NEW HAVEN RAIL YARD FACILITIES IMPROVEMENTS

NEW HAVEN RAIL YARD
New Haven, CT

MAINTENANCE OF WAY BUILDING

SPECIFICATIONS

(VOLUME 2 OF 3)

April 2015

STATE PROJECT NO. 0301-0124

Prepared For:

Connecticut Department of Transportation
2800 Berlin Turnpike
Newington, Connecticut 06131-7546

Submitted by:

Parsons Brinckerhoff
500 Winding Brook Drive
Glastonbury, Connecticut 06033

SECTION 00 01 01 - PROJECT TITLE PAGE

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END OF PROJECT TITLE PAGE

SECTION 00 01 11 - TABLE OF CONTENTS

VOLUME 1

DIVISION 00 – INFORMATION AND CONTRACTING REQUIREMENTS

00 01 01	PROJECT TITLE PAGE
00 01 11	TABLE OF CONTENTS
00 31 00	AVAILABLE PROJECT INFORMATION
00 73 93	ENVIRONMENTAL HEALTH AND SAFETY REQUIREMENTS*

DIVISION 01 - GENERAL REQUIREMENTS

01 11 00	SUMMARY OF WORK
01 18 13	UTILITY SERVICE CONNECTIONS
01 20 00	CONTRACT CONSIDERATIONS
01 25 00	SUBSTITUTION PROCEDURES
01 26 00	CONTRACT MODIFICATION PROCEDURES
01 29 76	PROGRESS PAYMENT PROCEDURES
01 31 00	PROJECT MANAGEMENT AND COORDINATION
01 31 19	PROJECT MEETINGS
01 32 16.13	CPM SCHEDULES
01 32 33	PHOTOGRAPHIC DOCUMENTATION
01 33 00	SUBMITTAL PROCEDURES
01 33 00.13	DOCUMENT CONTROL**
01 35 13	SPECIAL PRODUCT PROCEDURES
01 35 26	GOVERNMENT SAFETY REQUIREMENTS
01 42 20	REFERENCE STANDARDS AND DEFINITIONS
01 45 00	QUALITY CONTROL
01 45 23.13	TESTING FOR INDOOR AIR QUALITY, BASELINE INDOOR AIR QUALITY AND MATERIALS
01 50 00	TEMPORARY FACILITIES AND CONTROLS
01 51 33	TEMPORARY TELECOMMUNICATIONS
01 51 39	TEMPORARY SUPPORT OF UTILITIES
01 55 26	TRAFFIC CONTROL
01 55 26.13	TRAFFIC PERSON
01 57 13	TEMPORARY EROSION AND SEDIMENT CONTROL
01 57 26	SITE WATERING FOR DUST CONTROL
01 57 30	INDOOR ENVIRONMENTAL CONTROL
01 57 40	CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT PLAN
01 60 00	PRODUCT REQUIREMENTS
01 71 23	FIELD ENGINEERING
01 71 23.16	CONSTRUCTION SURVEYING
01 73 29	CUTTING AND PATCHING
01 74 19	CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
01 75 00	STARTING AND ADJUSTING
01 77 00	CLOSEOUT PROCEDURES
01 78 23	OPERATION AND MAINTENANCE DATA

01 78 30 WARRANTIES AND BONDS
01 81 13 SUSTAINABLE DESIGN REQUIREMENTS
01 91 00 COMMISSIONING *

DIVISION 02 – EXISTING CONDITIONS

02 22 26 DUCT BANK ASSESSMENT
02 41 13 SELECTIVE SITE DEMOLITION
02 41 13.23 UTILITY LINE REMOVAL
02 41 13.33 RAILTRACK REMOVAL
02 41 19.01 REMOVE POLE
02 67 00 REMOVAL AND DISPOSAL OF CONTAMINATED RAIL ROAD TIES *

DIVISION 03 - CONCRETE

03 05 05 UNDERSLAB VAPOR BARRIER
03 10 00 CONCRETE FORMING AND ACCESSORIES
03 20 00 CONCRETE REINFORCING
03 30 00 CAST-IN-PLACE CONCRETE
03 30 10 CONCRETE FLOOR HARDENER
03 36 00 CONCRETE FLOOR FINISHES

DIVISION 04 - MASONRY

04 05 11 MASONRY MORTARING AND GROUTING
04 20 01 MASONRY VENEER
04 27 31 REINFORCED UNIT MASONRY

DIVISION 05 - METALS

05 12 00 STRUCTURAL STEEL FRAMING
05 21 00 STEEL JOIST FRAMING
05 31 00 STEEL DECKING
05 40 00 COLD-FORMED METAL FRAMING
05 50 00 METAL FABRICATIONS
05 51 00 METAL STAIRS
05 52 13 PIPE AND TUBE RAILINGS
05 53 05 METAL GRATINGS AND FLOOR PLATES

VOLUME 2

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

06 10 00 ROUGH CARPENTRY
06 41 00 ARCHITECTURAL WOOD CASEWORK
06 61 00 SOLID POLYMER SURFACING FABRICATIONS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 05 23 AIR BARRIER SYSTEM PRESSURE TESTING
07 08 00 COMMISSIONING OF THERMAL AND MOISTURE PROTECTION *
07 14 00 FLUID-APPLIED WATERPROOFING
07 21 00 THERMAL INSULATION
07 25 00 AIR BARRIER SYSTEM
07 41 13 METAL ROOF PANELS
07 42 13 METAL WALL PANELS
07 42 64 ALUMINUM COMPOSITE MATERIAL WALL PANELS
07 54 00 THERMOPLASTIC MEMBRANE ROOFING
07 62 00 SHEET METAL FLASHING AND TRIM
07 72 00 ROOF ACCESSORIES
07 84 00 FIRESTOPPING
07 90 05 JOINT SEALERS

DIVISION 08 - OPENINGS

08 08 00 COMMISSIONING OF OPENINGS *
08 11 13 HOLLOW METAL DOORS AND FRAMES
08 31 00 ACCESS DOORS AND PANELS
08 33 23 OVERHEAD COILING DOORS
08 43 13 ALUMINUM-FRAMED STOREFRONTS
08 44 13 GLAZED ALUMINUM CURTAIN WALLS
08 62 23 TUBULAR SKYLIGHTS
08 71 00 DOOR HARDWARE
08 80 00 GLAZING

DIVISION 09 - FINISHES

09 21 16 GYPSUM BOARD ASSEMBLIES
09 22 16 NON-STRUCTURAL METAL FRAMING
09 30 00 TILING
09 51 00 ACOUSTICAL CEILINGS
09 65 00 RESILIENT FLOORING
09 68 13 TILE CARPETING
09 90 00 PAINTING AND COATING

DIVISION 10 - SPECIALTIES

10 11 01 VISUAL DISPLAY BOARDS
10 14 00 SIGNAGE
10 14 53 TRAFFIC SIGNAGE

10 21 13.16 SOLID PLASTIC TOILET COMPARTMENTS
10 22 13 WIRE MESH PARTITIONS
10 26 01 WALL AND CORNER GUARDS
10 28 00 TOILET, BATH, AND LAUNDRY ACCESSORIES
10 44 00 FIRE PROTECTION SPECIALTIES
10 51 00 LOCKERS
10 56 00 STORAGE EQUIPMENT
10 75 00 FLAGPOLE

DIVISION 11 - EQUIPMENT

11 06 00 EQUIPMENT SCHEDULE
11 11 36 VEHICLE CHARGING EQUIPMENT
11 13 13 LOADING DOCK BUMPERS
11 40 00 FOOD SERVICE EQUIPMENT
11 96 00 SHOP EQUIPMENT

DIVISION 12 - FURNISHINGS

12 24 00 WINDOW SHADES

DIVISION 13 – SPECIAL CONSTRUCTION

13 34 23.10 PRE-FABRICATED HAZARDOUS MATERIALS STORAGE STRUCTURES

DIVISION 14 – CONVEYING EQUIPMENT

14 20 10 PASSENGER ELEVATORS

DIVISION 21 – FIRE SUPPRESSION

21 05 00 COMMON WORK RESULTS FOR FIRE SUPPRESSION
21 05 17 SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING
21 05 18 ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING
21 05 48 VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT
21 13 13 AUTOMATIC SPRINKLER SYSTEM

DIVISION 22 – PLUMBING

22 00 00 PLUMBING
22 07 00 PLUMBING INSULATION
22 08 00 PLUMBING SYSTEMS COMMISSIONING *
22 13 13 FACILITY SANITARY SEWERS
22 13 73 FACILITY FLOOR DRAIN WATER TANKS

DIVISION 23 – HEATING, VENTILATION, AND AIR-CONDITIONING (HVAC)

23 05 00	COMMON WORK RESULTS FOR HVAC
23 05 13	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
23 05 17	SLEEVES AND SLEEVE SEALS FOR HVAC PIPING
23 05 29	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
23 05 48	VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT
23 05 53	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
23 05 93	TESTING, ADJUSTING, AND BALANCING FOR HVAC
23 07 13	DUCT INSULATION
23 08 00	HVAC SYSTEMS COMMISSIONING *
23 09 23	BUILDING AUTOMATION SYSTEM
23 23 00	REFRIGERANT PIPING
23 29 23	VARIABLE FREQUENCY DRIVES
23 31 13	METAL DUCTS
23 33 00	AIR DUCT ACCESSORIES
23 36 00	AIR TERMINAL UNITS
23 51 00	LISTED TYPE III VENTS
23 55 23	GAS-FIRED RADIANT HEATERS
23 74 13	PACKAGED OUTDOOR ROOFTOP AIR-HANDLING UNITS
23 74 33	ENERGY RECOVERY UNITS
23 81 26	SPLIT-SYSTEM AIR-CONDITIONERS

VOLUME 3

DIVISION 26 – ELECTRICAL

26 01 00	BASIC ELECTRICAL REQUIREMENTS
26 05 00	COMMON WORK RESULTS FOR ELECTRICAL
26 05 13.19	SITE - MEDIUM VOLTAGE CABLES
26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
26 05 33	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
26 05 43.13	CLEANING UNDERGROUND DUCTS
26 05 48	VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
26 05 53	IDENTIFICATION FOR ELECTRICAL SYSTEMS
26 05 73	OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
26 08 00	ELECTRICAL SYSTEMS COMMISSIONING *
26 09 23	LIGHTING CONTROL DEVICES
26 12 00	MEDIUM VOLTAGE TRANSFORMERS
26 13 00	MEDIUM VOLTAGE SWITCHGEAR
26 22 00	LOW-VOLTAGE TRANSFORMERS
26 24 16	PANELBOARDS
26 27 13	ELECTRICITY METERING
26 27 26	WIRING DEVICES
26 28 13	FUSES
26 28 16	ENCLOSED SWITCHES AND CIRCUIT BREAKERS
26 32 13	ENGINE GENERATORS
26 33 53	STATIC UNINTERRUPTIBLE POWER SUPPLY
26 36 00	TRANSFER SWITCHES
26 41 13	LIGHTNING PROTECTION FOR STRUCTURES
26 51 00	INTERIOR LIGHTING
26 56 26	SITE LIGHTING
26 56 29	SERVICE ENTRANCE AND CABINET
26 56 30	TEMPORARY ILLUMINATION UNIT

DIVISION 27 – COMMUNICATIONS

27 05 36	CABLE TRAYS FOR COMMUNICATIONS SYSTEMS
27 11 00	COMMUNICATIONS EQUIPMENT ROOM FITTINGS
27 13 00	COMMUNICATIONS BACKBONE CABLING
27 14 00	COMMUNICATIONS OUTSIDE PLANT CABLING
27 15 00	COMMUNICATIONS HORIZONTAL CABLING
27 51 16	PUBLIC ADDRESS SYSTEMS
27 51 23	INTERCOM SYSTEMS

DIVISION 28- ELECTRONIC SAFETY AND SECURITY

28 01 00	BASIC SECURITY SYSTEMS REQUIREMENTS
28 05 13	CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY
28 13 00	ACCESS CONTROL SYSTEM
28 23 00	VIDEO SURVEILLANCE SYSTEM
28 31 11	DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

DIVISION 31 – EARTHWORK

31 11 00	CLEARING AND GRUBBING
31 22 16.23	ROADWAY SUBGRADE FORMATION
31 23 16	EXCAVATION
31 23 16.13	TRENCHING
31 23 19	DEWATERING
31 23 23	FILL
31 23 23.14	PERVIOUS STRUCTURE BACKFILL
31 23 23.33	FLOWABLE FILL
31 35 19.17	GEOTEXTILE (SEPARATION - HIGH SURVIVABILITY)
31 41 00	SHORING
31 62 13.19	PRECAST PRESTRESSED CONCRETE PILES

DIVISION 32 – EXTERIOR IMPROVEMENTS

32 11 23	AGGREGATE BASE COURSES
32 12 16	ASPHALT PAVING
32 16 13.13	CAST-IN-PLACE CONCRETE CURBS AND GUTTERS
32 16 13.43	STONE CURBS
32 16 23.13	CONCRETE SIDEWALK
32 16 23.16	CONCRETE PAD
32 17 23.13	PAINTED PAVEMENT MARKINGS
32 17 26.01	RUMBLE STRIPS - MANUAL
32 31 13	CHAIN LINK FENCES AND GATES
32 33 13	SITE BICYCLE RACKS
32 33 43.23	SITE BOLLARDS
32 91 19.13	TOPSOIL PLACEMENT AND GRADING
32 92 19	SEEDING

DIVISION 33 - UTILITIES

33 01 30.16	TV INSPECTION OF SEWER PIPELINES
33 22 00	WATER DISTRIBUTION SYSTEM
33 41 10	PUMPING STATION
33 41 13	PUBLIC STORM UTILITY DRAINAGE PIPING
33 41 20	FORCE MAIN
33 44 19.21	HYDRODYNAMIC SEPARATOR
33 49 00	STORM DRAINAGE STRUCTURES
33 49 27	STORM DRAINAGE TIDEGATE MANHOLE

DIVISION 34 - TRANSPORTATION

34 11 26.13	TRACK RAIL BALLAST

DIVISION 41 – MATERIAL PROCESSING AND HANDLING EQUIPMENT

41 22 00	CRANES AND HOISTS
41 63 00	GENERAL VEHICLES

DIVISION 44 – POLLUTION CONTROL EQUIPMENT

44 11 16 INDUSTRIAL DUST COLLECTORS
44 11 37 FUME AND EXHAUST EXTRACTION SYSTEMS

* Not authored by Parsons Brinckerhoff
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END OF TABLE OF CONTENTS

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Roofing nailers.

B. Preservative treated wood materials.

C. Fire retardant treated wood materials.

D. Miscellaneous framing and exterior wall sheathing.

E. Communications and electrical room mounting boards.

F. Concealed wood blocking, nailers, and supports.

G. Miscellaneous wood nailers, furring, and grounds.

1.2 RELATED REQUIREMENTS

A. Section 07 72 00 - Roof Accessories: Prefabricated roof curbs.

1.3 SUBMITTALS

A. See Section 01 18 13 – Sustainable Design Requirements.

B. See Section 01 33 00 – Submittal Procedures and Section 01 33 00.13 – Document Control.

1.4 REFERENCE STANDARDS

A. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

B. ASTM D2898 Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 1999

C. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2013a.

D. AWPA U1 Use Category System: User Specification for Treated Wood; American Wood Protection Association; 2012.

E. PS 20 American Softwood Lumber Standard; National Institute of Standards and Technology, Department of Commerce; 2010.

1.5 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.

1. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.

2. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

B. Lumber fabricated from old growth timber is not permitted.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

A. Sizes: Nominal sizes as indicated on drawings, S4S.

B. Moisture Content: S-dry or MC19.

C. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:

1. Lumber: S4S, No. 2 or Standard Grade.

2. Boards: Standard or No. 3.

2.3 CONSTRUCTION PANELS

A. Wall Sheathing: Plywood, PS1, Grade C-C, Exterior Exposure.

B. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.4 ACCESSORIES

A. Fasteners and Anchors:

1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2. Anchors: Toggle bolt type for anchorage to hollow masonry.

2.5 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.

1. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

B. Preservative Treatment:

1. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.25 lb/cu ft retention.

a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.

b. Treat lumber in contact with roofing, flashing, or waterproofing.

c. Treat lumber in contact with masonry or concrete.

2. Preservative Pressure Treatment of Plywood Above Grade: AWPA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative to 0.25 lb/cu ft retention.

a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.

b. Treat plywood in contact with roofing, flashing, or waterproofing.

c. Treat plywood in contact with masonry or concrete.

C. Fire Retardant Treatment:

1. Manufacturers:

a. Arch Wood Protection, Inc: www.wolmanizedwood.com.

b. Hoover Treated Wood Products, Inc: www.frtw.com.

c. Osmose, Inc: www.osmose.com.

2. Exterior Type: AWPA U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.

a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.

b. Treat all exterior rough carpentry items.

c. Do not use treated wood in direct contact with the ground.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.2 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

B. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.

3.3 ROOF-RELATED CARPENTRY

A. Coordinate installation of roofing carpentry with roofing assembly installation.

B. Provide wood curb at all roof openings and as indicated on drawings except where prefabricated curbs are specified and where specifically indicated otherwise. Form corners by alternating lapping side members.

3.4 INSTALLATION OF CONSTRUCTION PANELS

A. Wall Sheathing: Secure with long dimension perpendicular to framing members, with ends staggered and over firm bearing, using screws.

B. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.

1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
3. Install adjacent boards without gaps.

END OF SECTION 06 10 00

SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Specially fabricated cabinet units.

B. Cabinet hardware.

C. Factory finishing.

D. Preparation for installing utilities.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Support framing, grounds, and concealed blocking.

B. Section 12 36 00 - Countertops.

1.3 REFERENCE STANDARDS

A. ASTM E84	Standard Test Method for Surface Burning Characteristics Of Building Materials; 2014
B. AWI/AWMAC/WI (AWS)	Architectural Woodwork Standards; 2009.
C. ANSI/BHMA A156.9	American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association; 2010 (ANSI/BHMA A156.9).
D. NEMA LD 3	High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Shop Drawings: Indicate architectural cabinet construction including notation of all fabrication and finish materials, component profiles, fastening methods, jointing details, and accessories.

C. Product Data: Provide data for hardware accessories and plastic laminate, to include adhesives.

D. Samples: Submit samples of proposed finish materials to include plastic laminate and melamine as applicable, 5-inch x 7-inch in size, along with samples of proposed pulls,

hinges, shelf standards, drawer glides and locksets demonstrating hardware design, quality and finish.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

B. Fire-test response characteristics: Provide decorative plastic laminate with the following surface burning characteristics as determined by testing identical products per ASTM E84 by UL or another testing agency acceptable to authorities having jurisdiction:
   1. Flame-spread index: 25 or less.
   2. Smoke developed index: 450 or less.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle and protect materials in accordance with manufacturers written instructions.
   1. Provide protective coverings of suitable materials. Take special precautions at corners.
   2. Protect units from moisture damage.

1.8 FIELD CONDITIONS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 - PRODUCTS

2.1 CABINETS

A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI//AWMAC/WI Architectural Woodwork Standards for Premium Grade.

B. Plastic Laminate Faced Cabinets: Custom grade.

2.2 LAMINATE MATERIALS

A. High Pressure Plastic Laminate: Formica, Natural Cherry #7737-58 or equal. www.formica.com.

B. Other acceptable Manufacturers:
   1. Panolam Industries International, Inc/Nevamar; www.nevamar.com.
   2. Wilsonart International, Inc; www.wilsonart.com.
   3 Substitutions: See Section 01 60 00 - Product Requirements.

C. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
   1. Grade: 10 or 20
   2. Surface burning characteristics in accordance with ASTM E84.

D. Provide specific types as scheduled.
   1. Horizontal Surfaces: HGS, 0.045 inch nominal thickness, colors as scheduled, finish as scheduled.
   2. Vertical Surfaces: VGS, 0.026 inch nominal thickness, colors as scheduled, finish as scheduled.
   3. Cabinet Liner: CLS, 0.020 inch nominal thickness, through color.
   4. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.4 ACCESSORIES

A. Adhesive: Type recommended by manufacturers written installation instructions to suit application.

B. Fasteners: Size and type to suit application.

C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.

D Concealed Joint Fasteners: Threaded steel.

2.5 HARDWARE

A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.

B. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.

C. Drawer and Door Pulls: "U" shaped wire pull, steel with brushed nickel finish, 4 inch centers, ADA Compliant.

D. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.

E. Drawer Glides:
   1. Type: Full extension.
   2. Static Load Capacity: Commercial grade, not less than 100 pounds.
   3. Mounting: Side mounted with appropriate quantity of screws for stability.
   4. Stops: Integral type with positive stops.
   5. Features: Provide self closing/stay closed type.

F. Hinges: European style concealed self-closing type, steel with polished finish to meet or exceed ANSI/BHMA A 156.9-2001 Grade 2 requirements.

2.6 FABRICATION

A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

B. Edging: Fit shelves, doors, and exposed edges with matching hardwood, laminate or 3mm PVC edging. Do not use more than one piece for any single length.

C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.

1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
2. Cap exposed plastic laminate finish edges with material of same finish and pattern.

E. Mechanically fasten back splash to countertops as recommended by laminate manufacturer at 16 inches on center and provide a silicone caulk bead between backsplash and wall finish.

F. Coordinate and provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges. See 22 00 00 Plumbing.

2.7 SHOP FINISHING

A. Finish work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards, Section 5 - Finishing for Grade specified and as follows:

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with work of this section.

3.2 INSTALLATION

A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

B. Use fixture attachments in concealed locations for wall mounted components.

C. Use concealed joint fasteners to align and secure adjoining cabinet units.

D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.

E. Secure cabinets to floor using appropriate angles and anchorages.

F. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.3 ADJUSTING

A. Adjust installed work.

3.4 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 06 41 00

SECTION 06 61 00 – SOLID POLYMER SURFACING FABRICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Countertops for manufactured casework.

B. Shower surround wall panel and shower pan units.

C. Solid surface floor transitions/thresholds.

D. Solid surface window stools.

1.2 RELATED REQUIREMENTS

A. Section 06 41 00 - Architectural Wood Casework.

B. Section 09 30 00 – Tiling.

1.3 REFERENCE STANDARDS

A. ISFA-2 Classification and Standards for Solid Surfacing Material; International Solid Surface Fabricators Association; 2001 (2007).

B. NEMA LD 3 High-Pressure Decorative Laminates; 2005.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.

2. Storage and handling requirements and recommendations.

3. Specimen warranty.

C. Shop Drawings: Complete details of materials and installation; combine countertop shop drawings with shop drawings for cabinets and casework specified in other sections.

D. Selection and Verification Samples: For each finish product specified, provide 4-inch x 4-inch samples of material representing proposed colors, patterns and texture options.

E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Same fabricator as for cabinets on which tops are to be installed. Shower surround wall panels and shower pan to be provided from a reputable fabricator with a minimum of 5 (five) years experience.

B. Installer Qualifications: Certified by Fabricator and with a minimum of 5 (five) years experience.

C. Complete field verification of all required material dimensions prior to preparing shop drawings for approval.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 - PRODUCTS

2.1 COUNTERTOP ASSEMBLIES

A. Solid Surfacing Countertops: solid, nonporous, homogeneous sheet material composed of 1/3 acrylic resin and 2/3 natural minerals, over continuous substrate. Manufacturer: Dupont Corian, Thyme; or equal.

1. Flat Sheet Thickness: 1/2-inch, minimum. Sheet size 144-inch x 30-inch.

2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA-2 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.

   a. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.

   b. Color and Pattern: As noted above and on drawings.

   c. Other Acceptable Manufacturers:
      1) Formica Corporation: www.formica.com.
      2) Avonite Surfaces: www.avonitesurfaces.com.
      3) Wilsonart International, Inc: www.wilsonart.com.

3. Other Components Thickness: 1/2 inch minimum; 1/4-inch at shower wall panels.

4. Exposed Edge Treatment: Built up to minimum 1-1/2 inch thick; bullnose edge; use marine edge at sinks.

5. Back and End Splashes: Same sheet material, Square top; minimum 4 inches high, 1/4-inch to 1/2-inch thickness as indicated on drawings loose, field attached. Caulk joints continuous.

6. Fungal, bacterial and boiling water resistance.

7. Flame spread and smoke developed index: ASTME E84: < 25.

8. Directional private collection follow fabrication technical guide (CTDC-143) and follow sheet veining. Pattern to run in same direction.

2.2 SHOWER SURROND WALL PANELS AND SHOWER PAN UNITS

A. Shower wall enclosures shall provide a system of solid polymer components to include: panels, corner trim, soap dish, shelves, panel edge trim, and shower pan. Dimensions of all components shall be as indicated on the drawings or standard manufacturer's standard 1/4-inch or 1/2-inch thick sheet product as indicated on drawings. Panels shall be full width and height with seams occurring only at the inside corners of the enclosure. Soap dish and shelves shall be of a configuration, shape and location as standard with the manufacturer's system. Shower pan dimension per drawings.

2.3 SOLID SURFACE FLOOR TRANSITIONS/THRESHOLDS

A. Provide solid surface transitions where porcelain tile floor meets another floor finish. Material thickness to the 1/2-inch and compliant with ADA transition standards. Width to be 4-inches by length as required to span door or wall opening and transition length. Color as indicated on drawings.

2.4 SOLID SURFACE WINDOW STOOLS

A. Fabricate window stools from 1/2-inch thick solid surfacing, solid polymer material as indicated on drawings. Dimensions, edge shape, and other details shall be selected from manufacturer's available pre-fabricated standards.

2.5 TRIM AND ACCESSORY MATERIALS

A. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

b. Waterproofing membrane, Schluter, Ditra, or equal. Pressure stable polyethylene membrane, vacuum-formed in a cut back grid design, with an anchoring fleece laminated to its underside; 1/8-inch, emits zero VOC. Membrane to be installed on floors and walls at shower and towel drying area portions of toilet room (only). Coordinate with 09 30 00 - Tiling.

2.6 FABRICATION

A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.

1. Join lengths of tops using best method recommended by manufacturer.

2. Fabricate to overhang fronts and ends of cabinets 1-inch except where top butts against cabinet or wall.

3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.

B. Provide back/side splash wherever counter edge abuts vertical surface unless otherwise indicated.

1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.

2. Height: 4-inches, unless otherwise indicated.

C. Provide skirts, aprons, brackets, and braces for wall-mounted counters as indicated on drawings, finished to match.

D. Fabricate shower surround panels most practical and economical sheet size possible to minimize joints.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely attach units to substrate using concealed fasteners. Make flat surfaces level; shim where required.

B. Seal joint between back/side splashes and adjacent vertical wall surfaces, joint between window stool and adjacent walls and window sill, joint between shower surround wall panels and adjacent wall surface, and joint between shower pan and adjacent wall panels and wall surfaces.

3.2 CLEANING

A. Clean surfaces thoroughly following installation.

3.3 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 06 61 00

SECTION 07 05 23 AIR BARRIER SYSTEM PRESSURE TESTING

PART 1 GENERAL

1.1 SECTION INCLUDES

Requirements for an independent agency to conduct the pressure test on the building envelope in accordance with this specification section and ASTM E779.

1.2 RELATED REQUIREMENTS

A. Section 07 25 00 – Building Air Barrier System

1.3 REFERENCE STANDARDS

A. ANSI/ASNT CP-189	(2011) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel (ANSI/ASNT CP-105-2006)
B. ASNT CP-105	(2011) ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel - Item No. 2821
C. ASNT SNT-TC-1A	(2011; Text Correction 2013) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing
D. ASTM E1186	(2003; R 2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
E. ASTM E1827	(2011) Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
F. ASTM E779	(2010) Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
G. ISO 6781	(1983) Thermal Insulation - Qualitative Detection of Thermal Irregularities in Building Envelopes - Infrared Method

1.4 DEFINITIONS

The following terms as they apply to this section:

A. Air Barrier Envelope

The surface that separates the inside air from the outside air. The combination of air barrier assemblies and air barrier components, connected by air barrier accessories are designed to provide a continuous barrier to the movement of air through an environmental separator. A single building may have more than one air barrier envelope. The air barrier surface includes the top, bottom, and sides of the envelope. The term "air barrier envelope" is also known as "air barrier system" or simply "air barrier".

B. Air Leakage Rate

How leaky, or conversely how air tight a building envelope is. The air leakage is normally described in terms of air flow rate for the surface area of the envelope at a defined differential pressure.

