   2. Provide lighting fixtures meeting the requirements of the basis of the lighting design for this Contract, and which have the special details specified in this Section.
      a. Submit Shop Drawings and manufacturer's installation instructions to show details of assemblies and sub-assemblies, and specially-fabricated supporting and fastening devices.
      b. Submit bills of material for the fixtures and their appurtenances.
         1) Reference the bills of material to the Shop Drawings.
         2) Identify each part with a part number and/or manufacturer number.
      c. Provide fixtures for exterior installation that are designed to be completely waterproof.
      d. Provide luminaire brackets designed to be compatible with configuration of the luminaire.
   3. Prior to providing light fixtures substituted for the fixtures identified in the Lighting Fixture Schedule on the Contract Drawings, submit the following information to obtain the Engineer's approval to substitute the fixtures:
      a. The manufacturer's catalog cuts indicating the type, design, dimensions, mounting arrangement, and other industry standard lighting fixture information.
         1) Describe the lighting fixtures, exit signs, emergency battery units, and appurtenances.
      b. Manufacturer's photometric data, distribution curves, isolux charts, glare factor data, and coefficient of utilization.
      c. Calculations showing the substituted fixture is equivalent to the named fixture, including lighting level, Visual Comfort Performance (VCP), glare, Equivalent Sphere Illumination, and energy usage, and showing that the fixture is suitable for the location where it will be installed.

1.5 SUBMITTALS

1. Section 26 05 00 - Common Results for Electrical Work with all referenced related sections.
2. Product Data:
   a. Luminaire fixture cuts
   b. Ballast catalog cuts
   c. Photometric data
3. Shop Drawings:
   a. Bills of material

4. Quality Assurance/Quality Control Submittals:
   a. Design Calculations demonstrating that substituted fixtures are equivalent to the named fixtures.

1.6 QUALITY ASSURANCE

A. Refer to Section 26 05 00, Common Results for Electrical Work.

1.7 EXTRA MATERIALS

A. Lamps:
   1. For the lighting fixtures furnished, provide an additional 10 percent of each lamp type specified over the quantity required to initially lamp the fixtures furnished.

B. Maintenance Tools:
   1. Provide two each of the special maintenance tools as may be necessary for re-lamping fixtures and for fixture maintenance.

C. As the equipment for which the extra materials can be used is substantially completed, turn the extra materials for that equipment over to the Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The manufacturers of the fixtures that were used as the basis for the lighting design for this Contract are listed in the Lighting Fixture Schedule on the Contract Drawings.
   1. The manufacturers' fixture descriptions and corresponding fixture model numbers are also listed in the Lighting Fixture Schedule.
   2. Additional manufacturers who can provide products comparable to those provided by the manufacturers listed and whose products the Contractor proposes to use for this Contract must first be submitted to and receive the approval of the Engineer prior to being substituted for the listed manufacturers.

2.2 MANUFACTURED UNITS

A. Light Fixtures:
   1. All lighting fixture shall be UL listed and labeled.
   2. Provide those fixtures indicated on the Luminaire Schedule on the Contract Drawings or approved substitutions.
   3. Fixture Grounding Device and Conductor:
      a. Provide the housing of each fixture with a separate, factory-installed grounding device and ground conductor.
   4. Exterior Fixtures:
      a. Factory-equip fixtures intended for exterior installation with waterproof gaskets and anodized aluminum frames unless indicated otherwise on the Contract Drawings.
         1) Provide outlet boxes, neoprene gaskets, and stainless steel hardware to render the exterior fixture installation waterproof.

b. Finish:
1) Provide fixtures for exterior installation with a finish free of scratches and other surface blemishes.
c. Brackets:
1) Provide brackets of the type and style indicated or scheduled on the Contract Drawings and color matched to the light fixture.

B. Lamps:
1. Provide the proper type of lamps for the lighting fixtures scheduled on the Contract Drawings or indicated on the approved Shop Drawings.
a. Match the voltages of fluorescent and HID lamps to installed fixtures.
b. Provide lamps having the proper type of sockets to suit the fixtures provided.
2. Basis of design lamp characteristics:
a. Fluorescent T5 Lamps: low mercury content, T5 lamps having a minimum CRI of 85, color temperature of as indicated on the Contract Drawings and suitable for operation with electronic ballasts or as otherwise specified. Minimum expected life (w/ 12 hour start) shall be 36,000 hours.
b. Fluorescent T8 Lamps: low mercury content, T8 lamps having a minimum CRI of 86, color temperature as indicated on the Contract Drawings and suitable for operation with electronic ballasts or as otherwise specified. Minimum expected life (w/ 12 hour start) shall be 24,000 hours.
c. Compact Fluorescent Lamps: minimum CRI of 82, color temperature as indicated on the Contract Drawings, suitable for operation with electronic ballasts or as otherwise specified. Minimum expected life (w/ 12 hour start) shall be 20,000 hours. Compact Fluorescent lamps that are to be dimmed shall be coordinated with the dimming ballast manufacturer and shall be supplied with pin configuration per the manufacturer.
d. Acceptable Manufacturers:
1) General Electric
a) Ecolux series for T5/T8 lamps
b) SPX series for Compact Fluorescent
2) Osram Sylvania
3) Philips
4) Approved Equal