C. Bias Pressure

Also known as zero flow pressure, baseline pressure, offset pressure or background pressure. With the envelope not artificially pressurized, bias is the differential pressure that always exists between the envelope that has been prepared (sealed) for the pressure test and the outdoors. Bias pressure is made up of two components, fixed static offset (usually due to stack effect or the HVAC system) and fluctuating pressure (usually due to wind or a moving elevator). Because of pressure fluctuations many bias pressure readings are recorded and averaged for use in the calculations.

D. Blower Door

Commonly used term for an apparatus used to pressurize and depressurize the space within the building envelope and quantify air leakage through the envelope. The blower door typically includes a door fan and an air resistant fabric or a series of hard panels that extends to cover and seal the door opening between the fan shroud and door frame. The door fan is a calibrated fan capable of measuring air flow and is usually placed in the opening of an exterior door. With the air barrier otherwise sealed, air produced by the door fan pressurizes or de-pressurizes the envelope, depending on the fan's orientation.

E. Environmental Separator

The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments. The term "environmental separator" is also known as the "control layer".

F. Pressure Test

A generic term for a test in which the envelope is either pressurized or de-pressurized with respect to the outdoors.

1. Negative Pressure Test (Depressurization Test)

   A test wherein air inside the envelope is drawn to the outdoors. This places the envelope at a lower (negative) pressure with respect to the outdoors.

2. Positive Pressure Test (Pressurization Test)

   A test wherein outdoor air is pushed into the envelope. This air movement places the envelope at a higher (positive) pressure with respect to the outdoors.

1.5 WORK PLAN

Submit the following not later than 120 calendar days before start of pressure testing work, steps to be taken by the lead pressure test technician to accomplish the required testing.

A. Memorandum of test procedure.

1. Proposed dates for conducting the pressure, thermographic and fog tests.

2. Submit detailed pressure test procedures prior to the test. Provide a plan view showing proposed locations (personnel doors or other similar openings) to install blower doors or flexible ducts (for trailer-mounted fans), if used.

B. Test equipment to be used.

C. Scaffolding, scissor lifts, power, electrical extension cords, duct tape, plastic sheeting and other Trade Contractor's support equipment required to perform all tests.

D. Other Trade Contractor's support personnel who will be on site for testing.

1.6 SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Work Plan

C. Product Data

1. Thermal Imaging Camera

D. Design Data Envelope Surface Area Calculations

E. Certificates

1. Pressure Test Agency
2. Thermographer Qualifications
3. Test Instruments
4. Date Of Last Calibration

F. Test Reports

1. Pressure Test Procedures

2. Air Leakage Test Report

3. Diagnostic Test Report

4. No later than 14 days after completion of the pressure test, submit 6 copies of an organized report bound in a durable 3-ring binder. The report is to contain a table of contents, an executive summary, an introduction, a results section and a discussion of the results. Submit the Air Leakage Test Report as described in paragraph AIR LEAKAGE TEST REPORT. Submit a diagnostic test report as described in paragraph LOCATING LEAKS BY

DIAGNOSTIC TESTING. The diagnostic test report is to include the Thermographic Investigation Report and the Fog Test Report.

5. Submit field data and completed report forms found in the appendices. Use the sample forms, Test Agency Qualification Sheet, Air Leakage Test Form and Air Leakage Test Results Form to summarize the tests for the appropriate building envelope. Submit both electronically populated and field hand filled-in forms.

6. Report Data. Include in the report the following information for all tests:

   a. Date of Issue

   b. Project title and number

   c. Name, address, and telephone number of testing agency

   d. Dates and locations of samples and tests or inspections

   e. Names of individuals making the inspection or test

   f. Designation of the work and test method

   g. Identification of product and Specification Section

   h. Complete inspection or test data

   i. Test results and an interpretation of test results

   j. Comments or professional opinion on whether inspected or tested work complies with trade contract document requirements

   k. Recommendations on retesting

1.7 QUALITY ASSURANCE

A. Modification of References

Perform all pressure and diagnostic tests according to the referenced publications listed in paragraph REFERENCE STANDARDS and as modified by this section. Consider the advisory or recommended provisions, of the referred references, as mandatory.

B. Qualifications

1. Pressure Test Agency

Submit, no later than 15 calendar days after trade contract award, information certifying that the pressure test agency is not affiliated with any other company participating in work on this trade contract. The work of the test agency is limited to pressure testing the building envelope, performing a thermography test and fog test, and investigating, through various methods, the location of air leaks through the air barrier. See paragraph 3.1 PRESSURE TEST AGENCY for additional requirements.

Use the sample TEST AGENCY QUALIFICATIONS SHEET form (Appendix C), to submit the following information.

a. Verification of 2 years of experience as an agency in pressure testing commercial and/or industrial buildings.

b. List of at least ten commercial/industrial facilities with building envelopes that the agency has tested within the past 2 years. Include building name, address, and name of prime construction trade contractor and trade contractor's point-of-contact information.

c. Confirmation of 2 years of commercial and or industrial building pressure test experience for the lead pressure test technician and the thermographer in using the specified ASTM E779 testing standard.

d. Verification that the lead pressure test technician has been employed by a building pressure testing agency in the capacity of a lead pressure test technician for not less than 1 year.

2. Thermographer Qualifications

To perform an infrared diagnostic evaluation, use a lead thermographer who has at least an active Level II Certification that is based on the requirements in ASNT CP-105 or ANSI/ASNT CP-189 and is in accordance with ASNT SNT-TC-1A. The course of study is to be specifically focused on infrared thermography for building science. The thermographer must have at least two years of building science thermography experience in IR testing commercial or industrial buildings. The thermographer must also have experience in building envelopes and building science in order to make effective recommendations to the trade contractor should the envelope require additional sealing. Submit the thermographer's certificate for approval. Submit a list of at least ten commercial/industrial buildings on which the thermographer has performed IR thermography in the past two years. The thermographer is to have a current active certification. Submit certification at least 60 days prior to thermography testing.

3. Test Instruments and Date Of Last Calibration

Submit a signed and dated list of test instruments, their application, manufacturer, model, serial number, range of operation, accuracy and date of most recent calibration.

1.8 CLIMATE CONDITIONS SUITABLE FOR A PRESSURE TEST

As the test date approaches, monitor the weather forecast for the test site. Avoid testing on days forecast to experience high winds, rain, or snow. Monitor weather forecasts prior to shipping pressure test equipment to the site. Preferred ambient weather test conditions as stated in ASTM E779 are 0 to 4 mph winds and an ambient temperature range of 41 - 95 degrees F. Based on current and forecast weather conditions, the Owner’s representative is to grant final approval for testing to occur.

A. Rain

Rain can temporarily seal roof and wall assemblies so that they leak less than under no-rain conditions. Do not test during rain or if rain is anticipated during testing. If pneumatic hoses are installed and exposed to rain inspect the hose to insure rainwater has not migrated into the hose ends. Orient all exposed hose ends to keep them out of water puddles. Success in temporarily sealing outdoor ventilation components such as louvers and exhaust fans may also be compromised by rain. Don't seal roof-mounted ventilation components during times of potential lightning.

B. Snow

Snow piled against a wall or on top of a roof can make a building envelope appear to be more airtight than it actually is. Snow may also impact thermography readings. Remove snow from around and on top of the building prior to testing.

C. Wind

Because wind can skew pressure test results, test only on days and at times when winds are anticipated to be the calmest. Avoid pressure testing during gusty or high wind conditions.

PART 2 PRODUCTS

2.1 PRESSURE TEST EQUIPMENT

Depending on site conditions and size of the envelope, the test may be conducted using blower door equipment and/or trailer-mounted fans. The testing agency is to supply sufficient quantity of blower equipment that will produce a minimum of 75 Pa differential pressure between the envelope and outdoors using the test methods described herein. Supplying additional blower test equipment to provide additional airflow capacity or to act as a backup is highly recommended.

A. Blower Door Fans and Trailer Mounted Fans

Each air flow measuring system including blower door fans and trailer mounted fans are to be calibrated within the last 3 years in accordance with ASTM E1827. Calibrated blower door fans and trailer mounted fans must measure accurately to within plus or minus 5 percent of the flow reading. Blower door equipment and trailer mounted fans are to be specifically designed to pressurize building envelopes. Each set of blower door equipment is to include fan(s), digital gage(s), door frame, door fabric or hard panels.

B. Digital Gages as Test Instruments

Use only digital gages as measuring instruments in the pressure test; analog gages are not acceptable. The gauges must be accurate to within 1.0 percent of the pressure reading or 0.15 Pa, whichever is greater. Each gage is to have been calibrated within two years of the test. The calibration is to be checked against a National Institute of Standards and Technology (NIST, formerly National Bureau of Standards) traceable standard.

2.2 THERMAL IMAGING CAMERA REQUIREMENTS

The thermal imaging camera used in the thermography test must have a thermal sensitivity (Noise Equivalent Temperature Difference.) of +/- 0.18 degrees F at 86 degrees F or less. Ensure the camera's operating spectral range falls between 2 and 15 micrometers. Ensure the camera's IR image viewing screen resolution measures at least 240x180 pixels. Ensure the camera has a means of recording thermal images seen on the camera viewing screen. The camera is to display output as individual still frame images that also can be downloaded and inserted into an electronic Thermographic Investigation Report. Submit camera make and model, and catalog information that defines the camera thermal sensitivity for approval.

PART 3 EXECUTION

3.1 PRESSURE TEST AGENCY

The test agency is to be an independent third party trade subcontractor, not an affiliated or subsidiary of the prime trade contractor, trade subcontractors or A/E firm. The agency is to be regularly engaged in pressure testing of commercial/industrial building envelopes. If using blower door or trailer-mounted fans, the lead test technician must have at least two years of experience in using such equipment in building envelope pressurization tests. Formal training using pressure test equipment is highly recommended.

A. Field Work

The lead pressure test technician and thermographer are to be present at the project site while testing is performed and is to be responsible for conducting, supervising, and managing of their respective test work. Management includes health and safety of test agency employees.

B. Reporting Work

The lead pressure test technician is to prepare, sign, and date the test agenda, equipment list, and submit a certified Air Leakage Test Report. The thermographer is to prepare, sign, and date the test agenda, equipment list, and submit a certified Thermographic Investigation Report. The trade contractor is to prepare a final report that identifies improvements that were made to the envelope to reduce leaks, mitigate thermal bridging, eliminate moisture migration, repair insulation voids discovered during diagnostic tests. Jointly submit all reports.

3.2 ENVELOPE SURFACE AREA CALCULATION

The architectural air barrier boundary includes the floor, walls, and ceiling. After construction of the air barrier envelope is complete, field measure the envelope to ensure the physical measurements match the design drawings and the air barrier envelope surface area calculations. If the measurements are not consistent with the defined air barrier boundary as indicated, re-calculate the envelope surface area and submit the envelope surface area calculation and results for review.

3.3 PREPARING THE BUILDING ENVELOPE FOR THE PRESSURE TEST

A. Testing During Construction

The pressure test cannot be conducted until all components of the air barrier system have been installed. After all sealing as described herein has been completed, inspect the envelope to ensure it has been adequately prepared. During the pressure test, stop all ongoing construction within and neighboring the envelope which may impact the test or the air barrier integrity. The pressure test may be conducted before finishes that are not part of the air barrier envelope have been installed. For example, if suspended ceiling tile, interior gypsum board or cladding systems are not part of the air barrier the test can be conducted before they are installed. Recommend testing prior to installing the finished ceilings within the envelope and immediately surrounding it. The absence of finished ceilings allows for inspection and diagnostic testing of the roof/wall interface and for implementation of repairs to the air barrier, if necessary to comply with the maximum allowed leakage.

B. Sealing The Air Barrier Envelope

Seal all penetrations through the air barrier. Unavoidable penetrations due to electrical boxes or conduit, plumbing, and other assemblies that are not air tight are to be made so by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly. Support the air barrier so as to withstand the maximum positive and negative air pressure to be placed on the building without displacement or damage, and transfer the load to the structure. Durably construct the air barrier to last the anticipated service life of the assembly and to withstand the maximum positive and negative pressures placed on it during pressure testing. Do not install lighting fixtures that are equipped with ventilation holes through the air barrier.

C. Sealing Plumbing

Prime all plumbing traps located within the envelope full of water.

D. Close and Lock Doors

Close and lock all doors and windows in the envelope perimeter. For doors not equipped with latching hardware, temporarily secure them in the closed position. Secure the doors in such a way that they remain fully closed even when the maximum anticipated differential air pressure produced during the test acts on them.

E. Hold Excluded Building Areas at the Outdoor Pressure Level

Keep building areas immediately surrounding but excluded from the test envelope at the outdoor pressure level during the pressure test. Maintain these areas at the outdoor pressure level by propping exterior doors open, opening windows and de-energizing all air moving devices in or serving these areas.

F. Maintain an Even Pressure within the Envelope

Ensure the pressure differences within the envelope are minimized by opening all internal air pathways including propping open all interior doors. Distribute test fans throughout the envelope as necessary to ensure the internal pressures are uniform (within 10 percent of the average differential pressure). Ideally, suspended ceilings will not be installed until after all pressure tests have been completed. If, however the envelope includes finished suspended ceiling spaces, temporarily remove approximately 5 percent of all ceiling tiles or a minimum of 1 tile from each isolated suspended ceiling space, whichever comprises the greatest surface area. Temporarily remove additional ceiling tiles during testing to allow for inspection and diagnostic testing of the ceiling/wall interface.

G. Maintain Access to Mechanical and Electrical Rooms

Maintain access to mechanical rooms and electrical rooms associated with the envelope to allow for de-energizing ventilation equipment and resetting circuit breakers tripped by blower door equipment, if used.

H. Minimize Potential for Blowing Dust and Debris

Because high velocity air may be blown into and out of the envelope during the test, debris, including dust and litter, may become airborne. Airborne debris may become trapped or entangled in test equipment, thereby skewing test results. Ensure areas within and surrounding the envelope are free of dust, litter and construction materials that are easily airborne. If pressurizing existing, occupied areas, provide adequate notice to building occupants of blowing dust and debris, and general disruption of normal activities during the test.

I. De-energize Air Moving Devices

De-energize all air moving devices serving the envelope to keep air within the envelope as still as reasonably achievable. De-energize all fans that deliver air to, exhaust air from, or recirculate air within the envelope. Also de-energize all fans serving areas adjacent to but excluded from the envelope.

J. Installing Blower Door Equipment in a Door Opening

Where blower door fans are used, before installing blower door equipment, select a door opening that does not restrict air flow into and out of the envelope and has at least 5 feet clear distance in front of and behind the door opening. Disconnect the door actuator and secure the door open to prevent it from being drawn into the fan by fan pressure.

3.4 BUILDING ENVELOPE AIR TIGHTNESS REQUIREMENT

For each building envelope, perform two pressure tests; the Architectural Only test and the Architectural Plus HVAC System test. The purpose of the pressure (air leakage) test is to determine final compliance with the airtightness requirement by demonstrating the performance of the continuous air barrier. An effective air barrier envelope minimizes infiltration and exfiltration through unintended air paths (leaks). The tests may be performed in any desired order.

A. Architectural Only Test

The test envelope is the architectural air barrier boundary as defined on the trade contract drawings. This boundary includes connecting walls, roof and floor which comprise a complete, whole, and continuous three dimensional envelope. Perform both a positive pressure test and a negative pressure test on this envelope, unless otherwise directed.

1. Test Goal

Input data from the test into the Air Leakage Rate by Fan Pressurization spreadsheet as described in paragraph CALCULATION PROGRAM via the Air Leakage Test Form. Compare output from the spreadsheet against the maximum allowable leakage defined in Section 07 25 00 AIR BARRIER SYSTEM. The envelope passes the test if the leakage rate, as calculated using the spreadsheet, is equal to or lower than the Architectural Plus HVAC System leakage rate goal.

2. Preparing The Envelope For The Pressure Test - Seal All Openings Through The Air Barrier

Temporarily close all perimeter windows, roof hatches and doors in the envelope perimeter except for those doors that are to remain open to accommodate blower door or trailer mounted fan test equipment installation. Seal, or isolate all other intentional openings, pathways and fenestrations through the architectural envelope prior to pressure testing. Follow the Recommended Test Envelope Conditions identified in ASTM E1827, Table 1, for the Closed Envelope condition. These openings may include boiler flues, fuel-burning water heater flues, fuel-burning kitchen equipment, clothes dryer vents, fireplaces, wall or ceiling grilles, diffusers etc. Before sealing flues, close their associated fuel valves and verify the associated pilot lights are extinguished. Prime all plumbing traps located within the envelope full of water. In lieu of applying tape and/or plastic, Typical temporary sealing materials include tape and sheet plastic or a self-adhesive grille wrap. Use and apply tape and plastic in a manner that does not deface or remove paint or mar the finish of permanent surfaces. Be especially aware of residue that may remain from tape applied to stainless steel surfaces such as kitchen hoods or rollup doors. For painted surfaces, use tape types that will not remove finish paint when the tape is removed. If paint is removed from the finished surface, repaint to match existing surfaces. Secure dampers closed either manually or by using the building's HVAC system controls. Use the table below for further guidance in building preparation.

Building Component	**Envelope Condition**
Air handling units, duct fans	As found (open) or temporarily sealed as necessary
Clothes dryer	Off
Clothes dryer vents	Temporarily sealed
Dampers - intake, exhaust	Physically closed or closed using control power or temporarily sealed
Diffusers, registers, grilles within the envelope	Temporarily sealed
Doors, personnel type, at the envelope perimeter	Secured closed
Doors, personnel type, within the envelope	Secured (propped) open
Doors, roll-up type, at the envelope perimeter	Closed (no additional sealing)
Exhaust hoods	Closed* and temporarily sealed
Fireplace hearth	Temporarily sealed *
Kitchen hoods	Temporarily sealed *
Pilot light and associated fuel valve	Extinguished and closed, respectively
Vented combustion appliance	Temporarily sealed *

Building Component	Envelope Condition
Vented combustion appliance exhaust flue	Off
Windows	Secured closed
* If the building component has an associated manual or automatic damper, consider securing the damper closed in lieu of temporarily sealing.	

B. 3.4.2 Architectural Plus HVAC System Test

This test envelope includes the architectural air barrier boundary as defined on the trade contract drawings plus all HVAC supply, return and exhaust systems that penetrate and terminate within said architectural air barrier boundary and that extends outward from said boundary. All associated ductwork, intake and exhaust dampers, and air moving devices, including air handling units and fans, are included in this test envelope even if they are physically located outside of the architectural air barrier boundary. The boundary extends to and includes the low leakage intake and exhaust dampers. Perform both a positive pressure test and a negative pressure test on this envelope, unless otherwise indicated.

1 Test Goal

Data from the test is to be input into the Air Leakage Rate by Fan Pressurization spreadsheet as described in paragraph CALCULATION PROGRAM via the Air Leakage Test Form. If both a positive and negative pressure tests were performed, both data sets are together to be input in the spreadsheet. Compare output from the spreadsheet against the leakage rate goal. The envelope passes the test if the leakage rate, as calculated using the spreadsheet, is equal to or lower than the Architectural Plus HVAC System leakage rate goal.

2 Preparing the Building for the Pressure Test

In preparation of this test, de-energize all air moving devices within this envelope by putting their controls in the Unoccupied mode. This allows the building's HVAC controls to close all associated motorized intake, exhaust, and relief dampers. Make no other changes to the HVAC systems. Temporarily sealing diffusers, grilles, registers, kitchen hoods, exhaust hoods, fans, air handling units and all other HVAC system elements with tape and/or plastic sheeting is not allowed. If the envelope includes a fireplace hearth do not seal it with tape and plastic. Use the table below for further guidance in building preparation.

Building Component	Envelope Condition
Air handling units, duct fans	As found (open
Clothes dryer	Off
Clothes dryer vents	As found (no preparation)

Building Component	Envelope Condition
Dampers - intake, exhaust	As found (no preparation)
Diffusers, registers, grilles within the envelope	As found (open)
Doors, personnel type, at the envelope perimeter	Secured closed
Doors, personnel type, within the envelope	Secured (propped) open
Doors, roll-up type, at the envelope perimeter	Closed (no preparation)
Exhaust hoods	Closed
Fireplace hearth	As found (open)
Kitchen hoods	As found (open)
Pilot light and associated fuel valve	Extinguished and closed, respectively
Vented combustion appliance	Off
Vented combustion appliance exhaust flue	As found (open)
Windows	Secured closed

3.5 CONDUCTING THE PRESSURE TEST

Notify the Owner at least 10 working days before conducting the pressure tests to provide the Owner the opportunity to witness the tests and to monitor weather forecasts for conditions favorable for testing. Do not pressure test until verifying that the continuous air barrier is in place and installed without failures in accordance with installation instructions. During the pressure test periodically inspect temporarily sealed items to ensure they are still sealed. Seals on temporarily sealed items tend to release more readily at higher pressures. Test data obtained after temporarily sealed items become unsealed cannot be used as input into the calculation program. Follow the Envelope Pressure Test Procedures in the paragraphs below. Submit detailed pressure test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed for the building envelope pressure (air tightness) test. Submit these procedures not later than 60 days after Notice to Proceed.

A. Extend Pneumatic Tubes and Establish a Reference Differential Pressure

Confirm the various zones within the envelope have a relatively uniform interior pressure distribution by establishing a representative differential pressure between the envelope and the outdoors with blower door or trailer-mounted fans operating. The number of indoor pressure difference measurements (pneumatic hoses) required depends on the number of interior zones separated by bottle necks that could create significant pressure drops (e.g. doorways and stairwells). Extend at least four pneumatic hoses (differential pressure monitoring ports) to

locations within the envelope that are physically opposite of each other. In multiple story buildings, especially those over three stories, extend hoses to multiple floors. Locate the hose ends away from the effects of air discharge from blower test equipment. Select one of the four (or more) interior hoses, one judged by the test agency to be the most unaffected by air velocity produced by blower test equipment, to serve as the interior reference pressure port. Extend at least one additional pneumatic hose to the outdoors (outdoor pressure port). To the end of this hose manifold at least four hoses together and terminate each hose on a different side of the building. With the envelope sealed and the blowers energized, measure the differential pressure using the interior reference pressure port and the four outdoor pressure ports. Then measure and record the differential pressure by individually using each of the remaining three interior hoses. Ensure each reading is within plus or minus 10 percent of the reference reading. Thus at an average 75 Pa maximum pressure difference across the envelope, the difference between the highest and lowest interior pressure difference measurements should be 15 Pa or less. If this condition cannot be met, attempt to create additional air pathways within the envelope to minimize pressure differences within the envelope. If necessary, move the interior hose ends. See step 2.13 of the Air Leakage Test Form in Appendix A.

B. Bias Pressure Readings

With the fan pressurization equipment de-energized and the envelope sealed, obtain the differential pressure between the outdoors and the envelope. Record 12 bias pressure readings before the pressure test and 12 bias pressure readings after the pressure test. Each reading is the average of ten or more 1-second measurements. Include positive and negative signs for each reading. To help dampen bias pressures that significantly contribute to test pressure, reduce temperature differences between indoor and outdoor air. Temperature differences can be reduced by operating test fan equipment for a few minutes to replace most of the indoor air with outdoor air.

C. Testing in Both Positive and Negative Directions

The preferred method for testing a building envelope is to test in both the pressurized and depressurized directions. Testing in one direction is only allowed if opposite direction testing cannot logistically be performed due to test equipment limitations or restrictions. After obtaining the pre-test bias differential pressure readings, conduct the pressure test. Record the envelope pressures (in units of Pascals) from one interior pneumatic hose (monitoring port) and the outdoor pneumatic hose(s), averaged or manifolded, with corresponding flows (in units of cfm) for each fan. Record the flow rates at least 10 to 12 positive and 10 to 12 negative building pressure readings. If conducting both positive and negative pressure tests the lowest allowable test pressure is 40 Pa and the highest test pressure is 85 Pa. Keep at least 25 Pa difference between the lowest and highest test pressure readings. Include the 75 Pa pressure value between the lowest and highest readings. The 10 to 12 readings in each direction are to be roughly evenly spaced along the range of pressures and flows. After testing is complete de-energize the equipment used to provide pressurization and obtain an additional 10 to 12 post-test bias pressure readings. None of the bias pressure readings are allowed to exceed 30 percent of the minimum test pressure. If these limits are exceeded the test fails and must be repeated.

D. Failed Pressure Test

If the pressure test fails to meet the established criteria, use diagnostic test methods described in paragraph LOCATING LEAKS BY DIAGNOSTIC TESTING to discover the leak locations. Provide additional permanent sealing measures to reduce or eliminate leak sources discovered

during diagnostic testing. Retest (perform another pressure test) after sealing has been completed. Repeat this sequence of documenting test results in the test report, performing diagnostic tests, documenting recommendations for additional sealing measures in the test report, sealing leak locations per recommendations, and re-testing as necessary until the building envelope passes the pressure test and is in compliance with the performance requirements.

E. Air Leakage Test Report

Report volumetric flow rates and corresponding differential pressures in cubic feet per minute (cfm) and Pascals (Pa), respectively, on the Air Leakage Test Form sample form found in Appendix A. Populate the accompanying spreadsheet file entitled Pressure Test Data Analysis with information obtained during the test. The spreadsheet uses equations found in ASTM E779 as a basis for calculating the envelope leakage rate. Other similar leakage rate calculation programs cannot be used or submitted for review. Submit a printout of the data input and output in the report. Should any air tightness (pressure) test fail, the pressure test report is to include data and results from all previous failed tests along with the final successful test data and results. Indicate if the resulting leakage rate did or did not meet the goal leakage requirement. Identify and document deficiencies in the building construction upon failure of a test to meet the specified maximum leakage rate.

Include the Test Agency Qualification Sheet, Air Leakage Test Form and Air Leakage Test Results Form in the written report. Document every test set-up condition with diagrams and photos to ensure the tests can be made repeatable. Document all pneumatic hose termination locations. Record in detail how the building envelope was prepared for the tests. Also describe in detail which building items were temporarily sealed. Include photos of test equipment and sealing measures in the report. Include an electronic (pdf) version of all test reports on a CD. If the building envelope fails to meet the leakage rate goal, provide recommendations to further seal the envelope and document these recommendations in the test report.

3.6 LOCATING LEAKS BY DIAGNOSTIC TESTING

Use diagnostic test methods described herein to discover obvious leaks through the envelope. Perform diagnostic tests on the building envelope regardless of the envelope meeting or failing to meet the designated leakage rate goal. Use diagnostic test methods in accordance with ASTM E1186 and in conjunction with pressurization equipment as necessary. Use the thermography diagnostic test to establish a baseline for envelope leakage. Apply additional diagnostic tests (find, feel, fog or other tests) as necessary to further define leak locations and pathways discovered using thermography or to find additional leaks not readily detected by thermography. Using a variety of diagnostic tests may help locate leaks that would otherwise go undetected if only a single diagnostic test were used. Pay special attention to locating leaks at interfaces where there is a change in materials or a change in direction of like materials. These interfaces, at a minimum, include roof/wall, wall/wall, floor/wall, wall/window, wall/door, wall/louver, roof mounted equipment/roof curb interfaces and all utility penetrations (ducts, pipes, conduit, etc) through the envelope's architecture. Also use diagnostic tests to check for leakage between the air duct and duct damper, when the damper, under normal control power, is placed in the closed position. Should leaks be discovered during diagnostic tests, thoroughly document their exact locations on a floor plan so that sealing can be later applied. If the envelope passes the leakage test, use the diagnostic test procedure described above to identify obvious leakage locations. Seal the leaks at the discretion of the COR based on the magnitude, location, potential for liquid moisture penetration or retention, potential for condensation, presence of daylight through an architectural surface or if the leakage location could potentially cause rapid deterioration or mold

growth of, or in the building envelope materials and assemblies. Apply sealing measures after diagnostic testing is complete and all pressurization blowers are off. To verify that the applied sealing measures that are effective, re-test for leaks using the same diagnostic methods that discovered the leak. Reseal and retest until the envelope meets the leakage rate goal and all obvious leaks through the envelope are sealed.

A. Find Test

Use visual observation to locate daylight and/or artificial light streaming from the opposite side of the envelope. Observe all interfaces identified above.

B. Feel Test

Use the building's air handling system or blower door equipment to negatively pressurize the building envelope, to at least 25 Pa but no greater than 85 Pa, with respect to the outdoors. The larger the pressure difference, the easier discovering leaks by feeling them becomes. While inside the envelope, hand feel roof/wall, wall/wall, and floor/wall interfaces and utility penetrations (ducts, pipes, conduit, etc) for leaks and note the leak locations on a floor plan. The "Feel" test may also be used to check for leaks between the ductwork and ductwork damper. To do this, positively pressurize the envelope and check for air movement from the envelope exterior.

C. Infrared Thermography Test

Avoid performing thermography tests just after pressure testing the building envelope (pressurizing and/or depressurizing the building envelope) as thermography readings may be inaccurate due to excessive air-wash. Perform thermography either before the pressure test or wait an appropriate amount of time after pressure test completion for the temperatures within the building envelope to stabilize before starting the thermography tests. Coordinate thermography examination with the pressure test agency and the test agency's pressurization equipment. The pressure test agency is to allow adequate time for the thermographer to perform a complete thermographic examination, as described hereinafter, of the envelope interior and exterior.

1. Thermography Test Methods

Before thermographic testing, remove furniture, construction equipment, and all other obstructions both inside and outside the building as necessary to gain a clear field of view. In the Thermographic Investigation Report, document all areas where obstructions remain. For exterior thermal examination of the envelope, verify that no direct solar radiation has heated the envelope surfaces to be examined for a period of approximately 3 hours for frame construction and for approximately 8 hours for masonry veneer construction. Conduct exterior investigations after sunset, before sunrise, or on an overcast day when the influence of solar radiation can be determined to be minimal. Limit exterior examinations to times when the influence of solar radiation is minimal, such as after sunset or before sunrise or during an overcast day. Conduct thermal imaging tests only when wind speeds are less than 8 mph at the time of analysis and at the end of analysis. Document any variations in wind during the test. Document all variations of test conditions in the Thermographic Investigation Report. Test only when exterior surfaces are dry. Monitor and document ongoing test parameters, such as the temperatures inside and outside the air barrier envelope, wind speed, and differential pressure.

a. Thermography Testing of the Air Barrier

Test the building envelope in accordance with ISO 6781, and ASTM E1186. Perform a complete thermographic inspection consisting of the full inspection of the interior and exterior of the complete air barrier envelope. Document envelope areas that are inaccessible for testing. Use infrared thermography technology in concert with standard pressurization methods (blower doors, trailer mounted fans and/or the building's own air handling systems) to locate leaks through the air barrier. Because thermography works best with at least a 18 degree F temperature difference between the envelope interior and the exterior, adjust the HVAC system, if possible, to create or enhance this temperature difference. The minimum allowable temperature difference is 3 degrees F. Maintain this temperature difference for at least 3 hours prior to the test. Use pressurization methods to establish a minimum of +20 Pa pressure difference with respect to the outdoors while using an infrared camera to view the envelope from outdoors. When viewing with the camera from inside the envelope, keep the envelope at a pressure differential of -20 Pa with respect to the outdoors using pressure testing equipment or the building's own air handling system.

b. Thermography Testing of the Insulation Envelope to Find Insulation Voids (Qualitative Test)

After installation of the insulation envelope is complete, use thermography to identify anomalies (insulation voids) in this envelope. Test only when the temperature difference between inside and outside wall surfaces and as defined by the surface being imaged must be a minimum of 18 degrees F or greater for a period of 4 hours before the test. Alternatively, the thermographer is to verify and document in the Thermographic Investigation Report that the imaging system is capable of providing satisfactory results with less temperature difference between inside and outside. Test during a time when there is no more than 0.05 inches differential pressure across the insulation envelope. Document the location of the voids on floor plans or wall sections.

c. Thermography Testing of Thermal Bridging

Sample thermal images must be taken of representative parts of the building envelope being examined and analyzed that demonstrate the majority of areas with anomalies or identifiable thermal features. Also sample thermal bridges in parts of the building that have no apparent anomalies to demonstrate the correct functioning of building components.

d. Thermography Test Results

Document the location of all leaks, anomalies, and unusual thermal features on a floor plan and/or elevation view and catalog them with a visible light picture for locating the defect for correction. The thermographer is to recommend corrective actions to eliminate the leaks, anomalies and unusual thermal features. Where leaks are found perform corrective sealing as necessary to achieve the whole envelope air leakage rate specified. After sealing, again use thermography in concert with standard pressurization methods to verify that the air leakage has been reduced. After these leaks have been permanently sealed note all actions taken on the drawings or in the Thermographic Investigation Report. Submit the drawings for approval as part of the Thermographic Investigation Report. Also include thermographic photos that show where leaks were discovered.

Include thermograms using an imaging palette that clearly shows the observed thermal patterns indicating air leakage. The Owner's Representative is to witness all testing.

D. Diagnostic Test Report

Once the diagnostic tests have been completed and the leakage locations identified and sealed, document these procedures, locations and recommendations in the diagnostic test report. Submit plan and/or profile drawings that thoroughly identify leak locations. Describe in detail all leak locations so that the seal-up crew knows where to apply sealing measures. After sealing measures have been applied, describe the methods used along with applicable photos of the final sealed condition.

1. Thermographic Investigation Report

Submit a report of each thermographic investigation identifying the thermal discontinuities in the thermal control layer. Indicate in the final report locations to which improvements for both the air control layer and the thermal control layer were made to reduce air leaks and correct discontinuities in the thermal control layer. Include in the report some selected radiometric images of suspected failure points in the air barrier envelope that indicate before and after conditions. Indicate in the final report improvements that were made to the envelope to reduce air leaks, correct wet roof and wall areas, and repair insulation. Include the following items in the report:

a. Brief description of the building construction

b. Types of interior and exterior surface materials used in the building.

c. Geographical orientation of the building with a description of the exterior surroundings including other buildings, vegetation, landscaping, and surface water drainage.

d. Camera brand, model and serial number, and date of most recent calibration date; optional lenses with serial numbers (if applicable)

e. Thermographer's and Owner Inspector's names

f. Date and time of tests

g. Air temperature and humidity inside the air barrier envelope

h. Outdoor air temperature and humidity

i. General information for the last 12 hours on the solar radiation conditions in the geographic area where the test is being performed.

j. Ambient conditions such as precipitation and wind direction and speed occurring with the last 24 hours, as applicable. Refer to specific requirements in each section of each thermographic inspection type for requirements in each specific area.

k. Documentation of those portions of the building envelop which were not within test conditions when the scan was performed and which portions were obstructed by adjacent structures, interior furnishings, intervening cavities or reflective surfaces.

l. Other relevant information, which may have influenced test results.

m. Drawings, sketches, floor plans and/or photographs detailing the locations in the buildings where thermograms were taken detailing possible irregularities in the components being tested.

n. Thermal images taken during the inspection with their relative locations and written or voiced recorded explanations of the anomaly listed along with visual and reference images.

o. An identification of the aspects or components of the building being examined.

p. Explanations for the type and the extent of each construction defect observed during the inspection.

q. Any results from additional measurements and investigations. Identify additional equipment used and support with type, model number, serial number and date of most recent calibrated.

3.7 CALCULATION PROGRAM

To calculate the envelope leakage rate and other required outputs, input the data obtained during the pressure tests as documented in the Air Leakage Test Form (Appendix A) into the Air Leakage Rate by Fan Pressurization Excel spreadsheet. This spreadsheet can be found at the following web site: http://wbdg.org/ccb/NAVGRAPH/graphtoc.pdf.

3.8 AFTER COMPLETION OF THE PRESSURE AND/OR DIAGNOSTIC TEST

After all pressure and/or diagnostic testing has been completed unseal all temporarily sealed items. Unless otherwise directed by the Owner, return all dampers, doors, and windows to their pre-test condition. Remove tape and plastic from all temporarily sealed openings, being careful not to deface painted surfaces. If paint is removed from finished surfaces, repaint to match existing surfaces. Unless otherwise directed by the Owner’s representative, return fuel (gas) valves to their pre-test position and relight pilot lights. Return all fans and air handling units to pre-test conditions.

3.9 REPAIR AND PROTECTION

Repair and protection is the Trade Contractor's responsibility, regardless of the assignment of responsibility for testing, inspection, and similar services. Upon completion of inspection, testing, or sample taking and similar services, repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

3.10 APPENDICES

The following forms are available for download as a MS Word file at http://wbdg.org/ccb/NAVGRAPH/graphtoc.pdf.

Appendix A - Air Leakage Test Form

Appendix B - Air Leakage Test Results Form

Appendix C - Test Agency Qualifications Sheet

-- END OF SECTION – 07 05 23

SECTION 07 08 00 – COMMISSIONING OF THERMAL AND MOISTURE PROTECTION

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Trade Contract, including General and Supplementary Conditions and Notice to Trade Contractor Sections, apply to this Section. Refer to Section 01 91 00 – General Commissioning Requirements for a full description of the commissioning process and requirements.

1.2. SUMMARY

A. Commissioning consists of systematically documenting that specified components and systems have been installed and started up properly and then functionally tested to verify and document proper operation through all sequences of operation and conditions. In addition, training of the Owner's Operations Personnel will be verified and final project O&M Documents will be reviewed for completeness.

PART 2 – PRODUCTS

2.1. FUNCTIONAL PERFORMANCE TESTING EQUIPMENT AND INSTRUMENTS

A. Trade Contractor shall provide all tools, instruments, laptop computers, PDA's, software programs and services required to perform system Functional Performance Testing procedures. This includes providing the connection to systems to be tested, operation of the test equipment & instrumentation and generating test results as required.

PART 3 – EXECUTION

3.1. FUNCTIONAL PERFORMANCE TESTING

A. The trade contractor shall demonstrate to the Engineer and the Cx Authority the performance of the following Building Envelope Systems to the performance level identified.

1. Fluid Applied Waterproofing:

a. System/Equipment to be Tested:

1) Waterproofing membrane at pit perimeter walls

2) Water proofing membrane on concrete base slabs below component change out shop structure concrete floor slab and below entire building floor slab

b. Functions to be Tested:

1) Refer to ASTM D 4787 regarding "Holiday Testing"

c. Conditions of the Test:
   1) Refer to ASTM D 4787 regarding “Holiday Testing”

d. Acceptance Criteria:
   1) Refer to Section 07 14 00 – “Fluid Applied Waterproofing” for requirements for Membrane Installation

2. Fabricated Wall Panel System:

a. System/Equipment to be Tested:
   1) Horizontal and vertical wall panel systems, including all insulation, sealants, and gaskets
   2) Fixed aluminum windows and translucent panels within the wall panel system

b. Functions to be Tested:
   1) Refer to AAMA 501.1 regarding “Water Penetration – Dynamic Testing”
   2) Refer to AAMA 501.2 regarding “Water-Spray Test”
   3) Refer to AAMA 508-05 regarding “Pressure Equalization of Horizontal Joinery”
   4) Refer to ASTM E 783 regarding “Air Infiltration”
   5) Refer to ASTM E 331 regarding “Horizontal Panel Joint Performance”

c. Conditions of the Test:
   1) Refer to AAMA 501.1 regarding “Water Penetration – Dynamic Testing”
   2) Refer to AAMA 501.2 regarding “Water-Spray Test”
   3) Refer to AAMA 508-05 regarding “Pressure Equalization of Horizontal Joinery”
   4) Refer to ASTM E 783 regarding “Air Infiltration”
   5) Refer to ASTM E 331 regarding “Horizontal Panel Joint Performance”

d. Acceptance Criteria:
   1) Refer to Section 07 42 63 – “Fabricated Wall Panel System” parts 1.5 and 3.5

3. Sheet Metal Roofing:

a. System/Equipment to be Tested:
   1) Sheet metal roofing system over membrane underlayment and plywood sheathing

b. Functions to be Tested:
   1) Refer to ASTM E 1646
   2) Refer to ASTM E 1680

c. Conditions of the Test:
   1) Refer to ASTM E 1646
   2) Refer to ASTM E 1680

d. Acceptance Criteria:
   1) Refer to Section 07 61 00 – “Sheet Metal Roofing” part 1.5

4. Air Barrier System:

a. System/Equipment to be Tested:
   1) Sheet metal roofing system over membrane underlayment and plywood sheathing

b. Functions to be Tested:
    1) Refer to ANSI/ASNT CP-189 (2011)
    2) Refer to ASNT CP-105 (2011)
    3) Refer to ASNT SNT-TC-1A
    4) Refer to ASTM E1186
    5) Refer to ASTM E779
    6) Refer to ASTM E1827
    7) Refer to ISO 6781

c. Conditions of the Test:
    1) Refer to ANSI/ASNT CP-189 (2011)
    2) Refer to ASNT CP-105 (2011)
    3) Refer to ASNT SNT-TC-1A
    4) Refer to ASTM E1186
    5) Refer to ASTM E779
    6) Refer to ASTM E1827
    7) Refer to ISO 6781

d. Acceptance Criteria:
    1) Refer to Section 07 05 23 – "Air Barrier System Pressure Testing"

END OF SECTION 07 08 00

SECTION 07 14 00 - FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fluid applied membrane waterproofing.

B. Protection boards.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete substrate.

1.3 REFERENCE STANDARDS

A.	ASTM C836/C836M	Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use With Separate Wearing Course; 2012.
B.	ASTM C1306	Standard Test Method for Hydrostatic Pressure Resistance of a Liquid-Applied Waterproofing Membrane; 2008.
C.	ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers- Tension; 2006a (Reapproved 2013).
D.	ASTM E96/E96M	Standard Test Methods For Water Vapor Transmission of Materials; 2013.
E.	ASTM E154/E154M	Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover; 2008a (Reapproved 2013).
F.	ICC-ES AC29	Acceptance Criteria for Cold, Liquid-Applied, Below-Grade, Exterior Dampproofing and Waterproofing Materials; ICC Evaluation Service, Inc.; 2011.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide data for membrane.

C. Certificate: Certify that products meet or exceed specified requirements.

D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of fluid-applied waterproofing membranes with three years experience.

B. Installer Qualifications: Company specializing in installation of fluid-applied waterproofing approved by manufacturer.

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until cured.

1.7 WARRANTY

A. See Section 01 78 30 – Warranties and Bonds, for additional warranty requirements.

B. Trade Contractor shall correct defective Work within a five year period after Date of Substantial Completion; remove and replace materials concealing waterproofing at no cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cold-Applied Rubberized Asphalt Waterproofing Manufacturers:
   1. Henry Company; HE784 - Aqua-Bloc WB: www.henry.com. or equal
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 WATERPROOFING APPLICATIONS

A. Cold-Applied Rubberized Asphalt Waterproofing: Use at 20 square feet per gallon.
   1. Cover with protection board.

2.3 MEMBRANE AND FLASHING MATERIALS

A. Cold-Applied Rubberized Asphalt Waterproofing: Rubberized asphaltic compound, suitable for installation on concrete and concrete masonry.
   1. Complying with ICC-ES AC29; evidence of compliance includes current ICC-ES evaluation report citing AC29.
   2. Hydrostatic Pressure Resistance: When tested in accordance with ASTM C1306, at least 50 pounds per square inch by the rapid test and at least 35 pounds per square inch by the long term test.

3. Low Temperature Resistance: No cracking, loss of adhesion, splitting or pinholes when tested at minus 15 degrees F in accordance with ASTM C836/C836M.
4. Adhesion: No separation when tested in accordance with ASTM C836/C836M.
5. Decay Resistance: No decay when tested in accordance with ASTM E154/E154M.
6. Wet Film Sag Resistance: No sag or sag within plus/minus 5 mils when tested in accordance with ASTM C836/C836M.
7. Water Vapor Permeance: Less than one perm, when tested in accordance with ASTM E96/E96M.
8. Heat Aging Resistance: No cracking, splitting, or pinholes when tested in accordance with ASTM C836/C836M.
9. Elongation at Break: 1000 percent, minimum, when tested in accordance with ASTM D412.

2.4 ACCESSORIES

A. Protection Board: Type capable of preventing damage to waterproofing due to backfilling and construction traffic.
   1. Use one of the following:
      a. Polystyrene foam board, 1/4 inch thick. Henry Company; DB Series Drainage Board, or equal
   2. Products:
      a. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.

C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.

D. Verify that items that penetrate surfaces to receive waterproofing are securely installed.

3.2 PREPARATION

A. Protect adjacent surfaces not designated to receive waterproofing.

B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions.

C. Do not apply waterproofing to surfaces unacceptable to manufacturer.

D. Seal cracks and joints with sealant using methods recommended by sealant manufacturer.

3.3 INSTALLATION

A. Apply waterproofing in accordance with manufacturer's instructions to specified minimum thickness.

B. Seal membrane and flashings to adjoining surfaces.

3.4 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD

A. Place protection board directly against cured membrane; butt joints. Scribe and cut boards around projections, penetrations, and interruptions.

3.5 PROTECTION

A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION 07 14 00

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Board insulation at exterior wall behind masonry veneer and roof parapet.

B. Batt insulation and vapor retarder in exterior wall cold formed metal framing construction.

1.2 RELATED REQUIREMENTS

A. Section 04 20 01- Masonry Veneer

B. Section 04 27 31 – Reinforced Unit Masonry

C. Section 05 40 00 – Cold Formed Metal Framing

D. Section 07 25 00 – Air Barrier System: Air barrier materials.

E. Section 07 54 00 - Thermoplastic Membrane Roofing: Insulation specified as part of roofing system.

F. Section 09 21 16 - Gypsum Board Assemblies: Exterior gypsum board sheathing and acoustic insulation inside walls and partitions.

1.3 REFERENCE STANDARDS

A. ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2013.

B. ASTM C665 Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2012.

C. ASTM C1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2014.

D. ASTM D4397 Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications;

E. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2013a.

F. ASTM E136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace At 750 Degrees C; 2012.

G. NFPA 285 — Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2012

H. FM 4880 — Class 1 Fire Rating Of Insulated Wall Or Wall And Roof/Ceiling Panels, Interior Finish Materials Or Coatings And Exterior Wall Systems; 2010

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. See Section 01 81 13 – Sustainable Design

C. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 FIELD CONDITIONS

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 - PRODUCTS

2.1 FOAM BOARD RIGID INSULATION MATERIALS

A. Polyisocyanurate Board Insulation with Facers Both Sides: Faced rigid cellular foam, complying with ASTM C1289; Type I, aluminum foil both faces; Class 2, reinforced foam core.

1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
3. Class 1 fire rated per FM 4880.
4. IBC 2603.5 approved
5. Fire Performance Evaluation per NFPA 285
6. Compressive Strength: 25 psi
7. Board Size: 48 x 96 inch.
8. Board Edges: Square.
9. Thermal Resistance: as indicated on drawings

B. Products:

1. Dow Thermax Sheathing; DOW Chemical Company; www.dowbuildingsolutions.com. or equal
2. Substitutions: See Section 0160 00- Product Requirements

2.3 BATT INSULATION MATERIALS

A. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
   3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
   4. Formaldehyde Content: Zero.
   5. Thermal Resistance: as indicated on drawings.

2.4 VAPOR RETARDER MATERIALS

A. Vapor Retarder Sheet: ASTM D4397 polyethylene film reinforced with glass fiber square mesh, clear.
   1. Water Vapor Permeance: As required by referenced standard for thickness specified.

B. Vapor Retarder Tape: Polyethylene self adhering type, mesh reinforced, 2-inches wide, compatible with sheet material.

2.5 ACCESSORIES

A. Sheet Vapor Retarder: Specified in Section 07 25 00.

B. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation and adhesive.

B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.3 BOARD INSTALLATION AT EXTERIOR WALLS

A. Apply adhesive to back of boards:

B. Install boards horizontally on walls.
   1. Place boards to maximize adhesive contact.
   2. Install in running bond pattern.
   3. Butt edges and ends tightly to adjacent boards and to protrusions.

C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.5 BATT INSTALLATION AND VAPOR RETARDER

A. Install insulation and vapor retarder in accordance with manufacturer's instructions.

B. Install in exterior wall spaces without gaps or voids. Do not compress insulation.

C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

E. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over member face.

F. Tape seal tears or cuts in vapor retarder.

G. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane. Tape seal in place.

END OF SECTION 07 21 00

SECTION 07 25 00 AIR BARRIER SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air Barrier System requirements.

1.2 RELATED REQUIREMENTS

A. The air barrier system requires close and frequent coordination between the contractor and sub-contractors as well as between sub-contractors. As a result it is the contractor responsibility to assure that all such trades have a complete understanding of their responsibilities. Below is a partial list of related specifications.

B. Section 07 05 23 Air Barrier System Pressure Testing

1.3 REFERENCE STANDARDS

A. UL 723 (2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials

B. ASTM C203 (2005; R 2012) Breaking Load and Flexural Properties of Block-Type Thermal Insulation

C. ASTM C518 (2010) Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

D. ASTM C920 (2011) Standard Specification for Elastomeric Joint Sealants

E. ASTM D412 (2010)Tensile Strength Properties of Rubber and Elastomers

F. ASTM D1621 (2010) Compressive Properties of Rigid Cellular Plastics

G. ASTM D1622 (2008) Apparent Density of Rigid Cellular Plastics

H. ASTM D1970 Standard Guide to Methods of Evaluating Moisture Conditions of Concrete Floors to Receive Resilient Floor Coverings

I. ASTM D6226 (2010) Standard Test Method for Open Cell Content of Rigid Cellular Plastics

J. ASTM E 547 (2009) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference.

K. ASTM E1620 (2009) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference

L. ASTM E2112 (2007) Standard Practice for Installation of Exterior Windows, Doors and Skylights

M. ASTM E2178 Standard Test Method for Air Permeance of Building Materials

N. ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

O. ASTM E84 (2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

P. ASTM E283 (2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

Q. ASTM E331 (2000; R 2009) Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

R. ASTM E96/E96M (2013) Standard Test Methods for Water Vapor Transmission of Materials

S. CAN/ULC S710.1 Standard for Thermal Insulation - Bead - Applied One Component Polyurethane Air Sealant Foam

T. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials

1.4 SYSTEM DESCRIPTION

A. Design Requirements

All materials, methods and expertise that contribute to an airtight building enclosure and controls infiltration or exfiltration of air located in the non-accessible construction shall not exceed the maximum air permeance noted in this specification. This includes sealing of all penetrations, joints and transitions between materials, products, and assemblies forming the air-tightness of the building enclosure which is "the air barrier system" or ABS.

1. Provide materials and installation methods for a complete building Air Barrier System providing an airtight barrier conforming to the Performance Requirements specified in this Section between the conditioned interior building atmosphere and the exterior atmosphere; and located as shown on the Drawings.

2. Provide materials and installation methods to bridge and provide an airtight connection/seal, conforming to the Performance Requirements specified in this Section. All materials to be compatible in adhesion and chemically. The following air leakage pathways and gaps, to be sealed include, but are not limited to the following;

   a. Between the wall air barrier and the roof air barrier.

   b. Between the wall air barrier and the foundation.

c. Between the slab on grade under slab vapor barrier and the foundation or wall air barrier.

d. Between different substrate or exterior cladding materials/systems.

e. Between the various different air barrier products/systems

f. At masonry control joints.

g. At expansion joints, including airtight connection to adjacent air barriers.

h. Between the wall air barrier and window frames, storefront frames, wall louvers, etc

i. Between the wall air barrier and door frames.

j. Between the air barrier and any penetrations, including penetrations by piping, conduit, duct, structural members and similar.

k. Masonry ties, screws, bolts and similar penetrations.

l. All other air leakage pathways in the building air barrier envelope.

B. Performance Requirements

The air barrier to be furnished shall be constructed to perform as a continuous barrier that will remain adhered in place and durable for the life of the building and conform to the following requirements.

1. Building Air Barrier System: The completed building shall have an air leakage rate that does not exceed 0.25 cfm/ft2 at a pressure differential of 0.3” w.g. (1.57 psf or 75 Pa) .

2. Air Barrier Materials Air Permeance: Not to exceed 0.004 cubic feet per minute per square foot under a pressure differential of 0.3” w.g. (1.57 psf or 75 Pa) when tested in accordance with ASTM E2178.

3. Air Barrier Assembly Air Permeance: Not to exceed 0.040 cubic feet per minute per square foot under a pressure differential of 0.3” w.g. (1.57 psf or 75 Pa) when tested in accordance with ASTM E2357

4. ABS shall accommodate movements of building materials by providing for airtight barrier across building expansion and control joints.

5. ABS shall accommodate changes in substrate and perimeter sealing conditions.

6. Different air barrier products shall be permanently joined together where they meet in a manner approved by both manufacturers to provide an airtight juncture. These materials shall be compatible in both adhesion and chemical makeup.

C. The installed building Air barrier System shall conform to the following requirements:

1. Continuous, with all joints made air and water tight.

2. Structural Integrity: ABS shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on the envelope without damage or displacement, and shall transfer the load to the structure.

3. Shall not displace adjacent materials under full load.

4. Shall be joined in an air-tight, watertight and flexible manner to the air barrier material of adjacent systems, allowing for the relative movement of systems due to thermal and moisture variations and creep.

1.5 SUBMITTALS

A. See section 01 33 00 – Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data

1. Air Barrier System

a. Prior to commencing the Work, submit manufacturers product data, samples and complete set of standard details for the air barrier membrane system showing a continuous plane of air tightness throughout the building envelope.

C. Certificates

1. Prior to commencing the Work, submit copies of manufacturers current ISO certification. Membrane, primers, sealants, and adhesives shall be included.

D. Refer to paragraph 1.7 Quality Assurance for additional submittal requirements.

1.6 CONTRACTOR RESPONSIBILITIES

The Trade Contractor is responsible for the construction of an air barrier system that is contiguous and connected across the six surfaces of the building envelope meeting the performance requirements as outlined in this specification.

The Trade Contractor shall perform a building air tightness test and thermography test to demonstrate that the building envelope is properly sealed and insulated. The testing shall be performed in accordance with the procedures outlined in specification Section 07 05 23 AIR BARRIER SYSTEM PRESSURE TESTING.

1.6.1 Coordination of Trade Sub-Contractor(s)

The Trade Contractor shall provide coordination between the Trade Sub-Contractors involved in the construction of the air barrier system, coordinate the sequence of construction to ensure continuity of the air barrier system joints, junctures, and transitions between materials and assemblies of materials and products from substructure to walls to roof. The Trade Contractor shall provide quality assurance procedures, testing and verification as specified herein. The Trade Contractor shall facilitate inspections, tests, and other quality control services specified elsewhere in the Contract Documents and required by the Owner. These coordination efforts are critical to avoid costly removal and replacement of construction materials to accommodate inspections and tests. The cost of all tear out and rework shall be at the Trade Contractors expense, not the expense of the subcontractor(s).

1.6.2 Construction Mock-Up

The Contractor shall build a construction mock-up of every joint, juncture, and transition between materials, products, and assemblies of products specified in the different sections to be installed. Work will not begin until the mock-up is satisfactory to the Owner.

Mock-ups may be part of the permanent construction and shall demonstrate the proper installation sequence and workmanship required for the Air Barrier System installation to provide an airtight envelope conforming to the Performance Requirements specified in this Section. Select a representative locations for mock-up of each different condition found on the project, incorporating but not limited to the following:

A. Typical exterior wall with parapet

B. Wall air barrier system

C. Exterior cladding materials

D. Roofing

E. Roof air barrier system

F. Window, louver and door frame and sill

G. Air barrier seal around windows, door and louvers

H. Insulation

I. Flashing interface with air barrier system

J. Exterior wall corner conditions

K. Junction between exterior wall and roof systems

L. Junction between exterior wall and foundation

M. Typical construction, control and expansion joints

N. Typical penetrations and gaps; illustrating materials interface and seals.

O. Typical penetrations by structural members, conduits, electrical boxes, pipes and ducts.

P. Typical penetrations by masonry ties, screws, bolts and similar.

Any non-conforming mock-ups shall be corrected and become the standard of quality and construction for all subsequent similar conditions.

1.7 SEQUENCING AND SCHEDULING

A. The Contractor shall coordinate between subcontractors required to provide an airtight building enclosure, customized fabrication and installation procedures and the following:

1. Continuity of the air barrier materials and products with joints to provide assemblies. Continuity of all the enclosure assemblies with joints and transition materials to provide a whole building air barrier system.

2. Specific quality control requirements for individual construction activities are specified in the sections of the specifications. Requirements in those sections may also cover

production of standard products. It is the Contractor's responsibility to ensure that each subcontractor is adequately and satisfactorily performing the quality assurance documentation, tests, and procedures required by each section.

3. Specified inspections, tests, and related actions do not limit the Contractor's quality control procedures that facilitate compliance with Contract Document requirements.

1.8 QUALITY ASSURANCE

Provide the following in accordance with para. 1.5 Submittals above.

A. Evidence of evaluation of Product by the Air Barrier Association of America (ABAA).

B. Shop drawings showing locations and extent of air barrier and details of typical conditions.

C. Manufacturer's technical data sheets and material safety data sheets for Product and Accessories.

D. Manufacturer's installation instructions.

E. Manufacturer’s documentation of volatile organic compounds (VOC) content for Product and Accessories.

F. Certification of compatibility by Manufacturer, listing all materials on the Project with which the Product and Accessories may come into contact.