C. Lighting Fixture Ballasts:
1. Provide UL listed and certified lighting fixture ballasts that meet the requirements of the National Appliance Energy Conservation Act of 1988 and all amendments thereto.
2. Provide lighting fixture ballasts in accordance with the requirements of the standard ballast specifications established by ANSI.
a. Fluorescent Ballasts:
1) Provide lighting fixtures equipped with electronic program rapid start type or instant start type ballasts as shown on the Contract Drawings.
2) Ballasts to be UL listed, Class P, program rapid start, input current total harmonic distortion not to exceed 10 percent, be of the low noise level, multi-lamp capacity, to have an average lamp current crest factor of 1.7, a power factor of 90 percent or above, to have a frequency of operation of 42 KHz or greater and be stroboscopic corrected.
3) Ballasts shall comply with ANSI C62.41 Category A for transient protection.

4) Ground ballasts in accordance with NEC and provide in-fixture automatic resetting thermal protection for ballasts and capacitors.
5) Ballast shall provide lamp end of life protection circuit which meets NEMA recommendations.
6) Acceptable Manufacturers:
   a) Philips Advance
   b) General Electric
   c) Universal Lighting Technologies
   d) Approved Equal

D. LED Lighting Fixtures (excluding LED exit signs)
1. Drivers shall not exceed 350mA unless specifically noted otherwise on the lighting fixture schedule. Drivers shall have a Class A sound rating.
2. LED Light fixtures shall have a minimum expected life of 50,000 hours. The aforementioned life rating must be conducted with a 40 degrees calcium ambient temperature.
3. Power Factor: The LED fixture shall have a power factor of 0.90 or greater.
4. Total Harmonic Distortion induced into the AC power line by the luminaire shall not exceed 20 percent.
5. Surge Suppression: The LED fixture on-board circuitry shall include surge protective devices to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. The SPD shall protect the luminaire from damage and failure for common mode transient peak voltages up to 10 kV (minimum) and transient peak currents up to 5 kA (minimum). SPD shall conform to UL 1449 depending of the components used in the design. SPD performance shall be tested per the procedures in ANSI/IEEE C62.41-1992 (or current edition) for category A (standard). The SPD shall fail in such a way as the Luminaire will no longer operate. The SPD shall be field replaceable.
6. Operational Performance: the LED circuitry shall prevent visible flicker.
7. Thermal Management: The thermal management (of the heat generated by the LED's) shall be of sufficient capacity to assure the proper operation of the luminaire over the expected useful life. Thermal management shall be by passive design – the use of fans or other mechanical devices is not allowed.

E. Luminaire Brackets:
1. Provide luminaire brackets fabricated to be compatible with the configuration of the luminaire.

F. Boxes, Gaskets, Hardware, and Support Devices:
1. Provide outlet boxes, neoprene gaskets, and stainless steel hardware to render the installation of the lighting waterproof.
   a. Provide waterproof splice kits where required.
2. Supply pendant stems, special mounting supports and hardware, and miscellaneous materials and incidentals required to install the lighting and emergency battery unit products in place.
3. Provide neoprene spacers for maintaining clearance between lighting and emergency battery unit products and concrete, mortar, and other masonry surfaces.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all luminaires in accordance with the product listing requirements.

B. Assemble lighting fixtures if required; and install and wire the lighting fixtures, supports, brackets, and accessories at the locations and mounting heights indicated on the Contract Drawings.
   1. Ground the lighting fixtures in accordance with the requirements of Article 410 of NFPA 70 (NEC) and Section 26 05 26.

C. Recessed Fixture Installation:
   1. Support recessed fixtures on the ceiling system's structural elements rather than its surface materials such as tiles, plaster, drywall, or similar surfaces.
      a. Use the mounting yokes furnished with the fixtures.
   2. If the fixture is to be installed in modular tile ceilings, locate the fixture in the center of the ceiling panel unless indicated otherwise.
      a. Refer to the Architectural Reflected Ceiling Plan included in the Contract Drawings for modular tile ceiling layouts.
   3. If light leaks through gaps between the recessed fixture trim and the adjacent surface, install suitable sealing gaskets.

D. Exposed Fixture Installation:
   1. Install surface mounted and exposed fixtures as indicated on the Contract Drawings.
      a. Hang suspended fixtures plumb, with continuous rows of fixtures in alignment.
      b. Mount suspended fixtures in each room or area at the same height regardless of varying clear height conditions unless otherwise indicated on the Contract Drawings.
      c. Install surface mounted fixtures tight up against the substrate to eliminate gaps except where NFPA 70 (NEC) or local code restrictions require a separation between the fixtures and substrate.

   2. Exit Fixture Installation:
      a. Install exit fixtures for doors directly over the doorways as indicated on the Contract Drawings
      b. Center the fixtures over the doorways, and install the fixtures to clear the door and associated hardware.

3.2 INTERFACE WITH OTHER WORK

A. Verify the locations and clearances of other installed or proposed work, and coordinate lighting fixture installations accordingly.

B. Coordinate the installation of lighting fixtures with all building systems and components to avoid any installation conflicts.

3.3 CLEANING

A. Clean new lighting fixtures by following the cleaning procedures as recommended by the fixture manufacturer:
   1. Use only those products for cleaning as recommended in the fixture manufacturer's literature.

END OF SECTION 265000