G. Installer Qualifications:

1. Shall be experienced in applying the same or similar materials and shall be specifically approved in writing by Manufacturer.

2. Shall be licensed and certified to install Air Barriers by the Air Barrier Association of America (ABAA).

H. Warranties: Minimum five (5) year material warranty.

I. Product shall be installed in accordance with the manufacturer's recommendations and at thickness required for concrete masonry or exterior gypsum sheathing.

PART 2 PRODUCTS

Air barrier locations shall include but not be limited to:

A. Floor Slab On Grade /Vapor Barrier

B. Wall Air Barrier

C. Roof Air Barrier

D. Window, Door & Louver Air Barrier Seal

2.1 FLOOR SLAB ON GRADE VAPOR BARRIER

Specified in Section 03 05 05 Underslab Vapor Barrier.

2.2 EXTERIOR WALL FLUID APPLIED ELASTOMERIC ASPHALT EMULSION AIR BARRIER

A. Specified Properties below:

1. Fluid-applied, vapor impermeable, elastomeric waterproof membrane.

2. This product shall not be installed below grade.

3. Product shall be solvent free, have VOC content of not more than 25 grams per liter and shall be free of noxious odors.

REQUIREMENT	**RESULT**	**TEST METHOD**
Air Permeance	Not more than 0.001 CFM/square foot at 1.6 lbs per square foot	ASTM E-2178
Water Vapor Permeance	Not more than 0.02 Perm	ASTM E-96
Elongation Dry Film Thickness	Not less than 1,000 percent 45 mils on concrete or gypsum sheathing 65 ils on cmu	ASTM D-412

B. Products:

1. Henry Company; Air Bloc 06 WB: www.henry.com , or equal.

2. Substitutions : See Section 01 60 00 – Product Requirements.

C. Self-Adhered Transition Membrane

Self-Adhered transition membrane shall be an SBS modified bitumen, self-adhering sheet membrane complete with a blue engineered thermoplastic film. Membrane shall have the following physical properties:

1. Air leakage: <0.0001 CFM/ft² @1.6 lbs/ft2 to ASTM E2178,

2. Vapor permeance: 0.03 perms to ASTM E96/E96M (Desiccant Method),

3. Membrane Thickness: 0.0394 inches (40 mils),

4. Low temperature flexibility: -22 degrees F to CGSB 37-GP-56M,

5. Elongation: 200% to ASTM D412-modifed

D. Joint Treatment, Penetration and Termination Sealant

Joint Treatment, penetration and termination Sealant shall be a moisture cure, medium modulus polymer modified sealing compound having the following physical properties:

1. Compatible with sheet air barrier,
2. Complies with Fed. Spec. TT-S-00230C, Type II, Class A,
3. Complies with ASTM C920, Type S, Grade NS, Class 25,
4. Elongation: 450 - 550%,
5. Remains flexible with aging,
6. Seals construction joints up to 1 inch wide

E. Spray Foam Insulation

1. Low pressure spray polyurethane foam insulation
2. Applicable test standard for conformance:
   a. ASTM E2112
   b. ASTM E84
   c. ASTM E283
   d. ASTM E331
   e. ASTM E547
   f. ASTM C1620
   g. CAN/ULC S710.1
   h. ABAA
   i. UL 723
   j. ICC-ES ESR-1961

F. Physical Properties

1. Flexural strength, ASTM C203, 5.2 psi min.
2. K-Factor (thermal conductivity), ASTM C518, 0.262 per inch.
3. Compressive strength, ASTM D1621, 2.8 psi.
4. Density, ASTM D1622, 1.63 PCF.
5. Open cell content, ASTM D6226, less than 88.0 percent.
6. Flame spread/smoke developed, ASTM E84, 10/20.

G. Product:

1. Great Stuff Pro, DOW Chemical Company, or equal

2. Substitutions: See Section 01 60 00 – Product Requirements.

2.3 ROOF SYSTEM SHEET APPLIED AIR BARRIER

A Specified Properties Below:

1. Sheet applied, self adhesive, vapor impermeable, SBS rubberized asphalt compound, self gasketing.

REQUIREMENT	**RESULT**	**TEST METHOD**
Air Permeance	Not more than 0.001 CFM/square foot at 1.6 lbs per square foot	ASTM E-2178
Water Vapor Permeance	Not more than 0.03 perms	ASTM E-96
Elongation	200%	ASTM D412
Thickness	40 mils	
Nail Sealability	Pass	ASTM D1970

B. Products

1. Henry Company; Blueskin SA: www.henry.com or equal

2. Substitutions: See Section 016000 – Product Requirements

PART 3 EXECUTION

3.1 REPAIR AND PROTECTION

A. Take measures to protect the air barrier system from damage during construction.

B. Damaged air barriers shall be repaired as recommended by manufacturer by the air barrier installer prior to cover.

C. After completion of the building and upon completion of inspection and testing restore/repair any removed/damaged construction caused by finding and repairing leaks in the air barrier system and restore substrates, insulation and finishes to their original condition.

3.2 INSPECTION

The following inspections shall be conducted by the Contractor in the presence of the Owner during installation of the air barrier system.

A. Inspection:

1. Provide a Daily Report of Observations with a copy to the Owner. The report shall confirm the following:

   a. The continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.

   b. The structural support of the air barrier system can withstand design air pressures.

   c. The masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.

   d. Site conditions for application temperature, and dryness of substrates are within guidelines.

   e. The substrate surfaces are properly primed.

   f. Measure application thickness of liquid applied materials to manufacturer's specifications for the specific substrate.

   g. The correct materials are installed for compatibility.

   h. Proper transitions for change in direction and structural support at gaps.

   i. Ensure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

END OF SECTION 07 25 00

SECTION 07 41 13 - METAL ROOF PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Architectural roofing system of preformed aluminum panels.

B. Fastening system.

C. Factory finishing.

D. Accessories and miscellaneous components.

1.2 RELATED REQUIREMENTS

A. Section 07 90 05 - Joint Sealers: Field-installed sealants.

1.3 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.

B. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2010.

C. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2013.

D. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.

E. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.

F. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2013.

G. IAS AC472 - Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems; 2012.

1.4 SUBMITTALS

A. See Section 01 33 00 - Administrative Requirements and Section 01 33 00.13 – Document Control, for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Storage and handling requirements and recommendations.
   2. Installation methods.
   3. Specimen warranty.

C. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
   1. Show work to be field-fabricated or field-assembled.
   2. Include structural analysis signed and sealed by qualified structural engineer, indicating conformance of roofing system to specified wind loading conditions, indicated on structural drawings.

D. Selection Samples: For each roofing system specified, submit color chips representing manufacturer's full range of available colors and patterns.

E. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches square, representing actual roofing metal, thickness, profile, color, and texture.
   1. Include typical panel joint in sample.
   2. Include typical fastening detail.

F. Manufacturer Qualification Statement: Provide documentation showing metal roof panel fabricator is accredited under IAS AC472.

G. Test Reports: Indicate compliance of metal roofing system to specified requirements.

H. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in the manufacture of roofing systems similar to those required for this project.
   1. Not less than 5 years of documented experience.
   2. Accredited by IAS according to IAS AC472.

B. Installer Qualifications: Company trained and authorized by roofing system manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide strippable plastic protection on prefinished roofing panels for removal after installation.

B. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.7 WARRANTY

A. See Section 01 78 30 – Warranties and Bonds, for additional warranty requirements.

B. Finish Warranty: Provide manufacturer's special warranty covering failure of factory-applied exterior finish on metal roof panels and agreeing to repair or replace panels that show evidence of finish degradation, including significant fading, chalking, cracking, or peeling within specified warranty period of 5 year period from date of Substantial Completion.

C. Waterproofing Warranty: Provide manufacturer's warranty for weathertightness of roofing system, including agreement to repair or replace roofing that fails to keep out water within specified warranty period of 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Design is based on Double-Lock Zee-Lock, manufactured by Berridge Manufacturing Company: www.berridge.com.

B. Acceptable manufacturers are:
   1. ATAS International, Inc: www.atas.com.
   2. Petersen Aluminum Corporation: www.pac-clad.com.

C. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 ARCHITECTURAL METAL ROOF PANELS

A. Architectural Metal Roofing: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.

B. Metal Panels: Factory-formed panels with factory-applied finish.
   1. Aluminum Panels:
      a. Alloy: Aluminum conforming to ASTM B209/B 209M; temper as required for forming.
      b. Thickness: Minimum 0.032 inch.
   2. Profile: Standing seam, with minimum 2.0 inch seam height; concealed fastener system for field seaming with special tool.
   3. Texture: Smooth.
   4. Length: Maximum possible length to minimize lapped joints. Where lapped joints are unavoidable, space laps so that each sheet spans over three or more supports.
   5. Width: Maximum panel coverage of 16 inches.

2.3 ATTACHMENT SYSTEM

A. Concealed System: Provide manufacturer's standard stainless steel concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.4 PANEL FINISH

A. Fluoropolymer Coating System: Manufacturer’s standard multi-coat thermocured coating system, including minimum 70 percent fluoropolymer color topcoat with minimum total dry film thickness of 0.8 mil; color and gloss to match sample.

2.5 ACCESSORIES AND MISCELLANEOUS ITEMS

A. Miscellaneous Sheet Metal Items: Provide flashings, trim, moldings, and closure strips of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.

B. Sealants: As specified in Section 07 90 05.
   1. Exposed sealant must cure to rubber-like consistency.
   2. Concealed sealant must be non-hardening type.

C. Underlayment: Self-adhering rubber-modified asphalt sheet complying with ASTM D1970/D1970M; 22 mil total thickness; with strippable release film and woven polypropylene sheet top surface.
   1. Products:
      a. Henry Company; Blueskin RF200: www.henry.com.
      b. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 FABRICATION

A. Panels: Fabricate and finish panels and accessory items at factory, using manufacturer’s standard processes as required to achieve specified appearance and performance requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.

3.2 PREPARATION

A. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to assure that the completed roof will be free of leaks.

B. Remove protective film from surface of roof panels immediately prior to installation. Strip film carefully, to avoid damage to prefinished surfaces.

C. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by roof panel manufacturer.

D. Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.3 INSTALLATION

A. Overall: Install roofing system in accordance with approved shop drawings and panel manufacturer's instructions and recommendations, as applicable to specific project conditions. Anchor all components of roofing system securely in place while allowing for thermal and structural movement.

1. Install roofing system with concealed clips and fasteners.
2. Minimize field cutting of panels. Where field cutting is absolutely required, use methods that will not distort panel profiles. Use of torches for field cutting is absolutely prohibited.

B. Accessories: Install all components required for a complete roofing assembly, including flashings, trim, moldings, closure strips, caps, rib closures, and similar roof accessory items.

C. Roof Panels: Install panels in strict accordance with manufacturer’s instructions, minimizing transverse joints except at junction with penetrations.

1. Form weathertight standing seams incorporating concealed clips, using an automatic mechanical seaming device approved by the panel manufacturer.

3.4 CLEANING

A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.5 PROTECTION

A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.

B. Touch-up, repair, or replace damaged roof panels or accessories before date of Substantial Completion.

END OF SECTION

SECTION 07 42 13 METAL WALL PANELS

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

A. Insulated Core Metal Wall Panel System

Insulated horizontal wall panel system consisting of exterior metal sheet with interior metal liner panel, bonded to insulation core in thermally-separated profile, with factory sealed tongue-and-groove and rainscreen-design pressure-equalized-chamber horizontal joint, and attached to supports using concealed fasteners.

1. System is provided complete with integrated window units, integral coping, and subgirts.

1.2 RELATED REQUIREMENTS

A. Section 04 27 31 Reinforced Unit Masonry

B. Section 05 40 00 Cold Formed Metal Framing

C. Section 07 25 00 Air Barrier System

D. Section 07 62 00 Sheet Metal Flashing and Trim

E. Section 0790 05 Joint Sealers

F. Section 08 80 00 Glazing

1.3 REFERENCE STANDARDS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501.1	(2005) Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
AAMA 501.2	(2003) Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtainwalls and Sloped Glazing Systems
AAMA 508	(2005) Voluntary Test Method and Specifications for Pressure Equalized Rain Screen Wall Cladding Systems

AAMA 621	(1996) Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) & Zinc-Aluminum Coated Steel Substrates

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-10	Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A 653/A 653M	(2009) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 755/A 755M	(2003; R 2008) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM C 1363	(2005) Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
ASTM C 209	(2007ae1) Standard Test Methods for Cellulosic Fiber Insulating Board
ASTM C 645	(2008a) Nonstructural Steel Framing Members
ASTM C 754	(2009) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM E 1592	(2005) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E 283	(2004) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 329	(2008) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM E 331	(2000; R 2009) Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 72	(2005) Conducting Strength Tests of Panels for Building Construction
ASTM E 84	(2009a) Standard Test Method for Surface Burning Characteristics of Building Materials

ANSI/FM GLOBAL (ANSI/FM)

ANSI/FM 4880	(2001; R 2007) Standard for Evaluating Insulated Wall & Roof/Ceiling Assemblies
FM 4881	Class 1 Exterior Wall Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 285	(2006) Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2006) Architectural Sheet Metal Manual, Sixth Edition, Second Printing

UNDERWRITERS LABORATORIES (UL)

UL 1715	(1997) Fire Test of Interior Finish Material
UL 723	(2008) Standard for Test for Surface Burning Characteristics of Building Materials

1.4 PERFORMANCE REQUIREMENTS

Provide metal wall panel system meeting performance requirements as determined by application of specified tests by a qualified testing agency on manufacturer's standard assemblies.

A. Delegated Design

Engage a qualified engineer to provide design and engineering analysis of the metal wall panel system based on Project performance requirements and design criteria.

B. Air Infiltration

Maximum 0.06 cfm/sq. ft. air infiltration per ASTM E 283 at a static-air-pressure difference of 6.24 lbf/sq. ft., using minimum 10-by-10 foot test panel that includes horizontal and vertical joints.

C. Water Penetration, Static Pressure

No uncontrolled water penetration per ASTM E 331 at a minimum static differential pressure of 15 lbf/sq. ft., using minimum 10-by-10 foot test panel that includes horizontal and vertical joints.

D. Water Penetration, Dynamic Pressure

No uncontrolled water penetration per AAMA 501.1 at a minimum static differential pressure of 15 lbf/sq. ft., using minimum 10-by-10 foot test panel that includes horizontal and vertical joints.

E. System Performance

Meet minimum performance criteria per AAMA 508 using test panel that includes horizontal and vertical joints.

F. Water Absorption

Maximum 1.0 percent absorption rate by volume when tested according to ASTM C 209.

G. Structural Performance

Provide metal wall panel system capable of withstanding the effects of indicated loads and stresses within limits and under conditions indicated, per ASTM E 72 and complying with the load and stress requirements in accordance with ASTM E 1592. Wind Load force due to wind action governs the design for panels. Submit wind load tests to the CTDOT PM.

1. Wind Loads: Wind Load shall be as indicated on the structural drawings. Apply a Safety Factor of 2.0.

2. Limits of Deflection: Metal wall panel system shall withstand scheduled wind pressure with the following allowable deflection:

   a. Maximum allowable deflection limited to L/175 deflection of panel perimeter normal to plane of wall with no evidence of failure.

3. Window Wind Pressure: Minimum wind pressure load shall be 46.6 psf, as indicated on structural drawings. Apply a Safety Factor of 2.0.

H. Thermal Movements

Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction.

I. Thermal Performance

Thermal-resistance (R) value indicated, per ASTM C 1363.

1.5 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and Section 01 33 00.13 – DOCUMENT CONTROL:

A. Quality Assurance Submittals

1. Qualification of Manufacturer
2. Qualification of Installer
3. Warranty: Submit Sample Warranty

B. Shop Drawings

1. Fabrication and installation drawings prepared by manufacturer or manufacturer's authorized dealer. Include full elevations showing openings and penetrations. Include details of each condition of installation and attachment. Provide details at a minimum scale 1-1/2-inch per foot of all required trim and extrusions needed for a complete installation. Include spacing, sizing, and material types of fasteners and connections to be used in completed assembly.
2. Metal Wall Panel System
3. Flashing and Accessories
4. Anchorage Systems
5. Closure Materials, including metal closure strips.
6. Include data indicating compliance with performance requirements, prepared and signed by qualified professional engineer
7. Indicate points of supporting structure that must coordinate with metal wall panel system installation, including subgirts, concrete masonry and cold formed metal framing backup wall.

C. Product Data

1. Submit manufacturer's catalog data for specified products:
   a. Factory Color Finish
   b. Metal Wall Panel
   c. Flashing and Accessories
   d. Integrated Window System
   e. Secondary Metal Framing
   f. Repair Paint
   g. Anchorage systems
   h. Insulation
   i. Flashing Tape
   j. Fasteners

D. Samples

1. Metal Wall Panel system including integrated window and integral coping.
2. Sealants
3. Samples for Initial Selection: For each product specified including sealants. Submit manufacturer's color charts and chips showing full range of colors, including custom color indicated on drawings.
4. Samples for Verification: Provide 24-inch section of metal wall panel and integral window and coping, showing finishes, horizontal joinery, vertical joint, core material, panel stiffener and anchoring details. Provide 12-inch long pieces of each extruded aluminum trim.

E. Design Data

1. Calculations
2. Wind design analysis

F. Test Reports

1. Wind load tests
2. Wall system fire performance data.
3. Product test reports indicating compliance of products with requirements, from a qualified independent testing agency. Include spacing, sizing, and material types of fasteners and connections as used in tested assembly.

G. Certificates

1. Submit certificates for the following items showing conformance with referenced standards contained in this section:
   a. Fasteners
   b. Repair Paint
2. Qualification of Manufacturer
   a. Certify that the manufacturer of the metal wall panel system meets requirements specified under paragraph entitled "Qualification of Manufacturer."
3. Qualification of Installer
   a. Certify that the applicator meets requirements specified under paragraph entitled "Qualification of Installation Installer."
4. Submit the metal wall panel system assembly wind load and fire rating classification listings.

H. Manufacturer's Instructions

1. Installation of Metal Wall Panels, integrated windows, and integral coping.

I. Manufacturer's Field Reports

1. Water-Spray Test
2. Field Service Report

J. Closeout Submittals

1. Warranty
2. Instructions To: Owner
3. Include copies of Material Safety Data Sheets for maintenance/repair materials.

1.6 QUALITY ASSURANCE

A. Manufcturer/Source: Provide metal wall panel, integrated window and integral coping from a single manufacturer

B. Qualification of Manufacturer

Metal wall panel system manufacturer must have a minimum of five (5) years experience in manufacturing metal wall panel system and accessory products.

C. Qualification of Engineer

1. Provide engineering services by an authorized engineer; currently licensed in the State of Connecticut, having a minimum of four (4) years experience as an engineer knowledgeable in wind load design analysis, protocols and procedures for ASCE 7-10 and ASTM E 1592.

2. Provide certified engineering calculations using the products submitted for:

   a. Wind load requirements in accordance with ASCE 7-10.

D. Qualification of Installer

The installation contractor must be approved and certified by the metal wall panel manufacturer prior to beginning the installation of the metal wall system, and shall have a minimum of five (5) years of successful experience installing the specified system.

E. Testing Agency Qualifications

Qualify in accordance with requirements of ASTM E 329.

F. Fire Performance Characteristics

Provide metal wall panel systems with the following fire-test characteristics determined by indicated test standard as applied by UL or other testing and inspection agency acceptable to authorities having jurisdiction.

1. Surface-Burning Characteristics: Provide metal wall system panels with the following characteristics when tested per ASTM E 84 or UL 723.

   a. Flame spread index: 25 or less.

   b. Smoke developed index: 450 or less.

2. Fire Performance of Insulated Wall: Class 1 wall panel per ANSI/FM 4880.

3. Room Corner Test: NFPA 285 or UL 1715.

4. Intermediate Scale Multistory Fire Test: Representative mockup tested per NFPA 285.

G. Mockups

Build mockup in location as directed by CTDOT PM. Show details of metal wall panel system. Demonstrate methods and details of installation. Show details of penetrations, doors, windows,

pipe openings, inside and outside corners, top and bottom of wall, horizontal and vertical joints, and coping.

1. Perform water spray test of mockup to demonstrate working principles of rainscreen design.

2. Approval of mockup does not relieve Contractor of responsibility to comply with all requirements of contract documents.

3. Approved mockup may become part of installation if approved by the CTDOT PM.

1.7 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Conference

Conduct preinstallation meeting at site attended by Owner, Installer, manufacturer's technical representative, and other trade contractors, to review the following:

1. Coordinate building framing in relation to metal wall panel system.

2. Coordinate window, door and other openings and penetrations of metal wall panel system.

3. Review drawings, including Fabrication and Installation drawings, showing complete Wall Panel System, and specifications.

   Include review of submittal items as applicable for the following:

   Flashing and accessories
   Anchorage systems
   Manufacturer's catalog data
   Factory Color Finish and custom color finish.
   Insulation
   Closure Materials, including metal closure strips.
   Flashing Tape
   Fire Performance test data
   Fasteners

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

5. Methods and procedures related to metal wall panel system installation, including manufacturer's written instructions for Installation, and verification of wall system wind load and fire rating classification listings.

6. Support conditions for compliance with requirements, including alignment between and attachment to backup wall structural members. Provide details of wind design analysis including wind speed, exposure category, co-efficient, importance factor, designates type of facility, negative pressures for each zone, methods and requirements of attachment. Wind design analysis to include wall plan delineating dimensions and attachment patterns for each zone. Wind design analysis to be prepared and sealed by Licensed Engineer in the State of Connecticut

7. Flashing, special details, wall penetrations, openings, and condition of other construction that will affect metal wall panel system.

8. Governing regulations and requirements for insurance, certificates, tests and inspections if applicable. Include review of wall system assembly wind load, and fire rating classification. Safety plan review must include applicable Material Safety Data Sheets.

9. Temporary protection requirements for metal wall panel system during and after installation.

10. Metal Wall panel system observation and repair procedures after installation. Include review of sample repair paint.

11. Sample Warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect products of metal wall panel system during shipping, handling, and storage to prevent staining, denting, deterioration of components or other damage.

B. Deliver, unload, store, and erect metal wall panel system and accessory items without misshaping or exposing components to surface damage from weather or construction operations.

1.9 WARRANTY

A. Special Manufacturer's Warranty

On manufacturer's standard form, in which manufacturer agrees to repair or replace metal wall panel system including integrated window units, and coping, that fail in materials and workmanship within two (2) years from date of Substantial Completion.

B. Special Finish Warranty

On manufacturer's standard form, in which manufacturer agrees to repair or replace all components of the metal wall panel system that evidence deterioration of finish within twenty (20) years from date of Substantial Completion.

C. Refer to Section 01 78 30 Warranties and Bonds for additional information.

1.10 SUSTAINABLE DESIGN REQUIREMENTS

A. Refer to Section 01 81 13 Sustainable Design requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. CENTRIA, Formawall Dimension Series, PIR Insulated Core Metal Wall Panels, with Integrated Windows. Provide Horizontal Flat, Horizontal Profile DS59 (Ribbed Type B), and Horizontal Profile DS60 (Ribbed type A) panels, and integral coping extrusion.

CENTRIA Architectural Systems; Moon Township, PA 15108-2944.

Tel: (800) 759 7474. Tel: (412) 299-8000.

Web: www.CENTRIA.com

B. METL-SPAN, Envolution, with Integrated Windows. Provide horizontal "INNOVA" and "Bold RIB" panels, and integral coping.

METAL-SPAN; 1720 Lakepoint Drive, Lewisville, TX,75057

Tel: (877) 585-9969

Web: www.envolution.com

C. Kingspan Benchmark, Designwall, with Integrated Windows. Provide horizontal "2000" and "2000 R (Ribbed)" panels, and integral coping.

Kingspan Benchmark

720 Marion Road, Columbus, OH 43207

Tel: (877) 638-32666

Web: www.kingspanpanels.us.com

D. Approved Equal product as determined by Architect.

E. Substitutions: See Section 01 60 00 Product Requirements

2.2 PANEL MATERIALS

A. Metallic-Coated Steel Face Sheet

Coil-coated, ASTM A 755/A 755M.

a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90, structural quality.

b. Face Sheet Thickness: Minimum 0.034 inch/22 gage thick.

c. Surface: Smooth

B. Exposed Metal Finish:

1. Fluoropolymer Two-Coat System: 0.2-mil primer with 0.8-mil 70 percent PVDF fluoropolymer color coat, AAMA 621.

2. Color: As selected by Architect from manufacturer's standard colors and custom color indicated on drawings.

C. Metallic-Coated Steel Liner Sheet

Coil-coated, ASTM A 755/A 755M, 0.028 inch/24 gage thick.

a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90, structural quality.

b. Surface: Embossed planked.

c. Interior Liner Panel Finish: 0.2 mil primer with 0.6 mil acrylic color coat.

D. Exposed Trim

Match panel finish.

2.2 INSULATION FOR PANEL CORES

Metal Panel Insulation-Core: Urethane-modified isocyanurate, or manufacturer's standard, density 2.7 lb/cu. ft., minimum compressive strength 20 lb/sq. in., and containing no CFC or HCFC compounds.

2.3 INSULATION-CORE METAL WALL PANELS

Insulation-Core Metal Wall Panels: Factory insulated horizontal wall panel system consisting of an exterior metal face sheet with interior metal liner sheet, bonded to insulation core in thermally-separated profile, and with factory sealed tongue-and-groove and rainscreen-design pressure-equalized-chamber horizontal joint, attached to supports using concealed fasteners.

A. Panel Joinery

a. Horizontal Panels: Rainscreen design with pressure equalized chamber and vented weep holes.

b. Panel Ends: End Panels designed for drainage to the horizontal joints without end dam sealant. Provide insulated four sided metal vertical joint with metal back plate, insulation spline for continuity of insulation, and metal facing plate.

B. Panel Width

24 inch.

C. Panel Length

As indicated on drawings between vertical joints.

D. Panel Profile

Flat and Profile-faced in locations and sizes indicated on drawings.

a. Reveals: 1-3/16 inch deep by 1/2 inch width.

E. Panel Thickness:

2-1/2 inch, profiled 2-1/2 inch, flat.

F. Thermal-Resistance (R) Value:

R-12.5 minimum

2.4 METAL WALL PANEL ACCESSORIES

Provide complete metal wall panel system incorporating trim, integral copings, sills, inside and outside corners, and miscellaneous flashings. Provide manufacturer's factory-formed clips, shims, flashings, lap tapes, closure strips, and caps for a complete installation. Fabricate accessories in accordance with SMACNA 1793.

A. Formed Flashing and Trim

Match material, thickness, and color of metal wall panel face sheets.

B. Extrusion Trim

Provide manufacturer-provided extruded trim for the following locations and as indicated on Drawings:

a. Base trim.

b. Integral Coping.

c. Panel installation perimeter.

d. Opening perimeters.

C. Sealants

Type recommended by metal wall panel system manufacturer for application, meeting requirements of Section 07 90 05 JOINT SEALERS.

D. Flashing Tape

4 inch wide self-adhering butyl flashing tape.

E. Panel Clips

Concealed stainless steel clip configured specifically for metal wall panel profile, engaging face and liner panel edge without compressing panel insulation.

F. Fasteners

Self-tapping screws, bolts, nuts, and other acceptable fasteners recommended by panel manufacturer. Where exposed fasteners cannot be avoided, supply corrosion-resistant fasteners with heads matching color of metal wall panels by means factory-applied coating.

2.5 INTEGRATED WINDOW SYSTEM

Integrated Window Units: Thermally-improved fixed aluminum window units designed to integrate with metal wall panel profile and secondary support system without receptor channels or other flashing, with rain screen and pressure equalization design meeting system requirements. Sash shall accepts 1 inch insulating glass units.

A. Integrated Window System

Manufacturers

1. CENTRIA, Formavue FV-650
   a. Depth: 5-1/2 inch.
   b. R-Value: 3.5
   c. Sightlines: Head: 3 inch; Sill: 3 inch; Mullions: 3 inch
2. METL-SPAN, METL-VISION
   a. Depth: 4 inch minimum
3. Kingspan, Flushglaze 4500
   a. Depth: 4-1/2 inch minimum
4. Approved Equal product as determined by Architect.
5. Substitutions: See Section 01 60 00 Product Requirements.

B. Configuration

As indicated. Provide interior receptor anchorage clips as required for CMU or Cold Formed Metal Framing Anchorage as indicated on drawings.

C. Mullions

Full.

D. Frame

Thermally-improved 6063-T5 or 6560-T5 aluminum extrusion, fully integrated with panel joints, inside glazed.

E. Finish, Exterior

Match metal wall panel finish, Color 2 as indicated on the drawings.

F. Finish, Interior

Match metal wall panel finish.

G. Glazing

1 inch insulating glass, as specified in Section 08 80 00 GLAZING.

2.6 SECONDARY METAL FRAMING

Miscellaneous Framing Components, General: Cold-formed metallic-coated steel sheet, ASTM C 645, Grade 50, with ASTM A 653/A 653M, G90 (Z180) hot-dip galvanized zinc coating.

A. Subgirts

C- or Z- shaped sections, 0.054 inch minimum, depth as indicated on drawings.

B. Sill Channels

0.054 inch minimum.

C. Hat Channels

0.054 inch minimum.

PART 3 EXECUTION

3.1 EXAMINATION

Examine metal wall panel system substrate with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation.

A. Framing

Inspect framing that will support metal wall panel system to determine if support components are installed as indicated on approved shop drawings. Confirm presence of acceptable framing members at recommended spacing to match installation requirements.

B. Wall

Confirm that wall is within tolerances acceptable to metal wall panel system manufacturer.

1. Maximum deviations acceptable:
   a. 1/4 inch in 20 feet vertically or horizontally from face plane of framing.
   b. 1/2 inch maximum deviation from framing face plane on any building elevation.
   c. 1/8 inch in 5 feet.

C. Openings

Verify that window, door, and other penetrations match layout on shop drawings.

D. Correction

Correct out-of-tolerance work and other deficient conditions prior to proceeding with metal wall panel system installation.

3.2 PREPARATION

Secondary Metal Framing: Install secondary metal framing components as indicated. Install secondary metal framing and other metal panel supports per ASTM C 754 and metal wall panel system manufacturer's recommendations.

3.3 METAL WALL PANEL SYSTEM INSTALLATION

Install metal wall panel system in accordance with approved shop drawings and manufacturer's recommendations. Install metal wall panel system in orientation, sizes, and locations indicated. Anchor metal wall panel system and other components securely in place. Provide for thermal and structural movement

A. Attach to concrete masonry and cold formed metal framing structural wall backup system using recommended clips, screws, and fasteners indicated on approved shop drawings.

1. Fasteners: Stainless-steel for exterior locations and locations exposed to moisture; carbon steel for interior use only.

2. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as approved by manufacturer.

3. Fasten to supports with concealed clips at each joint at location, spacing, and with fasteners recommended by manufacturer. Install clips to supports with self-tapping fasteners.

4. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

5. Horizontal Joinery: Working from base of installation to top connect upper panel to lower panel at dry seal joinery.

6. Vertical Joinery: Provide as specified and indicated on shop drawings.

7. Dissimilar Materials: Where elements of metal wall panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.

B. Joint Sealers: Install, joint fillers, and sealants where indicated on shop drawings and where required for weatherproof performance of metal wall panel system.

3.4 ACCESSORY INSTALLATION

Install metal wall panel system accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

A. Install related flashings and sheet metal trim per requirements of Division 07 Section "Sheet Metal Flashing and Trim."

B. Install components required for a complete metal wall panel system, including trim, copings, corners, flashings, sealants, fillers, closure strips, and similar items.

C. Comply with performance requirements and manufacturer's written installation instructions.

D. Provide concealed fasteners.

E. Set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.5 INTEGRATED WINDOW UNIT INSTALLATION

Install window units in accordance with manufacturer's recommendations and approved shop drawings. Anchor supports to structure with approved anchors. Assemble components using gaskets, fasteners, and trim supplied by metal wall panel manufacturer. Separate dissimilar metals with bituminous coating.

3.6 FIELD QUALITY CONTROL

A. Testing Agency

Owner will engage an independent testing and inspecting agency to perform field tests and inspections and to prepare field test reports.

B. Water-Spray Test

After completing portion of metal wall panel assembly including accessories and trim, test 2-bay area selected by CTDOT PM for water penetration, according to AAMA 501.2.

C. Manufacturer's Field Service

Engage a service representative authorized by metal wall panel manufacturer to inspect completed installation. Submit written field service report. Correct deficiencies noted in report.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective films. Clean finished surfaces as recommended by metal wall panel manufacturer. Clear weep holes and drainage channels of obstructions, dirt, and sealant. Maintain in a clean condition during construction.

B. Replace damaged panels and accessories that cannot be repaired by finish touch-up or minor repair.

END OF SECTION 07 42 13

SECTION 07 42 64 ALUMINUM COMPOSITE MATERIAL WALL PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Composite wall panel system consisting of aluminum-faced composite panels in a rainscreen application as part of the assembly described below.

1. Metal Wall Panels over Multi-Component Framed Wall System: Aluminum-faced composite panels applied as exterior rainscreen cladding over wall framing with exterior sheathing. Metal wall panel installation specified in this Section includes secondary metal subgirt framing and mounting clips for panel attachment.

B. Weather Barrier

C. Metal Panel Soffitt System

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 Sustainable Design Requirements

B. Section 05 40 00 Cold Formed Metal Framing.

C. Section 07 62 00 Sheet Metal Flashing and Trim for flashings.

D. Section 07 90 05 Joint Sealers for field-applied joint sealants.

1.3 SYSTEM DESCRIPTION

A. Composite Metal Panel Wall System: Drained and back-ventilated rainscreen design consisting of dry seal joinery designed to minimize water penetration and induce air circulation in the space behind the panel system. Moisture weeping trim at panel base details allows water to drain out of the system.

1.4 REFERENCE STANDARDS

AMERICAN ARCHITECTURAL MANUFACTURER'S ASSOCIATION (AAMA):

A. AAMA 508-07 Voluntary Test Method and Specifications for Pressure Equalized Rain Screen Wall Cladding Systems

B. AAMA 509 Voluntary Test and Classification Method for Drained and Back Ventilated Rain Screen Wall Cladding Systems.

C. AAMA 620 Voluntary Specification High Performance Organic Coatings on Coil Coated Architectural Aluminum.

D. AAMA 2605 Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE):

E. ASCE 7 — Minimum Design Loads for Buildings and Other Structures.

ASTM INTERNATIONAL (ASTM):

F. ASTM A 653 — Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

G. ASTM B 209 — Specification for Aluminum and Aluminum Alloy Sheet and Plate.

H. ASTM C 645 — Specification for Nonstructural Steel Framing Members.

I. ASTM D 3359 — Standard Test Methods for Measuring Adhesion by Tape Tests.

J. ASTM E 84 — Test Methods for Surface Burning Characteristics of Building Materials.

K. ASTM E 329 — Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA):

L. NFPA 285 — Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.

1.5 PERFORMANCE REQUIREMENTS

A. General: Provide composite wall panel system meeting performance requirements as determined by application of specified tests by a qualified testing agency on manufacturer's standard assemblies.

B. Structural Performance: Design composite wall panel system fabricated to withstand effects of indicated loads and stresses within limits and under conditions indicated below.

1. Wind Loads: Determine loads based on uniform pressure, importance factor, exposure category, and basic wind speed indicated on drawings.

2. Limits of Deflection: Composite wall panel system shall withstand scheduled wind pressure with the following allowable deflection:

a. Maximum allowable deflection limited to L/175 deflection of panel head and sill normal to plane of wall.

b. Maximum allowable deflection of panel stiffeners and aluminum panel material combined limited to L/60.

C. System Performance: A third party test report utilizing the standard ASTM E 283, E 331 and AAMA 501 procedures following the test protocol described in AAMA 508-07. Test panel must include a horizontal joint, with an imperfect air barrier.

D. Drained and Back Ventilated Rain Screen Performance: Per AAMA 509-09:

1. Water penetration through panel system: W1 classification.

2. Ventilation: V4 classification.

E. Thermal Movements: Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Approved manufacturer listed in this Section with minimum 10 years experience in manufacture of similar products in successful use in similar applications.

B. Wall Systems Installer Qualifications: Experienced Installer with minimum of 5 years experience with successfully completed projects of a similar nature and scope.

C. Fire Performance Characteristics: Provide metal composite wall systems with the following fire-test characteristics determined by indicated test standard as applied by UL or other testing and inspection agency acceptable to authorities having jurisdiction.

1. Surface-Burning Characteristics: Provide metal composite wall system panels with the following characteristics when tested per ASTM E 84.

   a. Flame spread index: 25 or less.

   b. Smoke developed index: 450 or less.

2. Intermediate Scale Multistory Fire Test: Representative mockup tested per NFPA 285 for a complete wall system providing air, water, vapor and thermal barriers.

D. Mockups: Build mockup. Show details of composite wall panel system. Demonstrate methods and details of installation. Show details of gasketed return vertical joints, penetrations, inside and outside corners, top and bottom of wall, horizontal and vertical joints.

1. Approval of mockup does not relieve Trade Contractor of responsibility to comply with all requirements of contract documents.

2. Approved mockup may become part of installation if approved by Owner.

1.7 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct preinstallation meeting at site attended by Owner, manufacturer's technical representative, and other trade contractors.

1.8 ACTION SUBMITTALS

A. Product Data: Manufacturer’s data sheets for specified products.

B. Shop Drawings: Provide shop drawings prepared by manufacturer or manufacturer's authorized dealer. Include full elevations showing openings and penetrations. Include details of each condition of installation and attachment. Provide details at a minimum scale 1-1/2-inch per foot of all required trim and extrusions needed for a complete installation

1. Include data indicating compliance with performance requirements.

2. Indicate points of supporting structure that must coordinate with composite wall panel system installation.

C. Samples for Verification: Provide 24-inch (600 mm) section of wall panel showing finishes, horizontal joinery, vertical joint return, injected core material, panel stiffener and anchoring details. Provide 12-inch (300 mm) long pieces of each extruded aluminum trim and gaskets.

D. Product Test Reports: Indicating compliance of products with requirements, from a qualified independent testing agency.

E. Qualification Information: For Installer and Installer's field supervisor.

F. Manufacturer's warranty: Submit sample warranty.

G. Maintenance data.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect products of composite wall panel system during shipping, handling, and storage to prevent staining, denting, deterioration of components or other damage.

1. Deliver, unload, store, and erect composite wall panel system and accessory items without misshaping panels or exposing panels to surface damage from weather or construction operations.

1.10 WARRANTY

A. Special Manufacturer’s Warranty: On manufacturer’s standard form, in which manufacturer agrees to repair or replace metal wall panel assemblies that fail in materials and workmanship within two (2) years from date of Substantial Completion.

B. Special Panel Finish Warranty: On manufacturer’s standard form, in which manufacturer agrees to repair or replace wall panels that evidence deterioration of finish within twenty (20) years from date of Substantial Completion.

C. See Section 01 78 30 – Warranty and Bonds for additional warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: CENTRIA, FormaBond II Composite Wall Panel System.

1. CENTRIA Architectural Systems; Moon Township, PA 15108-2944. Tel: (800)759-7474. Tel: (412)299-8000. Fax: (412)299-8317. Email: info@CENTRIA.com. Web: www.CENTRIA.com.

2. Substitutions: See Section 01 60 00 Product Requirements.

2.2 MATERIALS

A. Aluminum Sheet: Smooth surface coil-coated sheet, ASTM B209.

B. Aluminum Extrusions: ASTM B 221, 3105 Aluminum.

2.3 ALUMINUM COMPOSITE METAL PANELS

A. Composite Metal Panels: Factory-formed, aluminum-faced composite panels fabricated from two sheets of 0.020 inch (0.51 mm) thick aluminum facing sheets with metal facings bonded to thermoplastic core, and rout and return joinery.

1. Thickness: 4 mm nominal.

2. Panel Flatness: Maximum allowable distortion: 1/32-inch in 24-inches (0.794 mm in 600 mm) in any direction.

3. Panel Core: Thermo-set polymeric.

4. Stiffeners: Manufacturer's standard stiffener as required to meet performance requirements.

5. System Depth: 2 ½-inches

B. Face Sheet Surface: Smooth.

C. Face Sheet Coil-Coated Finish:

1. Fluoropolymer Two-Coat System: 0.2-mil primer with 0.8-mil 70 percent PVDF fluoropolymer color coat, AAMA 620.

a. Basis of Design: CENTRIA Fluorofinish.

2. Color: As indicated on drawings

D. Unexposed Finish: Manufacturer's standard primer.

E. Exposed Trim and Fastener Finish: Match panel finish.

2.4 SECONDARY METAL FRAMING

A. Miscellaneous Framing Components, General: Cold-formed metallic-coated steel sheet, ASTM C 645, Grade 50, with ASTM A 653/A 653M, G90 (Z180) hot-dip galvanized zinc coating.

1. Hat Channels: 0.053 inch/16 ga. (1.34 mm) minimum.

2. Sill Channels: 0.053 inch/16 ga. (1.34 mm) minimum.

2.5 WEATHER BARRIER

A. Self-Adhered Water Resistant Barrier

B. Vapor Permeable

C. Thickness: 19 mils

D. Basis od Design: Blueskin VP 100 by Henry Company, or equal.

2.6 ACCESSORIES

A. Provide manufacturer's factory-formed clips, shims, flashings, sealants, and tapes for a complete installation.

B. Extruded Trim: Aluminum, minimum thickness 0.060 inch (1.59 mm) for trim and 0.90 inch (2.38 mm) for structural units. Include manufacturer-provided extruded trim for the following locations and as indicated on Drawings:

1. Base trim.

2. Coping.

3. Panel installation perimeter.

4. Opening perimeters.

C. Splines: Match panel material and finish.

D. Gaskets: Panel manufacturer's EPDM or neoprene, fire-retardant-treated.

E. Sealants: Type recommended by composite wall panel system manufacturer for application, meeting requirements of Section 07 80 05 Joint Sealers.

F. Flashing Tape: 4 inch (102 mm) wide self-adhering butyl flashing tape.

2.7 FABRICATION

A. General: Fabricate composite wall panels and accessories at factory identical to tested units using manufacturer's standard procedures and processes necessary to meet performance requirements.

1. Provide components of composite wall panel system that are products of one manufacturer, including composite panels, gaskets, head and sill trim, bottom weep, base extrusion, and metal copings.

B. Composite Panels: Fabricate composite wall panels with extruded aluminum stiffeners requiring no further fabrication or modification in field.

1. Horizontal Joints: Dry seal, drained and back ventilated.

2. Vertical Joints: Pre-formed returns with metal spline, gasket and aluminum extrusion receptors and extruded drain channels.

3. Reveals: 0.50 inch (12 mm).

4. Formed Panel Thickness: 2.50 inch (63.5 mm).

2.8 METAL PANEL SOFFIT SYSTEM

A. Basis of Design: Centria IW Series Profile IW-10A.

B. Substitutes: See Section 01 60 00 Product Requirements.

C. Material: 0.040 inch aluminum.

D. Panel width: 12 inches

E. Panel Depth: 1-1/2 inches

F. Panel Surface: Smooth Panel Surface.

G. Panel Finish: Same finish as aluminum composite material.

H. Provide 10 percent of panels perforated for venting.

I. Provide 16 gage galvanized 1-1/2 inch support framing.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine composite wall panel system substrate with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of composite wall panel system.

1. Inspect framing that will support composite wall panel system to determine if support components are installed as indicated on approved shop drawings and are within tolerances acceptable to composite wall panel system manufacturer.

a. Maximum deviations acceptable to composite wall panel system manufacturer:

1) 1/4-inch in 20 feet (6.4 mm in 6 m) vertically or horizontally from face plane of framing.
2) 1/2-inch (12.7 mm) maximum deviation from flat substrate on any building elevation.
3) 1/8-inch in 5 feet (3.2 mm in 1.5 m).

2. Confirm presence of acceptable framing members to match installation requirements of composite wall panel system.

a. Confirm framing minimum .053 inch/16 ga (1.34 mm) at maximum 24 inch (610 mm) spacing.

B. Correct out-of-tolerance work and other deficient conditions prior to proceeding with composite wall panel system installation.

3.2 ALUMINUM COMPOSITE WALL PANEL SYSTEM INSTALLATION

A. General: Install composite wall panel system in accordance with approved shop drawings and manufacturer's recommendations.

B. Installation: Attach panels to metal framing using recommended clips, screws, fasteners, sealants, and adhesives indicated on approved shop drawings.

1. Horizontal Joinery: Working from base of installation to top, connect upper panel to lower panel at dry seal joinery utilizing field-applied attachment clip.

2. Vertical Joinery: Provide reveal between vertical ends of panels as shown on shop drawings using hardware furnished by manufacturer.

a. Install gaskets where indicated.

b. Install splines where indicated.

3. Galvanic Action: Where elements of metal composite wall system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.

C. Rainscreen Installation: Proceed with installation of manufacturer's dry seal horizontal joinery. Keep open spaces in horizontal joinery intended to ventilate cavity behind system.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a service representative authorized by metal wall panel manufacturer to inspect completed installation. Submit written report. Correct deficiencies noted in report.

3.4 CLEANING AND PROTECTION

A. Remove temporary protective films within 2 weeks of erection. Clean finished surfaces as recommended by metal wall panel manufacturer. Clear weep holes and drainage channels of obstructions, dirt, and sealant. Maintain in a clean condition during construction.

B. Replace damaged panels and accessories that cannot be repaired by field repair.

END OF SECTION 07 42 64

SECTION 07 54 00 - THERMOPLASTIC MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fully adhered system with thermoplastic roofing membrane.

B. Insulation, flat and tapered.

C. Deck sheathing.

D. Flashings.

E. Roofing accessories.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements

B. Section 06 10 00 - Rough Carpentry: Wood nailers

C. Section 07 25 00 – Air Barrier System

D. Section 07 62 00 - Sheet Metal Flashing and Trim: Flashings.

E. Section 07 72 00 - Roof Accessories: Roof-mounted units; prefabricated curbs.

F. Section 08 62 23 - Tubular Skylights: Skylight frame, integral curb, and counterflashing.

G. Section 22 00 00 - Plumbing: Roof drains.

1.3 REFERENCE STANDARDS

A. ASTM C177/C177M Standard Specification for Glass Mat Gypsum Substarate for use as Sheathing; 2013.

B. ASTM C1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2014.

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

D. ASTM E1980 Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces; 2011.

E. FM P7825 — Approval Guide; Factory Mutual Research Corporation; current edition.

F. FM DS 1-28 — Wind Design; Factory Mutual Research Corporation; 2007.

G. NRCA ML104 — The NRCA Roofing and Waterproofing Manual; National Roofing Contractors Association; Fifth Edition, with interim updates.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

1. Review preparation and installation procedures and coordinating and scheduling required with related work.

1.5 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, and fasteners.

1. Sustainability Submittal: Include testing documentation of solar reflectance index.

C. Specimen Warranty: For approval.

D. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and setting plan for tapered insulation.

E. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.

H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 **QUALITY ASSURANCE**

A. Perform work in accordance with NRCA Roofing and Waterproofing Manual.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section:

1. With minimum 5 years documented experience.

2. Approved by membrane manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

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

B. Store products in weather protected environment, clear of ground and moisture.

C. Protect foam insulation from direct exposure to sunlight.

1.8 FIELD CONDITIONS

A. Do not apply roofing membrane during unsuitable weather.

B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above 120 degrees F.

C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.9 WARRANTY

A. See Section 01 78 30 – Warranties and Bonds, for additional warranty requirements.

B. Material Warranty: Provide membrane manufacturer's warranty agreeing to replace material that shows manufacturing defects within 5 years after installation.

C. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.

1. Warranty Term: 15 years.

2. For repair and replacement include costs of both material and labor in warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Thermoplastic Polyolefin (TPO) Membrane Materials:

1. Carlisle Roofing Systems, Inc; Sure-Weld TPO: www.carlisle-syntec.com.

2. Firestone Building Products, LLC; UltraPly TPO Series: www.firestonebpco.com.

3. GAF; EverGuard TPO: www.gaf.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation:

1. Atlas Roofing Corporation: www.atlasroofing.com.

2. Carlisle SynTec; SecurShield Insulation: www.carlisle-syntec.com.

3. GAF; EnergyGuard PolyIso Insulation: www.gaf.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 ROOFING - UNBALLASTED APPLICATIONS

A. Thermoplastic Membrane Roofing: One ply membrane, fully adhered, and insulation.

B. Roofing Assembly Requirements:

1. Solar Reflectance Index (SRI): 78, minimum, calculated in accordance with ASTM E1980.

a. Field applied coating may not be used to achieve specified SRI.

2. Factory Mutual Classification: Class I and windstorm resistance of I-90, in accordance with FM DS 1-28.

3. Insulation Thermal Value (R), minimum: as indicated on the drawings; provide insulation of thickness required.

C. Acceptable Insulation Types - Constant Thickness Application: Any of the types specified.

1. Minimum 2 layers of polyisocyanurate board.

2. Bottom layer of polyisocyanurate board covered with single layer of polyisocyanurate board.

D. Acceptable Insulation Types - Tapered Application: Any of the types specified.

1. Tapered polyisocyanurate board.

2.3 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

A. Membrane:

1. Material: Thermoplastic polyolefin (TPO) complying with ASTM D6878.

2. Reinforcing: Internal fabric.

3. Thickness: 60 mil.

4. Sheet Width: Factory fabricated into largest sheets possible.

5. Color: White.

B. Seaming Materials: As recommended by membrane manufacturer.

C. Flexible Flashing Material: Same material as membrane.

2.4 DECK SHEATHING

A. Deck Sheathing: Gypsum sheathing, ASTM C177/177M, special fire-resistant type, paper face, 5/8 inch thick.

1. Products:

a. Georgia Pacific DensDeck

b. Substitutions: See Section 01 60 00 – Product Requirements

2.5 INSULATION

A. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C1289, Type I; Class 1, non-reinforced foam core and with the following characteristics:

1. Compressive Strength: 16 psi

2. Tapered Board: Slope as indicated; minimum thickness 1 inch; fabricate of fewest layers possible.

3. Thermal Resistance: R-value of 20.

4. Board Edges: Square.

5. Manufacturers:

a. Atlas Roofing Corporation; ACFoam-II and Tapered ACFoam-II: www.atlasroofing.com.

b. GAF: www.gaf.com.

c. Versico, a division of Carlisle Construction Materials, Inc; SecurShield Insulation: www.versico.com.

6. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 ACCESSORIES

A. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; elastomeric material compatible with membrane.

B. Cant and Edge Strips: Wood fiberboard, compatible with roofing materials; cants formed to 45 degree angle.

C. Pre-Cut Tapered Insulation:

1. Manufacturers:

a. Atlas Roofing Corporation; Gemini Pre-Cut Crickets, Gemini One-Piece Drain Set, Gemini One-Piece Miter, and Gemini Tapered Edge Strip: www.atlasroofing.com.

b. Substitutions: See Section 01 60 00 - Product Requirements.

D. Insulation fasteners: Appropriate for purpose intended and approved by Factory Mutual and roofing manufacturer.

E. Membrane Adhesive: As recommended by membrane manufacturer.

F. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.

G. Thinners and Cleaners: As recommended by adhesive manufacturer, compatible with membrane.

H. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.

1. Composition: Roofing membrane manufacturer's standard.

2. Size: 18 x 18 inch.

3. Surface Color: White.

4. Fully adhered to roof membrane.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Perform work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer's instructions.

B. Do not apply roofing membrane during unsuitable weather.

C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.

D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.2 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

B. Verify deck is supported and secure.

C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.

D. Verify deck surfaces are dry and free of snow or ice.

E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.3 METAL DECK PREPARATION

A. Install deck sheathing on metal deck:

1. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.

2. Cut sheathing cleanly and accurately at roof breaks and protrusions to provide smooth surface.

3. Tape joints.

3.4 INSULATION

A. Attachment of Insulation: Mechanically fasten insulation to deck in accordance with roofing manufacturers' instructions and Factory Mutual requirements.

B. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.

C. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.

D. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.

E. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.

F. Do not apply more insulation than can be covered with membrane in same day.

3.5 MEMBRANE APPLICATION

A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.

B. Shingle joints on sloped substrate in direction of drainage.

C. Fully Adhered Application: Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.

D. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

E. At intersections with vertical surfaces:

1. Extend membrane over cant strips and up a minimum of 6 inches onto vertical surfaces.

2. Fully adhere flexible flashing over membrane and up to reglets.

F. Around roof penetrations, seal flanges and flashings with flexible flashing.

G. Coordinate installation of roof drains and sumps and related flashings.

3.6 FIELD QUALITY CONTROL

A. See Section 01 45 00 - Quality Control, for general requirements for field quality control and inspection.

B. Require site attendance of roofing and insulation material manufacturers daily during installation of the Work.

3.7 CLEANING

A. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.

B. Repair or replace defaced or damaged finishes caused by work of this section.

3.8 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION 07 54 00

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fabricated sheet metal items, including flashings and counterflashings.

B. Reglets and accessories.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements.

B. Section 06 10 00 - Rough Carpentry: Wood nailers.

C. Section 07 72 00 - Roof Accessories: Roof-mounted units.

D. Section 07 90 05 - Joint Sealers.

E. Section 08 62 23 - Tubular Skylights: Metal curbs.

1.3 REFERENCE STANDARDS

A. AAMA 2604	Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2013.
B. ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
C. ASTM B209M	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.
D. ASTM D4586/D4586M	Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2012)e1.
E. SMACNA (ASMM)	Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

C. Samples: Submit two samples 2-1/2 x 2-1/2 inch in size illustrating metal finish color.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.

B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 5 years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Prevent contact with materials that could cause discoloration or staining.

PART 2 - PRODUCTS

2.1 SHEET MATERIALS

A. Pre-Finished Aluminum: ASTM B209 (ASTM B209M); 0.040 inch thick; plain finish shop pre-coated with fluoropolymer coating.
   1. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system.
   2. Color: As selected by CTDOT PM from manufacturer's standard colors.

2.2 ACCESSORIES

A. Fasteners: Stainless steel, with soft neoprene washers.

B. Sealant: Type silicone specified in Section 07 90 05.

C. Plastic Cement: ASTM D4586, Type I.

D. Reglets: Recessed type, stainless steel.

2.3 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Fabricate cleats of same material as sheet.

C. Form pieces in longest possible lengths.

D. Hem exposed edges on underside 1/2 inch; miter and seam corners.

E. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

F. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

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

3.2 INSTALLATION

A. Secure flashings in place using concealed fasteners.

B. Apply plastic cement compound between metal flashings and felt flashings.

C. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

D. Seal joints watertight.

3.3 FIELD QUALITY CONTROL

A. See Section 01 45 00 - Quality Control, for field inspection requirements.

B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION 07 62 00

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manufactured curbs.

B. Roof hatches.

C. Ladder Safety Post.

D. Hatch Guardrail.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements

B. Section 05 31 00 - Steel Decking.

C. Section 06 10 00 – Rough Carpentry

D. Section 07 62 00 - Sheet Metal Flashing and Trim: Roof accessory items fabricated from sheet metal.

1.3 REFERENCE STANDARDS

A. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Manufacturer's data sheets on each product to be used.

1. Preparation instructions and recommendations.

2. Storage and handling requirements and recommendations.

3. Installation methods.

4. Maintenance requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products under cover and elevated above grade.

PART 2 - PRODUCTS

2.1 MANUFACTURED CURBS

A. Manufactured Curbs: Factory-assembled hollow sheet metal construction with fully mitered and welded corners, integral counterflashing, internal reinforcing, and top side and edges formed to shed water.

1. Sheet Metal: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33; G60 coating designation; 18 gage, 0.048 inch thick.

2. Manufacture curb bottom and mounting flanges for installation directly on roof deck, not on insulation; match slope and configuration of roof deck.

3. Provide the layouts and configurations shown on the drawings.

2.2 ROOF HATCHES

A. Manufacturers - Roof Hatches:

1. Bilco Company; Type S: www.bilco.com.

2. Dur-Red Products: www.dur-red.com.

3. Milcor by Commercial Products Group of Hart & Cooley, Inc: www.milcorinc.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Roof Hatches: Factory-assembled aluminum frame and cover, complete with operating and release hardware.

1. Style: Provide flat metal covers unless otherwise indicated.

2. Mounting: Provide frames and curbs suitable for mounting conditions indicated on the drawings.

3. For Ladder Access: Single leaf; 36 by 36 inches.

C. Frames/Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.

1. Material: Mill finished aluminum, 11 gage, 0.125 inch thick.

2. Insulation: 1 inch rigid glass fiber, located on outside face of curb.

3. Curb Height: 12 inches from finished surface of roof, minimum.

D. Metal Covers: Flush, insulated, hollow metal construction.

1. Capable of supporting 40 psf live load.

2. Material: Mill finished aluminum; outer cover 0.125 inch thick, liner 0.04 inch thick.

3. Insulation: 1 inch rigid glass fiber.

4. Gasket: Neoprene, continuous around cover perimeter.

E. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.

1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load.

2. Hinges: Heavy duty pintle type.

3. Hold open arm with vinyl-coated handle for manual release.

4. Latch: Upon closing, engage latch automatically and reset manual release.

5. Manual Release: Pull handle on interior.

6. Locking: Padlock hasp on interior.

2.3 LADDER SAFETY POST

A. Provide a ladder safety post. The ladder safety post shall be pre-assembled from the manufacturer.

B. Performance characteristics:

1. Tubular post shall lock automatically when fully extended.

2. Safety post shall have controlled upward and downward movement.

3. Release lever shall disengage the post to allow it to be returned to its lowered position.

4. Post shall have adjustable mounting brackets to fit ladder rung spacing up to 14 inches on center and clamp brackets to accommodate ladder rungs up to 1-3/4-inch in diameter.

C. Post: Shall be manufactured of high strength square tubing. A pull up loop shall be provided at the upper end of the post to facilitate raising the post.

D. Material of construction: Shall be steel.

E. Balancing spring: A stainless steel spring balancing mechanism shall be provided to provide smooth, easy, controlled operation when raising and lowering the safety post.

F Hardware: All mounting hardware shall be Type 316 stainless steel.

G. Finishes: Factory finish shall be yellow powder coat steel.

2.4 HATCH RAIL SYSTEM

A. Provide a hatch rail system on open sides of hatch. The hatch rail system shall be field assembled and installed per the manufacturer's instructions.

B. Performance Characteristics:

1. High visibility safety yellow color shall be molded in.

2. Hatch rail system shall attach to the capflashing of the roof hatch and shall not penetrate any roofing material.

3. Hatch rail system shall satisfy the requirements of OSHA 29 CFR 1910.23 and shall meet OSHA strength requirements with a factor of safety of two.

4. UV and corrosion resistant constructions with a twenty-five (25) year warranty.

5. Self-closing gate shall be provided with hatch rail system.

C. Post and Rails: Shall be round pultruded reinforced fire retardant yellow fiberglass treated with a UV inhibitor.

D. Hardware: Mounting brackets shall be 1/4-inch (6mm) thick hot dip galvanized steel. Hinges and post guides shall be 6063T5 aluminum. Fasteners shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Designer of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing weather integrity.

3.4 CLEANING

A. Clean installed work to like-new condition.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 07 72 00

SECTION 07 84 00 - FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Firestopping systems.

B. Firestopping of all joints and penetrations in fire-resistance rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements.

1.3 REFERENCE STANDARDS

A.	ASTM E814	Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a.
B.	ASTM E1966	Standard Test Method for Fire Resistive Joint Systems; 2007 (Reapproved 2011).
C.	ASTM E2307	Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2010.
D.	ASTM E2837	Standard Test Method for Determining Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2011.
E.	ASTM G21	Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2009.
F.	ITS (DIR)	Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
G.	FM 4991	Approval of Firestop Contractors; Factory Mutual Research Corporation; 2001.
H.	FM P7825	Approval Guide; Factory Mutual Research Corporation; current edition.
I.	SCAQMD 1168	South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.
J.	UL 2079	Standard for Tests for Fire Resistance of Building Joint Systems; Underwriters Laboratories Inc.; 2004.

K. UL (FRD) Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.3 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.

C. Product Data: Provide data on product characteristics, performance ratings, and limitations.

D. Sustainability Report: Submit VOC content documentation for all non-preformed materials.

E. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Certificate from authority having jurisdiction indicating approval of materials used.

H. Qualification statements for installing mechanics.

1.4 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
   1. Listing in the current-year classification or certification books of UL, FM Global or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
   2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
   3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section and:
   1. Trained by the manufacturer.
   2. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors, or meeting any two of the following requirements:.
   3. With minimum 3 years documented experience installing work of this type.
   4. Able to show at least 5 satisfactorily completed projects of comparable size and type.
   5. Licensed by authority having jurisdiction.

1.5 MOCK-UP

A. Install one firestopping assembly representative of each fire rating design required on project.

1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.

B. Obtain approval of authority having jurisdiction before proceeding.

C. If accepted, mock-up will represent minimum standard for the Work.

D. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.6 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

PART 2 - PRODUCTS

2.1 FIRESTOPPING - GENERAL REQUIREMENTS

A. Manufacturers:
   1. 3M Fire Protection Products: www.3m.com/firestop.
   2. Hilti, Inc: www.us.hilti.com.
   3. Nelson FireStop Products: www.nelsonfirestop.com.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Firestopping: Any material meeting requirements.

C. Firestopping Materials with Volatile Content: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

D. Mold Resistance: Provide firestoppping materials with mold and mildew resistance rating of 0 as determined by ASTM G21.

E. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

F. Fire Ratings: See Drawings for required systems and ratings.

2.2 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Perimeter Fire Containment Firestopping: Use any system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of the floor assembly.

B. Head-of-Wall Firestopping at Joints Between Non-Rated Floor and Fire-Rated Wall: Use any system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of floor or wall, whichever is greater.

C. Floor-to-Floor, Wall-to-Wall, and Wall-to-Floor Joints, Except Perimeter, Where Both Are Fire-Rated: Use any system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.

D. Through Penetration Firestopping: Use any system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

2.3 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.

B. Remove incompatible materials that could adversely affect bond.

C. Install backing materials to arrest liquid material leakage.

3.3 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

B. Do not cover installed firestopping until inspected by authority having jurisdiction.

C. Install labeling required by code.

3.4 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.5 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 07 84 00

SECTION 07 90 05 - JOINT SEALERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Sealants and joint backing.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements.

B. Section 07 25 00 – Air Barrier System: Sealants required in conjunction with air barriers.

C. Section 07 84 00 - Firestopping: Firestopping sealants.

D. Section 08 80 00 - Glazing: Glazing sealants and accessories.

E. Section 09 21 16 - Gypsum Board Assemblies: Acoustic sealant.

1.3 REFERENCE STANDARDS

A.	ASTM C509	Standard Specification For Elastomeric Cellular Preformed Gasket And Sealing Material; 2011
B.	ASTM C920	Standard Specification For Elastomeric Joint Sealants; 2014
C.	ASTM C1193	Standard Guide for Use of Joint Sealants; 2013.
D.	ASTM D1056	Standard Specification For Flexible Cellular Materials - Sponge Orexpanded Rubber; 2014
E.	ASTM 1667	Standard Specification For Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
F.	.SCAQMD 1168	South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Applicator Qualifications: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

1.6 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.7 WARRANTY

A. See Section 01 78 30 –Warranties and Bonds, for additional warranty requirements.

B. Correct defective work within a five year period after Date of Substantial Completion.

C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Gunnable and Pourable Sealants:
   1. BASF Construction Chemicals-Building Systems: www.buildingsystems.basf.com.
   2. Pecora Corporation: www.pecora.com.
   3. Tremco Global Sealants: www.tremcosealants.com.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 SEALANTS

A. Sealants and Primers - General: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

B. Interior Sealant
   1. Provide ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT. Location(s) and color(s) of sealant for the following:

LOCATION	COLOR
a. Small voids between walls or partitions and adjacent lockers, casework, shelving, door frames, built-in or surface-mounted equipment and fixtures, and similar items.	As selected

LOCATION	COLOR
b. Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces.	Match adjacent surface color
c. Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed.	Match adjacent surface color
d. Joints between edge members for acoustical tile and adjoining vertical surfaces.	White
e. Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted.	White
f. Joints between plumbing fixtures and ceramic tile; joints between shower receptors and ceramic tile; joints formed where nonplaner tile surfaces meet.	White
g. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.	Match grout color
h. Behind escutcheon plates at valve pipe penetrations and showerheads in showers.	White

C. Exterior Sealant

1. For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

LOCATION	COLOR
a. Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations.	Match adjacent surface color
b. Masonry joints where shelf angles occur.	Match mortar color
c. Expansion and control joints.	Match mortar color
d. Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required.	Match mortar color
e. Voids where items pass through exterior walls.	Match adjacent surface color
f. Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.	Match mortar color
g. Metal-to-metal joints where sealant is indicated or specified.	Match metal finish color

LOCATION	COLOR
h. Joints between ends of gravel stops, fascias, copings, and adjacent walls.	Match adjacent surface color

D. Floor Joint Sealant

1. ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

LOCATION	COLOR
a. Seats of metal thresholds for exterior doors.	Gray
b. Control and expansion joints in floors, slabs, ceramic tile, and walkways.	Match floor finish color

2.3 PRIMERS

A. Provide a nonstaining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application.

2.4 BOND BREAKERS

A. Provide the type and consistency recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

2.5 BACKSTOPS

A. Provide glass fiber roving or neoprene, butyl, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Make backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

1. Rubber

   Conform to ASTM D1056, Type 1, open cell, or Type 2, closed cell, Class A , round cross section for cellular rubber sponge backing.

2. Synthetic Rubber

   Conform to ASTM C509, Option I , Type I preformed rods for Synthetic rubber backing.

3. Neoprene

   Conform to ASTM D1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2 for Neoprene backing.

2.6 CLEANING SOLVENTS

A. Provide type(s) recommended by the sealant manufacturer except for aluminum and bronze surfaces that will be in contact with sealant.

2.3 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.

C. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean and prime joints in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Protect elements surrounding the work of this section from damage or disfigurement.

E. Exposed Concrete Floor Joints: Test joint filler in inconspicuous area of floor slab. Verify specified product does not stain or discolor slab.

3.3 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C1193.

C. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.

D. Install bond breaker where joint backing is not used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Tool joints concave.

3.4 CLEANING

A. Clean adjacent soiled surfaces.

3.5 PROTECTION

A. Protect sealants until cured.

3.6 SCHEDULE

END OF SECTION 07 90 05

SECTION 08 08 00 – COMMISSIONING OF OPENINGS

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Trade Contract, including General and Supplementary Conditions and Notice to Trade Contractor Sections, apply to this Section. Refer to NOTICE TO TRADE CONTRACTOR – COMMISSIONING for a full description of the commissioning process and requirements.

1.2. SUMMARY

A. Commissioning consists of systematically documenting that specified components and systems have been installed and started up properly and then functionally tested to verify and document proper operation through all sequences of operation and conditions. In addition, training of the Owner's Operations Personnel will be verified and final project O&M Documents will be reviewed for completeness.

PART 2 – PRODUCTS

2.1. FUNCTIONAL PERFORMANCE TESTING EQUIPMENT AND INSTRUMENTS

A. Trade Contractor shall provide all tools, instruments, laptop computers, PDA's, software programs and services required to perform system Functional Performance Testing procedures. This includes providing the connection to systems to be tested, operation of the test equipment & instrumentation and generating test results as required.

PART 3 – EXECUTION

3.1. FUNCTIONAL PERFORMANCE TESTING

A. The trade contractor shall demonstrate to the Engineer and the Cx Authority the performance of the following Building Envelope Systems to the performance level identified.

1. Metal Doors and Frames:

a. System/Equipment to be Tested:
   1) Interior and exterior metal doors

b. Functions to be Tested:
   1) Refer to ASTM E 783 regarding "Air Infiltration"

c. Conditions of the Test:
   1) Refer to ASTM E 783 regarding "Air Infiltration"

d. Acceptance Criteria:
    1) Refer to ASTM E 783 regarding “Air Infiltration”

2. Aluminum Framed Entrances and Storefronts:

    a. System/Equipment to be Tested:
        1) Aluminum Doors and Frames
        2) Aluminum Framed Storefront
        3) Translucent Wall and Roof Assemblies

    b. Functions to be Tested:
        1) Refer to ASTM E 783 regarding “Air Infiltration”
        2) Refer to ASTM E 331 regarding “Water Penetration”

    c. Conditions of the Test:
        1) Refer to ASTM E 783 regarding “Air Infiltration”
        2) Refer to ASTM E 331 regarding “Water Penetration”

    d. Acceptance Criteria:
        1) Refer to Section 08 41 13 – “Aluminum Framed Entrances and Storefronts” part 1.3

3. Tubular Skylight System:

    a. System/Equipment to be Tested:
        1) Insulated translucent sandwich panel skylights and aluminum flashing

    b. Functions to be Tested:
        1) Refer to AAMA 501.2 regarding “Water Testing”

    c. Conditions of the Test:
        1) Refer to AAMA 501.2 regarding “Water Testing”

    d. Acceptance Criteria:
        1) Refer to AAMA 501.2 regarding “Water Testing” and Section 08 62 23 – “Tubularl Skylight System”

END OF SECTION 08 08 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Non-fire-rated steel doors and frames.

B. Fire-rated steel doors and frames.

C. Thermally insulated steel doors.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 - Sustainable Design Requirements

B. Section 04 27 31 - Reinforced Unit Masonry

C. Section 08 71 00 - Door Hardware.

D. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.

E. Section 09 22 16 - Non-Structural Metal Framing

F. Section 09 90 00 - Painting and Coating

1.3 REFERENCE STANDARDS

A. AWS D1.1/D1.1M – Structural Welding Code – Steel, 2012; Errata 2011.

B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2009.

C. ANSI A250.8-SDI-100 Recommended Specifications for Standard Steel Doors and Frames; 2003.

D. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 1998 (R2011).

E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.

F. ASTM A 924/A924M – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process; 2013.

G. ASTM C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2012.

H. ASTM C591 – Standard Specification for Unfaced Performed Rigid Cellular Polyisocyanurate Thermal Insulation; 2012.

I. ASTN C612 – Mineral Fiber Block and Board Thermal Insulation; 2010.

J. ASTM C1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus; 2011.

K. ASTM D2863 – Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oyxgen Index); 2012.

L. ANSI/BHMA A156.115 – Hardware Preparation in Steel Doors and Steel Frames; 2006.

M. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames; 2006.

N. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 2007.

O. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2013.

P. NFPA 105 – Standard for Installation of Smoke Door Assemblies and Other Opening Protectives; 2013.

Q. NFPA 252 – Standard Methods for Fire tests of Door Assemblies; 2012

R. SDI/DOOR 113 - Standard Practice for Determining the Steady State Thermal Transmittance of Steel Door and Frame Assemblies; 2001; R2006.

S. SDI/DOOR A250.11 - Recommended Erection Instructions for Steel Frames; 2001.

T. SDI/DOOR A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2003; R2009

U. SDI/DOOR A250.8 - Recommended Specifications for Standard Steel Doors and Frames; 2003; R2008.

V. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.

W. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.

C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any. Schedules of doors and frames.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Maintain at the project site a copy of all reference standards dealing with installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in accordance with NAAMM HMMA 840.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Steel Doors and Frames:
1. Assa Abloy Ceco, Curries, or Fleming: www.assaabloydss.com.
2. Republic Doors: www.republicdoor.com.
3. Steelcraft, an Allegion brand: www.allegion.com/us.
4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 DOORS AND FRAMES

A. Requirements for All Doors and Frames:
1. Accessibility: Comply with ANSI/ICC A117.1.
2. Door Top Closures: Flush with top of faces and edges.
3. Door Edge Profile: Beveled on both edges.
4. Door Texture: Smooth faces.
5. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
6. Hardware Preparation: In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
7. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed), manufacturer's standard coating thickness.
8. Finish: Factory primed, for field finishing.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.3 STEEL DOORS

A. Exterior Doors:
   1. Grade: ANSI A250.8 Level 3, physical performance Level A, Model 2, seamless.
   2. Core: Polystyrene foam insulation.
   3. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness.
   5. Weatherstripping: Separate, see Section 08 71 00.

B. Interior Doors, Non-Fire-Rated:
   1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless.
   2. Core: Manufacturer’s standard core.
   3. Thickness: 1-3/4 inches.

C. Interior Doors, Fire-Rated:
   1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless.
   2. Fire Rating: As indicated on Door and Frame Schedule, tested in accordance with UL 10C ("positive pressure").
      a. Provide units listed and labeled by UL.
      b. Attach fire rating label to each fire rated unit.

2.4 INSULATED STEEL DOOR SYSTEMS

A. Insulated steel doors shall have a core of polyurethane foam and an R factor of 10.0 or more (based on a k value of 0.16); face sheets, edges, and frames of galvanized steel not lighter than 16 gage. Doors and frames shall receive phosphate treatment, rust-inhibitive primer, and baked acrylic enamel finish. Doors shall have been tested in accordance with SDI/DOOR A250.4. Prepare doors to receive specified hardware. Doors shall be 1-3/4 inch thick. Provide insulated steel doors and frames at all exterior doors unless noted otherwise.

2.5 ACCESSORIES

A. Astragals

For pairs of exterior steel doors which will not have aluminum astragals or removable mullions, as specified in Section 08 71 00 DOOR HARDWARE provide overlapping steel astragals with the doors. For interior pairs of fire rated and smoke control doors, provide stainless steel astragals complying with NFPA 80 for fire rated assemblies and NFPA 105 for smoke control assemblies.

B. Moldings

Provide moldings around glass of interior and exterior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings.

2.6 INSULATION CORES

A. Insulated cores shall be of type specified, and provide an apparent U-factor of .48 in accordance with SDI/DOOR 113 and shall conform to:

1. Rigid Cellular Polyisocyanurate Foam: ASTM C591, Type I or II, foamed-in-place or in board form, with oxygen index of not less than 22 percent when tested in accordance with ASTM D2863; or

2. Rigid Polystyrene Foam Board: ASTM C578, Type I or II; or

3. Mineral board: ASTM C612, Type I.

2.7 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level 3 , 14 gage, except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners. Provide steel frames for doors, sidelights, cased openings, and interior glazed panels, unless otherwise indicated. All exterior door frames shall be galvanized in accordance with ASTM A653/A653M.

A. Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded.

B. Stops and Beads

Form stops and beads from 20 gage steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 12 to 16 inch on center. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

C. Cased Openings

Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

D. Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated or painted with rust-inhibitive paint, not lighter than 18 gage.

1. Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 7.5 feet in height, provide one additional anchor for each jamb for each additional 2.5 feet or fraction thereof.

a. Masonry: Provide anchors of corrugated or perforated steel straps or 3/16 inch diameter steel wire, adjustable or T-shaped;

b. Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding;

2. Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member. Where floor fill occurs, terminate bottom of frames at the indicated finished floor levels and support by adjustable extension clips resting on and anchored to the structural slabs.

2.8 FIRE AND SMOKE DOORS AND FRAMES

NFPA 80 and NFPA 105 and this specification. The requirements of NFPA 80 and NFPA 105 shall take precedence over details indicated or specified.

A. Labels

Fire doors and frames shall bear the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing shall be in accordance with NFPA 252 or UL 10C. Labels shall be metal with raised letters, and shall bear the name or file number of the door and frame manufacturer. Labels shall be permanently affixed at the factory to frames and to the hinge edge of the door. Door labels shall not be painted.

B. Oversized Doors

For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

C. Astragal on Fire and Smoke Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements. On smoke control doors, conform to NFPA 105.

2.9 WEATHERSTRIPPING

As specified in Section 08 71 00 DOOR HARDWARE.

2.10 HARDWARE PREPARATION

Provide minimum hardware reinforcing gages as specified in SDI/DOOR A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to ANSI/BHMA A156.115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of SDI/DOOR A250.8, as applicable. Punch door frames, with the exception of frames that will have weatherstripping or soundproof gasketing, to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.11 FINISHES

A. Factory-Primed Finish

B. All surfaces of doors and frames shall be thoroughly cleaned, chemically treated and factory primed with a rust inhibiting coating as specified in SDI/DOOR A250.8.

C. Hot-Dip Zinc-Coated and Factory-Primed Finish

D. Fabricate exterior doors and frames from hot dipped zinc coated steel, alloyed type that complies with ASTM A924/A924Mand ASTM A653/A653M. The coating weight shall meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., A40. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in SDI/DOOR A250.8. .

2.12 FABRICATION AND WORKMANSHIP

A. Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable. On wraparound frames for masonry partitions, provide a throat opening 1/8 inch larger than the actual masonry thickness. Design frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive caulking compound.

B. Grouted Frames

For frames to be installed in exterior walls and to be filled with mortar or grout, fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of stop-applied head and jamb seals.

2.13 PROVISIONS FOR GLAZING

Materials are specified in Section 08 80 00, GLAZING.

PART 3 EXECUTION

3.1 INSTALLATION

A. Frames

Set frames in accordance with SDI/DOOR A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction.

B. Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

C. Fire and Smoke Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80. Install fire rated and smoke doors and frames in accordance with NFPA 80 and NFPA 105.

3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

END OF SECTION 08 11 13

SECTION 08 31 00 - ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall access door and frame units.

B. Ceiling access door and frame units.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements

B. Section 04 27 31 – Reinforced Unit Masonry

C. Section 09 22 16 – Non-Structural Metal Framing

D. Section 09 21 16 - Gypsum Board Assemblies

E Section 09 90 00 - Painting and Coating: Field paint finish.

F. Section 23 33 00 - Air Duct Accessories: Access doors in ductwork.

1.3 REFERENCE STANDARDS

A. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.

B. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

C. Shop Drawings: Indicate exact position of all access door units.

D. Project Record Documents: Record actual locations of all access units.

PART 2 - PRODUCTS

2.1 ACCESS DOOR AND PANEL APPLICATIONS

A. Walls, Unless Otherwise Indicated:

1. Material: Steel.
2. Size: 12 x 12 inches, unless otherwise indicated.
3. Standard duty, hinged door.
4. Tool-operated spring or cam lock; no handle.
5. In All Wall Types: Surface mounted face frame and door surface flush with frame surface.

B. Walls in Wet Areas:
1. Material: Steel, hot-dipped zinc or zinc-aluminum-alloy coated.
2. Size: 12 x 12 inches, unless otherwise indicated.
3. Standard duty, hinged door.
4. Tool-operated spring or cam lock; no handle.
5. In All Wall Types: Surface mounted face frame and door surface flush with frame surface.

C. Fire Rated Walls: See drawings for wall fire ratings.
1. Material: Steel.
2. Size: 12 x 12 inches, unless otherwise indicated.
3. Uninsulated, single thickness door panel.
4. Tool-operated spring or cam lock; no handle.

D. Ceilings, Unless Otherwise Indicated: Same type as for walls.
1. Material: Steel.
2. Size in Lay-in Grid Ceilings: To match grid module.
3. Size in Other Ceilings: 12 x 12 inches, unless otherwise indicated.
4. Standard duty, hinged door.
5. Tool-operated spring or cam lock; no handle.

E. Fire Rated Ceilings: See drawing for ceiling fire ratings.
1. Material: Steel
2. Size: 12 x 12 inches, unless otherwise noted.
3. Standard duty hinged door.
4. Tool-operated spring or cam lock; no handle.

2.2 WALL AND CEILING UNITS

A. Manufacturers:
1. Acudor Products Inc: www.acudor.com.
2. Karp Associates, Inc: www.karpinc.com.
3. Milcor by Commercial Products Group of Hart & Cooley, Inc: www.milcorinc.com.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Access Doors: Factory fabricated door and frame units, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies units are to be installed in.

1. Door Style: Single thickness with rolled or turned in edges.
2. Heavy Duty Frames: 14 gage, 0.0747 inch, minimum.
3. Heavy Duty Single Thickness Steel Door Panels: 14 gage, 0.0747 inch, minimum.
4. Units in Fire Rated Assemblies: Fire rating as required by applicable code for the fire rated assembly in which they are to be installed.
    a. Provide products listed and labeled by UL or ITS (Warnock Hersey) as suitable for the purpose specified and indicated.
5. Steel Finish: Primed.
6. Primed Finish: Polyester powder coat; manufacturer's standard color.
7. Hardware:
    a. Hardware for Fire Rated Units: As required for listing.
    b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
    c. Latch/Lock: Cylinder lock operated cam latch, two keys for each unit.
    d. Number of Locks/Latches Required: As recommended by the manufacturer for the size of the unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that rough openings are correctly sized and located.

3.2 INSTALLATION

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

B. Install frames plumb and level in openings. Secure rigidly in place.

C. Position units to provide convenient access to the concealed work requiring access.

END OF SECTION 08 31 00

SECTION 08 33 23 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Overhead insulated coiling doors, operating hardware, exterior, electric operation.

B. Wiring from electric circuit disconnect to operator to control station.

1.2 RELATED REQUIREMENTS

A. Section 01 78 30 Warranties and Bonds

B. Section 01 81 13 Sustainable Design Requirements

C. Section 04 27 31 Reinforced Unit Masonry

D. Section 08 71 00 Door Hardware: Cylinder cores and keys.

E Section 09 90 00 Painting and Coating: Field paint finish.

F. Section 26 01 00 Basic Electrical Requirements: Power to operators..

1.3 REFERENCE STANDARDS

A. ASTM A36/A36M Standard Specification for Carbon Structural Steel; 2012.

B. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.

C. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.

D. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

E. NEMA ICS 2 Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated 600 2000 Volts; National Electrical Manufacturers Association; 2000 (R2008).

F. NEMA MG 1 Motors and Generators; National Electrical Manufacturers Association; 2011.

G. ASCE 7-10 Minimum Design Loads for Buildings and Other Structures.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide general construction, component connections and details, electrical equipment.

C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details. Include detailed plans, elevations, and required clearances.

D. Samples: Submit two slats, 6 x 12 inch in size illustrating shape, color and finish texture.

E. Manufacturer's Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.

F. Manufacturer’s Certificates: Certify products meet or equal specified requirements.

G. Maintenance Data: Indicate general maintenance requirements and frequency

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years experience in the fabrication and installation of security overhead doors.

B. Installer Qualifications: Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.

C. Store materials in a dry, warm, ventilated weathertight location.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 COORDINATION

A. Coordinate Work with other operations and installation of adjacent materials to avoid damage to installed materials.

1.9 WARRANTY

A. Warranty: Manufacturer's limited door and operator system, except the counterbalance spring and finish, to be free from defects in materials and workmanship for 3 years or 20,000 cycles, whichever occurs first.

B. Warranty: Manufacturer's limited door warranty for 2 years for all parts and components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Overhead Coiling Doors:

1. Overhead Door Corporation: Stormtight Series 625 with High Wind Load Option, or equal.

3. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 COILING DOORS

A. Exterior Coiling Doors: Steel slat curtain.

1. Capable of withstanding wind loads of 44 psf, without undue deflection or damage to components, in conformance with ASCE 7-10.

2. Sandwich slat construction with insulated core of polyurethane foam type insulation; insulation R-Value: 7.7, U-Value: 0.13

3. Nominal Slat Size: 2 5/8 inches wide x required length.

4. Finish: Galvanized.

5. Finish: 0.2 mils baked-on prime coat and 0.6 mils baked-on polyester top coat. Color selected by Architect.

6. Guides: Angles; galvanized steel.

7. Hood Enclosure: Manufacturer's standard; galvanized steel.

8. Electric operation.

9. Mounting: Face-of-wall mounted.

10. Exterior lock and latch handle.

2.3 MATERIALS

A. Curtain Construction: Interlocking slats.

1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.

2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.

3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.

B. Steel Slats: Minimum 24 gage ASTM A653/A653M galvanized steel sheet.

1. Galvanizing: Minimum G90/Z275 coating.

C. Guide Construction: Continuous, of profile to retain door in place, mounting brackets of same metal.

D. Steel Guides: ASTM A36/A36M steel angles, size as indicated, hot-dip galvanized per ASTM A 123/A 123M.

E. Hood Enclosure: Internally reinforced to maintain rigidity and shape.

1. Minimum 24 gage.

2. Prime paint.

3. Internal hood baffle weatherseal.

F. Hardware:

1. Lock Cylinders: Specified in Section 08 71 00.

2. Latching: Inside mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position.

3. Latch Handle: Interior handle.

G. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.4 ELECTRIC OPERATION

A. Operator, Controls, Actuators, and Safeties: Provide products listed by UL.

B. Electric Operators:

1. Mounting: Front of Hood.

2. Motor Enclosure:

a. Exterior doors: NEMA MG 1 Type 4; open drip proof.

3. Motor Rating: 1/2 hp; continuous duty.

4. Motor Voltage: 120 volt, single phase, 60 Hz.

5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.

6. Controller Enclosure: NEMA 250 Type 1.

7. Opening Speed: 12 inches per second.

8. Brake: Adjustable friction clutch type, activated by motor controller.

9. Manual override in case of power failure.

C. Control Station: Standard three push-button operated (OPEN-STOP-CLOSE) momentary control for each operator.

1. Surface mounted on interior.

D. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to reverse operator upon striking object, hollow neoprene covered.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that opening sizes, tolerances, vertical and horizontal clearances, and conditions are acceptable.

B. Special consideration shall be given to space restrictions due to structural steel column and beam locations. Refer to the design drawings.

3.2 INSTALLATION

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

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service.

F. Complete wiring from disconnect to unit components.

G. Install perimeter trim and closures.

3.3 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation from Plumb: 1/16 inch.

C. Maximum Variation from Level: 1/16 inch.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.4 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.5 CLEANING

A. Clean installed components.

B. Remove labels and visible markings.

END OF SECTION 08 33 23

SECTION 08 43 13 - ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Aluminum-framed storefront, and doors for interior storefront.

B. Weatherstripping.

C. Perimeter sealant.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements.

B. Section 07 90 05 - Joint Sealers: Perimeter sealant and back-up materials.

C. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.

D. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.3 REFERENCE STANDARDS

A. AAMA CW-10 Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2012.

B. AAMA 1503 Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; American Architectural Manufacturers Association; 2009.

C. AAMA 2604 Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2013.

D. ASTM A36/A36M Standard Specification for Carbon Structural Steel; 2012.

E. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.

F. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2013.

G. ASTM B221M Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2013.

H. ASTM E283 Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).

I. ASTM E330/E330M Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014.

J. ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2009).

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.5 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, and door hardware.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances.

D. Design Data: Provide framing member structural and physical characteristics, dimensional limitations.

E. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in the drawings.

F. Samples: Submit two samples of framing, 12 inches in length illustrating finished aluminum surface.

G. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

H. Warranty: Submit manufacturer sample warranty.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum five (5) years of documented experience.

B. Installer Qualifications: Provide documentation of minimum of five (5) years installer experience in performance of the work specified.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.8 FIELD CONDITIONS

A. Field verify opening dimensions.

1.9 WARRANTY

A. See Section 01 78 30 – Warranties and Bonds, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Aluminum-Framed Storefront and Doors:

1. Kawneer North America; Trifab 400 with 350 doors: www.kawneer.com.
2. EFCO Corporation: www.efcocorp.com.
3. Tubelite, Inc: www.tubeliteinc.com.
4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.

1. Glazing Rabbet: For 1/4-inch glazing.

2. Glazing Position: Center-set.

3. Vertical Mullion Dimensions: 1-3/4 inches wide by 4 inches deep.

4. Finish: High performance organic coating.

a. Factory finish all surfaces that will be exposed in completed assemblies.

b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

c. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

5. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.

6. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.

7. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.

8. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.

9. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Performance Requirements:

1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.

a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.

2. Water Penetration Resistance: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 8.00 lbf/sq ft.

3. Air Leakage: Maximum of 0.06 cu ft/min/sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 pounds per square foot pressure differential across assembly.

4. Condensation Resistance Factor of Framing: 50, minimum, measured in accordance with AAMA 1503.

5. Overall U-value Including Glazing: 0.45 Btu/(hr sq ft deg F), maximum.

2.3 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections.

1. Glazing stops: Flush.

2. Cross-Section: 1-3/4 inches wide x 4 inches deep

3. Structurally Reinforced Members: Extruded aluminum with internal reinforcement of structural steel member.

B. Glazing: As specified in Section 08 80 00 - Glazing.

C. Swing Doors: Glazed aluminum.

1. Thickness: 1-3/4 inches.

2. Top Rail: 3-1/2 inches wide.

3. Vertical Stiles: 3-1/2 inches wide.

4. Bottom Rail: 10 inches wide.

5. Finish: Same as storefront.

2.4 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Structural Steel Sections: ASTM A36/A36M; galvanized in accordance with requirements of ASTM A123/A123M.

C. Fasteners: Stainless steel.

E. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.5 FINISHES

A. High Performance Organic Finish: AAMA 2604; multiple coats, thermally cured fluoropolymer system.

B. Color: As shown on the drawings.

C. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.6 HARDWARE

A. Door Hardware: Storefront manufacturer's standard type to suit application.

1. For each door, include pivots, pull handle, exit device, narrow stile handle latch, and closer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.2 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

G Install hardware using templates provided.

H. Install perimeter sealant in accordance with Section 07 90 05.

I. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.3 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.4 FIELD QUALITY CONTROL

A. See Section 01 45 00 - Quality Control, for independent testing and inspection requirements. Inspection will monitor quality of installation and glazing.

3.5 ADJUSTING

A. Adjust operating hardware for smooth operation.

3.6 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

C. Remove excess sealant by method acceptable to sealant manufacturer.

3.7 PROTECTION

A. Protect installed products from damage during subsequent construction.

END OF SECTION 08 43 13

SECTION 08 44 13 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aluminum-framed curtain wall, and doors for exterior locations

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements

B. Section 07 90 05 - Joint Sealers: Perimeter sealant and back-up materials.

C. Section 08 71 00 – Door Hardware: Hardware not specified in this section..

C. Section 08 80 00 - Glazing.

1.3 REFERENCE STANDARDS

A. AAMA CW-10 Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2012.

B. AAMA 1503 Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; American Architectural Manufacturers Association; 2009.

C. AAMA 2604 Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2013.

D. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2013.

E. ASTM B221M Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2013.

F. ASTM E283 Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).

G. ASTM E330/E330M Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014.

H. ASTM E331 Standard Test Method for WATER Penetration of exterior windows, skylights, doors and curtain walls by Uniform Static Air Pressure Difference; 2000

I. ASCE 7-10 Minimum Design Wind Loads for Buildings and Other Structures.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glazing and infill, internal drainage details.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details.

D. Samples: Submit two samples 24 x 24 inches in size illustrating finished aluminum surface, glazing, glazing materials.

E. Test Reports: Submit results of full-size mock-up testing. Certified reports of tests previously performed on the same design are acceptable.

F. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure.

G. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum five (5) years of documented experience.

B. Installer Qualifications: Provide documentation of minimum of five (5) years installer experience in performance of the work specified.

C. Pre-installation Meeting: Conduct pre-installation meeting to verify requirements, conditions and installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.7 FIELD CONDITIONS

A. Field verify all opening dimensions.

B. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.8 WARRANTY

A. See Section 01 78 30 – Warranties and Bonds, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Glazed Aluminum Curtain Wall:

1. Kawneer North America; 1600 Wall with 350 doors: www.kawneer.com.
2. EFCO, a Pella Company: www.efcocorp.com.
3. Tubelite, Inc: www.tubeliteinc.com.
4. United States Aluminum Corp: www.usalum.com.
5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 CURTAIN WALL

A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.

1. Frame dimension: 2-1/2 inch x 6 inch.

2. Outside glazed, with pressure plate and mullion cover.

3. Finish: High performance organic coating.

a. Factory finish all surfaces that will be exposed in completed assemblies.

b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

c. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

4. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.

5. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.

6. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.

1. Design Wind Loads: Comply with the following:

a. Minimum Wind Pressure: 44psf, as calculated according to Chapter 30 of ASCE 7-10.

b. Measure performance by testing in accordance with ASTM E330/E330M, using test loads equal to 1.5 times the design wind loads and 10 second duration of maximum pressure.

2. Movement: Accommodate the following movement without damage to components or deterioration of seals:

a. Expansion and contraction caused by 180 degrees F surface temperature.

b. Expansion and contraction caused by cycling temperature range of 170 degrees F over a 12 hour period.

c. Movement of curtain wall relative to perimeter framing.

d. Deflection of structural support framing, under permanent and dynamic loads.

C. Water Penetration Resistance: No uncontrolled water on indoor face when tested as follows:

1. Test Pressure Differential: 12 lbf/sq ft.

2. Test Method: ASTM E331

D. Air Leakage: Maximum of 0.06 cu ft/min/sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 pounds per square foot pressure differential across assembly.

E. Thermal Performance Requirements:

1. Condensation Resistance Factor of Framing: 60, minimum, measured in accordance with AAMA 1503.

2. Overall U-value Including Glazing: 0.45 Btu/(hr sq ft deg F), maximum.

2.3 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.

B. Glazing: As specified in Section 08 80 00.

2.4 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

C. Glazing Accessories: As specified in Section 08 80 00.

2.5 FINISHES

A. High Performance Organic Finish: AAMA 2604; multiple coats, thermally cured fluoropolymer system.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Coordinate attachment and seal of perimeter air and vapor barrier materials.

H. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.2 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

C. Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.3 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

3.4 PROTECTION

A. Protect installed products from damage during subsequent construction.

END OF SECTION 08 44 13

SECTION 08 62 23 - TUBULAR SKYLIGHTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Tubular skylights, consisting of skylight dome, integral curb, reflective tube, and ceiling diffuser assembly; configuration as indicated on the drawings.

1.2 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.

2. Storage and handling requirements and recommendations.

3. Installation methods.

C. Shop Drawings.

D. Test Reports: Independent testing agency reports verifying compliance with specified performance requirements.

E. Certifications:

1. Manufacturer’s certification that products supplied meet or exceed specified requirements.

2. Installers certification documenting experience.

1.3 REFERENCE STANDARDS

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 20 10.

B. ASTM B221 Standard Specification For Aluminum And Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, And Tubes; 2014

C. ASTM B209M Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.

D. ASTM D635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2010.

E. ASTM D1929 — Standard Test Method for Determining Ignition Temperature of Plastics; 20l3a.

F. ASTM D2843 — Standard Test Method For Density Of Smoke From The Burning Or Decomposition Of Plastics; 2010.

G. ASTM E84 — Standard Test Method for Surface Burning Characteristics of Building Materials; 20l3a.

H. ASTM E108 — Standard Test Methods for Fire Tests of Roof Coverings; 2011.

I. ASTM E283 — Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).

J. ASTM E330/E330M — Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014.

K. ASTM E331 — Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2009).

L. UL 790 — Standard for Standard Test Methods for Fire Tests of Roof Coverings; Current Edition, Including All Revisions.

M. Factory Mutual (FM Global)

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engaged in manufacture of tubular skylights for minimum of 10 years.

B. Installer Qualifications: Minimum 5 (five) years documented successful experience installing products specified.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.5 FIELD CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.6 WARRANTY

A. See Section 01 78 30 – Warranties and Bonds, for additional warranty requirements.

B. Skylights: Manufacturer's standard warranty for 10 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Sunoptics Prismatic Skylights, a Division of Acuity Brands; LightFlex Daylighting System: www.sunoptics.com.

B. DayLite, Natural Lighting Technologies: www.dayliteco.com.

C. Solatube International, Inc: www.solatube.com.

D. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 TUBULAR SKYLIGHTS

A. Tubular Skylights: Transparent roof-mounted skylight dome and curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces. Factory Mutual Approved.

1. All components made and assembled by one manufacturer.

2. Size: Nominal 24-inch x 48-inch.

3. Design to withstand the following loads without breakage or permanent damage to any parts, when tested in accordance with ASTM E330/E330M:

   a. Positive and negative wind load of 10 psf.

   b. No permanent deflection in excess of 0.2 percent of span.

   c. Live load of 100 psf on dome with safety factor of 3.

4. Air Infiltration: Maximum 0.10 cfm per foot of crack length at 6.24 psf pressure differential when tested in accordance with ASTM E283.

5. Water Resistance: No uncontrolled water leakage at 6.24 psf pressure differential with water rate of 5 gallons/h/sf, when tested in accordance with ASTM E331; design to ensure that water will not accumulate inside assembly.

6. Thermal Movement: Fabricate to allow for thermal movement resulting from temperature differential from minus 30 to 180 degrees F.

7. Flammability: Non-metal parts complying with the following:

   a. Roof-Top Components: Class B when tested in accordance with ASTM E108 or UL 790.

b. Self-Ignition Temperature: Greater than 650 degrees F, when tested in accordance with ASTM D1929.

c. Smoke Developed Index: Maximum of 450, when tested in accordance with ASTM E84; or maximum rating of 75, when tested in accordance with ASTM D2843.

d. Combustibility - Light Transmitting Parts: Burning extent of 1 inch or less (ICC Class CC-1), when tested in accordance with ASTM D635 in the thickness intended for use.

e. Combustibility - Non-Light Transmitting Parts: Minimum 2.5 inches/min (ICC Class CC-2), when tested in accordance with ASTM D635.

B. Roof Assemblies: Transparent, UV and impact resistant Factory Mutual Approved dome with flashing base supporting dome and top of tube.

1. Glazing: Double Glazed Acrylic, 0.165 inch minimum thickness.

2. Skylight Frame: ASTM B 221 alloy 6063-T5 extruded aluminum, insulated, thermal break, with integral condensate gutter. Standard mill finish. 1 1/2-inch foam rubber gasket between frame and curb.

3. Base Style: Integral Curb with flashing, 18 gage galvanized steel, insulated.

4. Solar Heat Gain Coefficient (SHGC) 0.42.

5. U-Valve 0.74

6. VLT 0.85

C. Reflective Tube: ASTM B209 (ASTM B209M) aluminum sheet, thickness between 0.015 inch and 0.020 inch.

D. Diffuser Assemblies: Supporting light transmitting surface at bottom termination of tube, with compression seal to minimize condensation and bug or dirt infiltration.

1. Ceiling Ring: Edge trim for ceiling opening; injection molded high impact ABS.

2. Diffuser Trim: Edge and attachment trim for diffuser lens; injection molded high impact ABS.

3. Diffuser Shape in Lay-In Ceiling Grid: Square, 24 x 48 inches, to fit acoustic ceiling grid; metal transition box.

4. Lens: Flush clear.

5. Lens Material: Acrylic plastic

6. Lens Thickness: 0.165 inch, minimum.

7. Seal: Closed cell EPDM foam rubber

2.3 ACCESSORIES

A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.

B. Joint Sealant: As specified in Section 07 90 05.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Designer of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

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

B. Seal joints exposed to weather using procedures specified in Section 07 90 05.

C. Conduct field test for water tightness; conduct water test in presence of Designer. Correct defective work and re-test until satisfactory.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 08 62 23

SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hardware for hollow steel and aluminum doors.

B. Hardware for fire-rated doors.

C. Electrically operated and controlled hardware.

D. Lock cylinders for doors for which hardware is specified in other sections.

E. Thresholds.

F. Weather-stripping, seals and door gaskets.

G. Gate locks.

H. Knox Box

1.2 RELATED REQUIREMENTS

A. Section 08 11 13 - Hollow Metal Doors and Frames.

B. Section 08 33 23 - Overhead Coiling Doors: Lockable coiling doors.

C. Section 08 43 13 - Aluminum-Framed Storefronts: Hardware for doors in storefront, including:
   1. Integral weather-stripping.
   2. Hinges.
   3. Exit devices.
   4. Closers.
   5. Push bars and pull handles.
   6. Thresholds.
   7. Installation of lock cylinders provided under this section.

D. Section 08 44 13 - Glazed Aluminum Curtain Walls: Hardware for integral doors and frames except lock cylinders; installation of cylinders.

E. Section 32 31 13 – Chain Link Fences and Gates

F. Division 28 – Electronic Safety and Security

1. Coordinate selection of hardware and fabrication of doors and frames with Facilities Security requirements as indicated on Drawings and in Specifications.

1.3 REFERENCE STANDARDS

A. BHMA A156.1 — American National Standard for Butts and Hinges; Builders Hardware Manufacturers Association, Inc.; 2006 (ANSI/BHMA A156.1).

B. BHMA A156.2 — American National Standard for Bored and Preassembled Locks and Latches; Builders Hardware Manufacturers Association, Inc.; 2006 (ANSI/BHMA A156.2)

C. BHMA A156.3 — American National Standard for Exit Devices; Builders Hardware Manufacturers Association; 2008 (ANSI/BHMA A156.3).

D. BHMA A156.4 — American National Standard for Door Controls - Closers; Builders Hardware Manufacturers Association, Inc.; 2008 (ANSI/BHMA A156.4).

E. BHMA A156.6 — American National Standard for Architectural Door Trim; Builders Hardware Manufacturers Association; 2010 (ANSI/BHMA A156.6).

F. BHMA A156.7 — American National Standard for Template Hinge Dimensions; Builders Hardware Manufacturers Association; 2003 (ANSI/BHMA A156.7).

G. BHMA A156.8 — American National Standard for Door Controls - Overhead Stops and Holders; Builders Hardware Manufacturers Association, Inc.; 2010 (ANSI/BHMA A156.8).

H. BHMA A156.22 — American National Standard for Door Gasketing and Edge Seal Systems, Builders Hardware Manufacturers Association; 2012 (ANSI/BHMA A156.22).

I. NFPA 80 — Building Materials Directory; Underwriters Laboratories Inc.; current edition.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the manufacture, fabrication, and installation of products onto which door hardware will be installed.

1.5 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project.

C. Hardware Schedule: Detailed listing of each item of hardware to be installed on each door. Use door numbering scheme as included in the Contract Documents. Identify electrically operated items and include power requirements.

D. Keying: The Contractor shall provide construction cores only. Final keying as directed by MNR. Key to the existing Best Masterkey System

E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

F. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Standards for Fire-Rated Doors: Maintain one copy of each referenced standard on site, for use by Designer and Trade Contractor.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

C. Hardware Supplier Qualifications: Company specializing in supplying commercial door hardware with 5 years of experience.

D. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) to assist in the work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

1.8 WARRANTY

A. See Section 01 78 30 – Warranties and Bonds, for additional warranty requirements.

B. Provide five year warranty for door closers, coordinators, electric strikes, and other mechanical components.

1.9 PERFORMANCE REQUIREMENTS – AUTOMATIC DOOR OPERATORS

A. Provide automatic door operators capable of withstanding structural loads and thermal movements based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Operating Range: Minus 30 deg F (29 deg C) to 130 deg F (54 deg C).

C. Opening-Force Requirements for Egress Doors: In the event power failure to the operator, swinging automatic entrance doors shall open with a manual force, not to exceed 30 lbf (133 N)

applied at 1” (25 mm) form the latch edge of the door.

D. Break Away Requirements: Automatic door operators shall breakaway with no more than 50 lbf (222 N) applied at 1” (25 mm) from the latch edge of the door.

E. Door Energy: The kinetic energy of a door in motion shall not exceed 1.25 lbd-ft (1.69 Nm).

F. Closing Time:
   1. Doors shall be field adjusted to close from 90 degrees to 10 degrees in 3 seconds or longer.
   2. Doors shall be field adjusted to close from 10 degrees to fully closed in not less than 1.5 seconds.

PART 2 - PRODUCTS

2.1 DOOR HARDWARE - GENERAL

A. Provide all hardware specified or required to make doors fully functional, compliant with applicable codes, and secure to the extent indicated.

B. Provide all items of a single type of the same model by the same manufacturer.

C. Provide products that comply with the following:
   1. Applicable provisions of federal, state, and local codes.
   2. Fire-Rated Doors: NFPA 80.
   3. All Hardware on Fire-Rated Doors: Listed and classified by UL as suitable for the purpose specified and indicated.
   4. Hardware for Smoke and Draft Control Doors: Provide hardware that enables door assembly to comply with air leakage requirements of the applicable code.
   5. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

D. Function: Lock and latch function numbers and descriptions of manufactures series as specified in related specification sections.

E. Electrically Operated and/or Controlled Hardware: Provide all power supplies, power transfer hinges, relays, and interfaces required for proper operation; provide wiring between hardware and control components and to building power connection. Hardware shall be designed for 24V DC power supply.

F. Finishes: Satin Chrome 626/652 ANSI finish code or Satin Stainless Steel 630 ANSI finish code, unless otherwise listed in Hardware Schedule.

2.2 HINGES

A. Hinges: Provide hinges on every swinging door.
   1. Provide five-knuckle full mortise butt hinges unless otherwise indicated.

2. Provide ball-bearing hinges at all doors having closers.
3. Provide hinges in the quantities indicated.
4. Provide non-removable pins on exterior out swinging doors.
5. Where electrified hardware is mounted in door leaf, provide power transfer hinges.

B. Butt Hinges: Comply with BHMA A156.1 and A156.7; heavy weight, unless otherwise indicated.
1. Provide hinge width required to clear surrounding trim.

C. Quantity of Hinges per Door:
1. Doors up to 60 inches High: Two hinges.
2. Doors From 60 inches High up to 90 inches High: Three hinges.
3. Doors 90 inches High up to 120 inches High: Four hinges.
4. Doors over 120 inches High: One additional hinge per each additional 30 inches in height.
5. Dutch Doors: Two hinges each leaf.

D. Manufacturers - Hinges:
1. Assa Abloy McKinney: www.assaabloydss.com.
2. Bommer Industries, Inc: www.bommer.com.
4. Hager Companies: www.hagerco.com.
5. Stanley Black & Decker: www.stanleyblackanddecker.com.
6. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS.

2.3 PUSH/PULLS

A. Push/Pulls: Comply with BHMA A156.6.
1. Provide push and pull on doors not specified to have lockset, latchset, exit device, or auxiliary lock.
2. On solid doors, provide matching push plate and pull plate on opposite faces.

B. Manufacturers - Push/Pulls:
1. Hager Companies: www.hagerco.com.
2. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS.

2.4 LOCKS AND LATCHES

A. Locks: Comply with BHMA A156.2; Grade 1, Extra Heavy Duty. Provide a lock for every door, unless specifically indicated as not requiring locking.
1. Hardware Sets indicate locking functions required for each door.
2. If no hardware set is indicated for a swinging door provide an office lockset (HW Set #9).
3. Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
4. Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.

5. Functions indicated in Hardware Schedule are ANSI Codes.

B. Electrically Operated Locks: Provide electric type as indicated with built-in request to exit switch (RQE). Coordinate with Division 28 card reader and security system; Fail secure unless otherwise indicated.

C. Lock Cylinders: Manufacturer's standard tumbler type, seven-pin interchageable core.
   1. Provide cams and/or tailpieces as required for locking devices required.

D. Keying: Final keying as directed by MNR. Key to the existing Best Masterkey System

E. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

2.5 DOOR SWITCHES

A. Coordinate requirements with FACILITIES SECURITY Drawings and Specifications (Division 28).

B. Furnish and install high-security magnetic contacts, recess mounted ANSI cut-out, factory calibrated for operation in steel.

   1. Contacts shall be adjustable to allow for true alignment.

   2. Characteristics are 50 VAC/VDC maximum; 0.5 A max current; Open or Closed Loop Type; SPDT configuration; up to 3/8" gap distance; anodized aluminum housing; UL and CUL compliant

C. Manufacturers:
   1. GE Security / Sentrol Model 2767 and as indicated
   2. SDC Security
   3. Securitron
   4. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS

2.6 EXIT DEVICES

A. Locking Functions: Functions as defined in BHMA A156.3, and as follows.

B. Electrically Operated Exit Devices: Provide electric latch retraction (ELR) type as indicated. Coordinate with Division 28 card reader and security system.

C. Manufacturers:
   1. Assa Abloy Corbin Russwin 5000, Sargent 80, or Yale 7000.
   2. Allegion: Von Duprin 98
   3. Stanley Security: Precision 2000
   4. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS.

2.7 CLOSERS

A. Closers: Complying with BHMA A156.4.
   1. Provide surface-mounted, door-mounted closers unless otherwise indicated.
   2. Provide a door closer on every exterior door.
   3. Provide a door closer on every fire-rated door. Spring hinges are not an acceptable self-closing device and shall not be provided.
   4. On pairs of swinging doors, if an overlapping astragal is present, provide coordinator to ensure the leaves close in proper order.
   5. Closers at exterior and as indicated to have Advanced Backcheck Feature.
   6. Auto Electric Closers as indicated. Provide with two 4-1/2 inch Stainless Steel Square Push Plates with Engraved ADA Accessibility Logo and “Push To Open” at each opening.

B. Manufacturers - Closers:
   1. Assa Abloy Corbin Russwin DC8000, Norton 7500, Sargent 351, or Yale 4400
   2. Allegion: LCN 4111
   3. Stanley Door Closers: CLD-4550
   4. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS.

C. Manufacturers – Power Operator (Electric) Closers:
   1. Assa Abloy Norton 6900, Sargent MP4000.
   2. Allegion: LCN 4640
   3. Stanley Door Closers: CLD-4990
   4. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS.

2.9 STOPS AND HOLDERS

A. Stops: Complying with BHMA A156.8; provide a stop for every swinging door, unless otherwise indicated.
   1. Provide wall stops, unless otherwise indicated.
   2. If wall stops are not practical, due to configuration of room or furnishings, provide overhead stop.
   3. Stop is not required if positive stop feature is specified for door closer; positive stop feature of door closer is not an acceptable substitute for a stop unless specifically so stated.

B. Manufacturers - Overhead Holders/Stops:
   1. Assa Abloy Rixson or Sargent: www.assaabloydss.com.
   2. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS.

C. Manufacturers - Wall and Floor Stops/Holders:
   1. Hager Companies: www.hagerco.com.
   2. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS.

2.10 GASKETING AND THRESHOLDS

A. Gaskets: Complying with BHMA A156.22.

1. On each exterior door, provide weather-stripping gaskets, unless otherwise indicated; top, sides, and meeting stiles of pairs.
   a. Where exterior door is also required to have fire rating, provide gaskets functioning as both smoke and weather seals.
2. On each exterior door, provide door bottom sweep, unless otherwise indicated.

B. Thresholds:
1. At each exterior door, provide a threshold unless otherwise indicated. Provise with stainless steel machine screws and expansion shields (SSMS/ES).
2. Drip Guard: Provide projecting drip guard over all exterior doors unless they are under a projecting roof or canopy.

C. Manufacturers - Gasketing and Thresholds:
1. Pemko Manufacturing Co: www.pemko.com.
2. National Guard Products
3. Reese Enterprises
4. Zero International
5. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS.

2.11 PROTECTION PLATES AND ARCHITECTURAL TRIM

A. Protection Plates:
1. Kick plate: Provide on push side of every door with closer and as indicated, except storefront and all-glass doors. Provide with Beveled edges and countersunk screws.

B. Manufacturers - Protection Plates and Architectural Trim:
1. Hager Companies: www.hagerco.com.
2. Trimco.
3. Burns Manufacturing.
4. Rockwood Manufacturing.
5. Substitutions: See Section 01 60 00 - PRODUCT REQUIREMENTS.

2.12 KEY CONTROLS

A. Final keying shall be as directed by MNR. Key to the existing Best Masterkey System

B. Fire Department Lock Box: Provide a single Knox Box for Fire Department access. Coordinate location at main entrance gate with CTDOT PM. Heavy-duty, weather-proof, solid welded-steel box with hinged door and interior gasket seal; single drill resistant lock with dust covers and tamper alarm switch.

1. Capacity: Holds 10 keys.

2. Finish: Manufacturer's standard dark bronze.

3. Mount securely to fence at main entrance gate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that doors and frames are ready to receive work; labeled, fire-rated doors and frames are present and properly installed, and dimensions are as indicated on shop drawings.

B. Verify that electric power is available to power operated devices and of the correct characteristics.

3.2 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions and applicable codes.

B. Use ANSI templates provided by hardware item manufacturer.

C. Do not install surface mounted items until finishes applied to substrate are complete.

D. Install hardware on fire-rated doors and frames in accordance with CT Building Code and NFPA 80.

E. Mounting heights for hardware from finished floor to center line of hardware item shall comply with ADA requirements and BHMA standards.

3.3 FIELD QUALITY CONTROL

A. Provide an Architectural Hardware Consultant to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.4 ADJUSTING

A. Adjust hardware for smooth operation.

B. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.5 CLEANING

A. Clean adjacent surfaces soiled by hardware installation. Clean finished hardware per manufacturer's instructions after final adjustments has been made. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.6 PROTECTION

A. Protect finished work from damage.

B. Do not permit adjacent work to damage hardware or finish.

Provide templates and hardware, except field-applied hardware, to the aluminum door and frame manufacturer for use in fabricating the doors and frames.

3.7 SCHEDULE

HARDWARE SET		DESCRIPTION	FINISH
SET #1			
3	Hinges	A8111 4 1/2 x 4 1/2	652
1	Fire Exit Device (Passage)	TYPE 1-14 x LEVER TRIM x UL	630
1	Door Closer	C02021 PT4D EDA	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Door Stop	L02011	626
1	Gasketing	R0E156	
SET #2			
5	Hinges	A5111 4 1/2 x 4 1/2 NRP	630
1	Elec. Hinge	A5111 4 1/2 x 4 1/2 - 4 WIRES	630
2	Flush Bolt	L04251	626
1	Electro-mech Lock	F86 x ELEC UNLOCK x RQE	626
1	Core	1CM-7MJ12	626
2	Door Closer | Stop | HO	C02061 x PT4G PT4J x EDA	689
2	Kick Plate	J102 10" x 2" LDW B4E CSK	630
2	Door Position Switch	HS SWITCH (MC-4M - SDC)	628
1	Dustproof Strike	LO4021	630
1	Latch Protector	NLP-106	630
2	Door Sweep	R3B436	
1	Weatherstrip	R3E166	
1	Drip Cap	R3Y976	
1	Astragal	R3E616	
1	Saddle Threshold	J32130-5" WIDE x SSMS/ES	AL
2	Door Silencers	L03011	

HARDWARE SET		DESCRIPTION	FINISH
SET #2.1			
6	Hinges	A5111 4 1/2 x 4 1/2 NRP	630
2	Flush Bolt	L04251	626
1	Storeroom Lockset	F86	626
2	Door Closer | Stop | HO	C02061 x PT4G PT4J x EDA	689
2	Kick Plate	J102 10" x 2" LDW B4E CSK	630
2	Door Position Switch	HS SWITCH (MC-4M - SDC)	628
1	Dustproof Strike	LO4021	630
1	Latch Protector	NLP-106	630
1	Weatherstrip	R3E166	
1	Drip Cap	R3Y976	
1	Astragal	R3E616	
2	Door Sweep	R3B436	
1	Saddle Threshold	J32130-5" WIDE x SSMS/ES	AL
2	Door Silencers	L03011	
SET #3			
6	Hinges	A8112 4 1/2 x 4 1/2 NRP	652
1	Set Auto Flush Bolts	3820 X 3810	630
1	Storeroom Lockset	F86	626
1	Core	1CM-7MJ12	626
2	Door Closer	C02021 x PT4D PT4G	689
1	Dustproof Strike	LO4021	630
1	Gasketing	R0E156	
1	Astragal	R3E616	
SET #4			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Storeroom Lockset	F86	626
1	Core	1CM-7MJ12	626
1	Door Closer | HO	C02051 x PT4D PT4H	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Wall Bumper	LO2251	630
3	Door Silencers	L03011	
SET #4.1 -			
6	Hinges	A8112 4 1/2 x 4 1/2	652
1	Storeroom Lockset	F86	626
1	Core	1CM-7MJ12	626
2	Door Closer | HO	C02051 x PT4D PT4H	689
2	Kick Plate	J102 10" x 2" LDW B4E CSK	630
2	Wall Bumper	LO2251	630
1	Set Seal	R3E166	
1	Gasketing	R0E156	
1	Astragal	R3E616	
2	Auto Door Bottom	R3C346	
1	Saddle Threshold	J32130-4" WIDE x SSMS/ES	AL

HARDWARE SET		DESCRIPTION	FINISH
SET #4.2 -			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Storeroom Lockset	F86	626
1	Core	1CM-7MJ12	626
1	Wall Bumper	LO2251	630
1	Gasketing	R0E156	
1	Auto Door Bottom	R3C346	
1	Saddle Threshold	J32130-4" WIDE x SSMS/ES	AL
SET #5			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Office Lockset	F81	626
1	Core	1CM-7MJ12	626
1	Door Closer	C02011 x PT4D	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Wall Bumper	LO2251	630
3	Door Silencers	L03011	
SET #5.1			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Office Lockset	F81	626
1	Core	1CM-7MJ12	626
1	Door Closer	C02011 x PT4D	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Wall Bumper	LO2251	630
1	Gasketing	R0E156	
SET #5.2			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Office Lockset	F81	626
1	Core	1CM-7MJ12	626
1	Door Closer | Stop | HO	C02061 x PT4G PT4J x EDA	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Wall Bumper	LO2251	630
1	Gasketing	R0E156	
SET #6			
2	Hinges	A5111 4 1/2 x 4 1/2 NRP	630
1	Elec. Hinge	A5111 4 1/2 x 4 1/2 - 4 WIRES	630
1	Electro-mech Lock	F86 x ELEC UNLOCK x RQE	626
1	Core	1CM-7MJ12	626
1	Door Closer | Stop | HO	C02061 x PT4G PT4J x EDA	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Latch Protector	NLP-106	630
1	Door Position Switch	HS SWITCH (MC-4M - SDC)	628
1	Drip Cap	R3Y976	
1	Weatherstrip	R3E166	
1	Door Sweep	R3B436	
1	Saddle Threshold	J32130-5" WIDE x SSMS/ES	AL
1	Card Reader	SECURITY SECTION	

HARDWARE SET		DESCRIPTION	FINISH
SET #7			
6	Hinges	A8112 4 1/2 x 4 1/2 NRP	652
2	Flush Bolt	L04251	626
1	Storeroom Lockset	F86	626
1	Core	1CM-7MJ12	626
1	Door Closer	C02021 PT4D EDA	689
2	Kick Plate	J102 10" x 2" LDW B4E CSK	630
2	Wall Bumper	LO2251	630
1	Dustproof Strike	LO4021	630
2	Door Silencers	L03011	
SET #7.1			
6	Hinges	A8112 4 1/2 x 4 1/2 NRP	652
1	Set Auto Flush Bolts	3820 X 3810	630
1	Storeroom Lockset	F86	626
1	Core	1CM-7MJ12	626
2	Door Closer	C02021 PT4D EDA	689
1	Coordinator	TYPE 25	600
2	Kick Plate	J102 10" x 2" LDW B4E CSK	630
2	Wall Bumper	LO2251	630
1	Dustproof Strike	LO4021	630
1	Gasketing	R0E156	
SET #8			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Passage Set	F75	626
1	Door Closer | HO	C02051 x PT4D PT4H	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Wall Bumper	LO2251	630
3	Door Silencers	L03011	
SET #8.1			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Passage Set	F75	626
1	Door Closer	C02021 PT4D EDA	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Wall Bumper	LO2251	630
3	Door Silencers	L03011	
SET #9			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Office Lockset	F81	626
1	Core	1CM-7MJ12	626
1	Wall Bumper	LO2251	630
3	Door Silencers	L03011	

HARDWARE SET		DESCRIPTION	FINISH
SET #9.1			
3	Hinges	A8111 4 1/2 x 4 1/2 NRP	652
1	Office Lockset	F81	626
1	Door Closer	C02021 x PT4D PT4H x EDA	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Wall Bumper	LO2251	630
3	Door Silencers	L03011	
SET #9.2			
3	Hinges	A8111 4 1/2 x 4 1/2 NRP	652
1	Office Lockset	F81	626
1	Door Closer | HO	C02051 x PT4D PT4H	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Wall Bumper	LO2251	630
3	Door Silencers	L03011	
SET #10			
1	Core	1CM-7MJ12	626
1	Mortise Cylinder	1E-74 L/C	626
1	Door Position Switch	HS SWITCH (MSS-1G - SECURITRON)	628

NOTE: Provide Cylinder or Padlock as required

SET #11			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Pull Plate	J405 - 4" x 16"	630
1	Push Plate	J301 - 8" x 16"	630
1	Door Closer | HO	C02051 x PT4D PT4H	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Wall Bumper	LO2251	630
3	Door Silencers	L03011	
SET #12			
2	Hinges	A8112 4 1/2 x 4 1/2	652
1	Elec. Hinge	A8112 4 1/2 x 4 1/2 - 4 WIRES	652
1	Electro-mech Lock	F86 x ELEC UNLOCK x RQE	626
1	Core	1CM-7MJ12	626
1	Door Closer	C02011 x PT4D	689
1	Wall Bumper	LO2251	630
1	Door Position Switch	HS SWITCH (MC-4M - SDC)	628
3	Door Silencers	L03011	

HARDWARE SET		DESCRIPTION	FINISH
SET #12.1			
2	Hinges	A8112 4 1/2 x 4 1/2 NRP	652
1	Elec. Hinge	A8112 4 1/2 x 4 1/2 - 4 WIRES	652
1	Electro-mech Lock	F86 x ELEC UNLOCK x RQE	626
1	Core	1CM-7MJ12	626
1	Door Closer	C02021 PT4D EDA	689
1	Wall Bumper	LO2251	630
1	Door Position Switch	HS SWITCH (MC-4M - SDC)	628
3	Door Silencers	L03011	
SET #12.2			
3	Hinges	A8112 4 1/2 x 4 1/2	652
1	Exit Set	F111	626
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Door Position Switch	HS SWITCH (MC-4M - SDC)	628
3	Door Silencers	L03011	
SET #13			
6	Hinges	A5111 4 1/2 x 4 1/2 NRP	630
1	Exit Device	TYPE 6-01	630
1	Elec Exit Device	TYPE 6-03 x ELR	630
1	Rim Cylinder	12E-72 L/C	626
1	Core	1CM-7MJ12	626
2	Door Pull	J402 - 1" DIA x 10" CTC x CONC MTG	630
2	Door Closer | Stop | HO	C02061 x PT4G PT4J x EDA	689
1	Power Transfer	EPT	
1	Power Supply	PS/ELR	
1	Card Reader	SECURITY SECTION	
1	Door Position Switch	HS SWITCH (MC-4M - SDC)	628
1	Weatherstrip	DOOR MFG	
2	Door Bottom	R3Y536	
1	Saddle Threshold	J32130-4" WIDE x SSMS/ES	AL
SET #13.1			
6	Hinges	A5111 4 1/2 x 4 1/2 NRP	630
1	Exit Device	TYPE 6-01	630
1	Elec Exit Device	TYPE 6-03 x ELR	630
1	Rim Cylinder	12E-72 L/C	626
1	Core	1CM-7MJ12	626
2	Door Pull	J402 - 1" DIA x 10" CTC x CONC MTG	630
2	Door Operators	Electric Operators	689
1	Power Transfer	EPT	
1	Power Supply	PS/ELR	
1	Card Reader	SECURITY SECTION	
1	Door Position Switch	HS SWITCH (MC-4M - SDC)	628
1	Weatherstrip	DOOR MFG	
2	Door Bottom	R3Y536	
1	Saddle Threshold	J32130-4" WIDE x SSMS/ES	AL

HARDWARE SET		DESCRIPTION	FINISH
SET #14			
6	Hinges	A8111 4 1/2 x 4 1/2	652
2	Push/Pull Set	J505 x CONC MTG	630
2	Door Closer | Stop | HO	C02061 x PT4G PT4J x EDA	689
1	Weatherstrip	DOOR MFG	
2	Door Bottom	R3Y536	
SET #14.1			
6	Hinges	A8111 4 1/2 x 4 1/2	652
2	Push/Pull Set	J505 x CONC MTG	630
2	Door Closer | Stop | HO	C02061 x PT4G PT4J x EDA	689
2	Brush Sweep	R3A436	
2	Meeting Stile Seal	R3A736	
SET #14.2			
6	Hinges	A8111 4 1/2 x 4 1/2	652
2	Push/Pull Set	J505 x CONC MTG	630
2	Door Operators	Electric Operators	689
2	Brush Sweep	R3A436	
2	Meeting Stile Seal	R3A736	
SET #15 -			
6	Hinges	A8111 4 1/2 x 4 1/2 NRP	652
1	Exit Device	TYPE 2-01 x LBR x UL	630
1	Exit Device	TYPE 2-08 x LEVER TRIM x LBR x UL	630
1	Rim Cylinder	12E-72 L/C	626
1	Core	1CM-7MJ12	626
2	Door Closer	C02021 PT4D EDA	689
2	Kick Plate	J102 10" x 2" LDW B4E CSK	630
2	Wall Bumper	LO2251	630
1	Gasketing	R0E156	
SET #16			
3	Hinges	A5111 4 1/2 x 4 1/2 NRP	630
1	Elec. Exit Device	TYPE 1-03 x GRIP PULL x ELR x RQE	630
1	Rim Cylinder	12E-72 L/C	626
1	Core	1CM-7MJ12	626
1	Door Closer | Stop | HO	C02061 x PT4G PT4J x EDA	689
1	Kick Plate	J102 10" x 2" LDW B4E CSK	630
1	Power Transfer	EPT	
1	Power Supply	PS/ELR	
1	Weatherstrip	R3E166	
1	Door Sweep	R3B436	
1	Door Bottom	R3Y536	
1	Saddle Threshold	J32130-5" WIDE x SSMS/ES	AL
3	Door Silencers	L03011	

HARDWARE SET	DESCRIPTION	FINISH
SET #17 (GATES - EGRESS)		
3 Gate Hinges	SEE DETAILS (BY GATE FABRICATOR)	
1 Exit Device	TYPE 1-03(NON-FERROUS)	
	(2103 x 1703A x S459)	626
1 Rim Cylinder	12E-72 L/C	626
1 Core	1CM-7MJ12	626
1 Door Closer	C02011 x PT4D (NON-FERROUS) (SS7500M)	689
2 Weld On Lock Box	K-BX515175	FF
SET #17.1 (GATE - SERVICE)		
3 Gate Hinges	SEE DETAILS (BY GATE FABRICATOR)	
1 Storeroom Lockset	F07 (NON-FERROUS) (ML2057 NSR – M26)	626
1 Mortise Cylinder	1E-74 L/C	626
1 Core	1CM-7MJ12	626
1 Door Closer	C02011 x PT4D (NON-FERROUS) (SS7500M)	689
1 Weld On Lock Box	K-BXMOR2	FF
1 Weld On Strike Box	K-BXSTR	FF

END OF SECTION 08 71 00

SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Glass.

B. Glazing compounds and accessories.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements

B. Section 07 42 13 – Metal Wall Panels: Integrated Windows.

C. Section 08 43 13 – Aluminum Framed Storefronts.

D. Section 08 44 13 - Glazed Aluminum Curtain Walls.

E. Section 10 28 00 - Toilet, Bath, and Laundry Accessories: Mirrors.

1.3 REFERENCE STANDARDS

A.	ASTM C1036	Standard Specification for Flat Glass; 2011e1.
B.	ASTM C1048	Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2012.
C.	ASTM C1172	Standard Specification For Laminated Architectural Flat Glass; 2014
D.	ASTM E1300	Standard Practice for Determining Load Resistance of Glass in Buildings; 2012a.
E.	ASTM E2190	Standard Specification for Insulating Glass Unit Performance and Evaluation; 2010.
F.	GANA (GM)	GANA Glazing Manual; Glass Association of North America; 2009.
G.	GANA (SM)	GANA Sealant Manual; Glass Association of North America; 2008.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

C. Manufacturer's Certificates: Certify that products meet or exceed specified requirements.

D. Samples: Submit two samples 12 x 12 inch in size of glass units, showing coloration and design.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with GANA Glazing Manual and GANA Sealant Manual for glazing installation methods.

1.6 FIELD CONDITIONS

A. Do not install glazing when ambient temperature is less than 50 degrees F.

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.7 WARRANTY

A. See Section 01 78 30 –Warranties and Bonds, for additional warranty requirements.

B. Sealed Insulating Glass Units: Provide a ten (10) year warranty to include coverage for seal failure, interpane dusting or misting, including replacement of failed units.

C. Laminated Glass: Provide a ten (10) year warranty to include coverage for delamination, including replacement of failed units.

PART 2 - PRODUCTS

2.1 GLAZING TYPES

A. Sealed Insulating Glass Units: Vision glazing, low-E, Hurricane Impact Resistant.

1. Basis of Design: PPG Glass Sungate 400 Low E Solargray: www.ppgideascapes.com
2. Substitutions: Refer to Section 01 60 00 - Product Requirements.
3. Between-lite space filled with argon.
4. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
5. Inboard Lite: Annealed laminated glass composed of two (2) pieces of 1/8-inch glass with a 0.090 PVB interlayer.
6 Total Thickness: 1 inch.
7. Thermal Resistance (U-value): 0.31 minimum
8. Total Solar Heat Gain Coefficient: 0.39 maximum

9. Total Visible Light Transmittance: 38% minimum.

B. Safety Glazing: Laminated Glass

1. Type: Laminated Glass

2. Tint: Clear.

3. Thickness: Two nominal 1/8-inch layers of annealed float glass laminated with minimum 0.030 inch thick clear polyvinyl butyral interlayer. Total thickness of 1/4-inch

4. Laminated in accordance with ASTM C1172

5. Comply with 16 CFR 1201 test requirements for category II.

2.2 EXTERIOR GLAZING ASSEMBLIES

A. Structural Design Criteria: Select type and thickness to withstand dead loads and wind loads acting normal to plane of glass at design pressures calculated in accordance with ASCE 7.

1. Use the procedure specified in ASTM E1300 to determine glass type and thickness.

2. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.

3. Thicknesses listed are minimum.

2.3 GLASS MATERIALS

A. Float Glass

1. Annealed Type: ASTM C1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select).

2. Heat-Strengthened and Fully Tempered Types: ASTM C1048.

3. Tinted Types: Color and performance characteristics as indicated.

4. Thicknesses: As indicated; for exterior glazing comply with specified requirements for wind load design regardless of specified thickness.

2.4 SEALED INSULATING GLASS UNITS

A. Sealed Insulating Glass Units: Types as indicated.

1. Durability: Certified by an independent testing agency to comply with ASTM E2190.

2. Edge Spacers: Aluminum, bent and soldered corners.

3. Edge Seal: Glass to elastomer with supplementary silicone sealant.

4. Purge interpane space with dry hermetic air.

2.5 GLAZING COMPOUNDS

A. Manufacturers:

1. Bostik Inc: www.bostik-us.com.

2. Pecora Corporation: www.pecora.com.

3. BASF Construction Chemicals-Building Systems: www.buildingsystems.basf.com.

4. Substitutions: Refer to Section 01 60 00 - Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerance.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

END OF SECTION 08 80 00

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Gypsum wallboard

B. Water-resistant gypsum board

C. Cementitious backer board

D. Exterior gypsum sheathing

E. Sound Attenuation Insulation

F. Joint treatment and accessories.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 – Sustainable Design Requirements

B. Section 05 40 00 – Cold-formed Metal Framing

C. Section 09 22 16 - Non-Structural Metal Framing.

1.3 REFERENCE STANDARDS

A.	ANSI A108.11	American National Standard for Interior Installation of Cementitious Backer Units; 2013.1.
B.	ASTM C475/C475M	Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2012.
C.	ASTM C645	Standard Specification for Nonstructural Steel Framing Members; 2013.
D.	ASTM C665	Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2012.
E.	ASTM C754	Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2011.
F.	ASTM C840	Standard Specification for Application and Finishing of Gypsum Board; 2013.
G.	ASTM C919	Standard Practice For Use Of Sealants In Acoustical Applications; 2012

H. ASTM C954 Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2011.

I. ASTM C1002 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2007 (Reapproved 2013).

J. ASTM C1177 Standard Specification For Glass Mat Gypsum Substrate For Use As Sheathing; 2013

K. ASTM C1288 Standard Specification For Discrete Non-Asbestos Fiber-Cement Interior Substrate Sheets; 2014

L ASTM C1396/C1396M Standard Specification for Gypsum Board; 2013.

M. ASTM E84 Standard Test Method For Surface Burning Characteristics Of Building Materials; 2014

N. GA-216 Application and Finishing of Gypsum Board; Gypsum Association; 2013.

1.4 SUBMITTALS

A. See Section 01 33 00 -Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide data on gypsum board, water-resistant gypsum board, cementitious backer board, exterior gypsum sheathing, acoustic insulation, accessories, and joint finishing system.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturers - Gypsum-Based Board:

1. Georgia-Pacific Gypsum: www.gpgypsum.com.

2. National Gypsum Company: www.nationalgypsum.com.

3. USG Corporation: www.usg.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Gypsum Wallboard: Paper-faced gypsum panels.

1. ASTM C1396/C1396M

2. Thickness: 5/8-inch

3. Tapered edge

4. Type X (Fire-Resistant): where indicated.

C. Water-Resistant Gypsum Board

1. ASTM C1396/C1396M

2. Thickness: 5/8-inch

3. Tapered edge

D. Cementitious Backer Board:

1. In accordance with Tile Council of America (TEA) Handbook

2. ASTM C1288

E. Exterior Gypsum Sheathing

1. ASTM C1396/C1396M and ASTM C1177/C1177M

2. Thickness: 5/8-inch

3. Square edge

2.2 SOUND ATTENUATION INSULATION

1. ASTM C665, Type I

2. Flame spread rating: 25 or less

3. Smoke developed rating: 50 or less

4. ASTM E84

2.3 ACCESSORIES

A. Acoustic Sealant ASTM C919: Non-hardening, non-skinning, for use in conjunction with gypsum board.

B. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.

C. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type; cadmium-plated for exterior locations.

D. Screws for Attachment to Steel Members From 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.2 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.3 BOARD INSTALLATION

A. Comply with ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Cementitious Backing Board: Install over substrait where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

3.4 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.5 JOINT TREATMENT

A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:

1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.

2. Level 1: Fire rated wall and ceiling areas above finished ceilings, whether or not accessible in the completed construction.

B. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.

1. Feather coats of joint compound so that camber is maximum 1/32 inch.

END OF SECTION 09 21 16

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Metal partition, ceiling, and soffit framing.

B. Framing accessories.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 Sustainable Design Requirements

B. Section 05 40 00 Cold Formed Metal Framing

C. Section 09 21 16 Gypsum Board Assemblies

1.3 REFERENCE STANDARDS

A. ASTM C645 Standard Specification for Nonstructural Steel Framing Members; 2013.

B. ASTM C754 Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2011.

C. ASTM C1002 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2007.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, and limitations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Metal Framing, Connectors, and Accessories:

1. Clarkwestern Dietrich Building Systems LLC: www.clarkdeitrich.com.

2. Marino: www.marinoware.com.

3. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FRAMING MATERIALS

A. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
   1. Studs: C shaped with flat or formed webs with knurled faces.
   2. Runners: U shaped, sized to match studs.
   3. Ceiling Channels: C Shaped
   4. Furring: Hat-shaped sections minimum depth of 7/8-inch.

B. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.

C. Partition Head to Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and screwed to secondary deflection channel set inside but unattached to top track.

D. Tracks and Runners: Same material and thickness as studs, bent leg retainer notched to receive studs with provision for crimp locking to stud.

E. Furring and Bracing Members: Of same material as studs; thickness to suit purpose; complying with applicable requirements of ASTM C754.

F. Fasteners: ASTM C1002 self-piercing tapping screws.

G. Sheet Metal Backing: 0.036-inch thick, galvanized.

H. Anchorage Devices: Powder actuated.

PART 3 - EXECUTION

3.1 INSTALLATION OF STUD FRAMING

A. Extend partition framing to structure where indicated.

B. Partitions Terminating at Structure: Attach extended leg top runner to structure and maintain clearance between top of studs.

C. Align and secure top and bottom runners at 24 inches on center.

D. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.

E. Install studs at 16-inches on center.

F. Align stud web openings horizontally.

G. Fabricate corners using a minimum of three studs.

H. Double stud at wall openings, door and window jambs, not more than 2 inches from each side of openings.

I. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.

3.2 CEILING AND SOFFIT FRAMING

A. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.

B. Install furring independent of walls, columns, and above-ceiling work.

C. Framing shall not be suspended from metal roof deck.

D Securely anchor hangers to structural members or embed in structural slab. Space hangers as required to limit deflection to criteria indicated.

E. Space main carrying channels at maximum 48 inch on center, and not more than 6 inches from wall surfaces. Lap splice securely.

F. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.

G. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.

END OF SECTION 09 22 16

SECTION 09 30 00 - TILING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Tile for floor applications.

B. Tile for wall applications.

C. Porcelain accessories.

D. Porcelain trim.

1.2 RELATED REQUIREMENTS

A. Section 09 21 16 - Gypsum Board Assemblies: Installation of tile backer board.

B. Section 06 61 00 – Solid Polymer Surfacing Fabrications

1.3 REFERENCE STANDARDS

A. ANSI A108/A118/A136.1 American National Standard Specifications for the Installation of Ceramic Tile - Version; 2013.1.

B. ANSI A108.1A American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2013.1.

C. ANSI A108.1B American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar; 2013.1.

D. ANSI A108.1C Specifications for Contractors Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Bed with Dry-Set or Latex-Portland Cement Mortar; 2013.1.

E. ANSI A108.4 American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile-Setting Epoxy Adhesive; 2013.1.

F. ANSI A108.5 American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar; 2013.1.

G. ANSI A108.6 American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy; 2013.1.

H. ANSI A108.8 American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 2013.1.

I. ANSI A108.9 American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 2013.1.

J. ANSI A108.10 American National Standard Specifications for Installation of Grout in Tilework; 2013.1.

K. ANSI A108.11 American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2013.1.

L. ANSI A108.12 American National Standard Specifications for Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar; 2013.1.

M. ANSI A108.13 American National Standard Specifications for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone; 2013.1.

N. ANSI A118.4 American National Standard Specifications for Modified Dry-Set Cement Mortar; 2013.1.

O. ANSI C648 Standard Test Method For Breaking Strength Of Ceramic Tile; 2014

P. ANSI C1028 Standard Test Method For Determining The Static Coefficient Of Friction Of Ceramic Tile And Other Like Surfaces By The Horizontaldynamometer Pull-Meter Method; 2010

Q. ANSI C650 Standard Test Method For Resistance Of Ceramic Tile To Chemical Substances; 2014

R. ANSI C1378 Standard Test Method For Determination Of Resistance To Staining; 2014

S. ISO 1300 Plastics - Polytetrafluoroethylene (Ptfe) Semi-Finished Products -Part 1: Requirements And Designation; 2006

T. TCNA (HB) Handbook for Ceramic, Glass, and Stone Tile Installation; 2013.1.

U. ASTM A118 Specification For Zinc-Coated Iron Or Steel Chain-Link Fence Fabric Galvanized Before Wearing; 2000

V. ASTM C627 Standard Test Method For Evaluating Ceramic Floor Tile Installation Systems Using The Robinson-Type Floor Tester; 2010

W. ASTM E492 — Standard Test Method For Laboratory Measurement Of Impact Sound Transmission Through Floor-Ceiling Assemblies Using The Tapping Machine; 2009

X. ASTM E2179 — Standard Test Method For Laboratory Measurement Of The Effectiveness Of Floor Coverings In Reducing Impact Sound Transmission Through Concrete Floors; 2009

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide manufacturer's data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.

C. Samples: Provide full size samples of tile, minimum of 12-inch x 12-inch to illustrate pattern and color variations and provide samples of grout.

1.5 QUALITY ASSURANCE

A. Maintain one copy of and ANSI A108/A118/A136.1 and TCNA (HB) on site.

PART 2 - PRODUCTS

2.1 TILE

A. Color through porcelain tile. Marazzi; Walnut Canyon, or equal: www.marazziusa.com

1. Single product line to include 2-inch x 2-inch, 13-inch x 13-inch and 6-inch x 13-inch cove base, and corresponding inside and outside corner trim.

2. Water absorption: ASTM C373 $\leq$ 0.50 percent.

3. Breaking strength: ASTM C648 $\geq$ 429 lbf.

4. Dry coefficient of friction: ASTM C1028 $0.70 \leq COF < 0.80$

5. Wet Coefficient of Friction: ASTM C1028 $0.60 \leq COF < 0.70$.

6. Chemical Resistance: ASTM C650, Class A

7. Stain Resistance: ASTM C1378, Class A.

B. Other acceptable manufacturers, all products by the same manufacturer:

1. American Olean Corporation: www.americanolean.com.

2. Dal-Tile Corporation: www.daltile.com.

3. Crossville Tile: www.crossvilleinc.com

4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 TRIM AND ACCESSORIES

A. Waterproofing membrane, Schluter, Ditra, or equal. Pressure stable polyethylene membrane vacuum-formed in a cut back grid design, with an anchoring fleece laminated to its underside; 1/8-inch, emits zero VOC. Membrane to be installed on floors and walls at the shower and towel drying area portions of toilet rooms (only). Coordinate to 06 61 00 – Solid Polymer Surfacing Fabrications.

B. Accessories: Color through porcelain finish, same color and finish as adjacent field tile; same manufacturer as tile.

C. Trim: Matching color through porcelain bullnose, decorative accent band, cove base, and cove ceramic shapes in sizes coordinated with field tile; same manufacturer as tile.

D. Threshold: Solid surface threshold to be provided by others.

2.3 SETTING MATERIALS

A. Anti fracture setting material; Laticrete #125 Sound and crack adhesive, or equal; www.laticrete.com

1. System crack resistance test, ANSI A118.12 5.4 High

2. 28-Day cure porcelain tile shear strength, ANSI A118.12 5.1.5, 100-135 psi (0.7-0.9 MPa)

3. Shear strength after accelerated aging, ANSI A118.12 5.1.6, 100-170 psi (0.7-0.9 MPa)

4. Tensile adhesion strength ISO 13007-2:4.4.4.2, 1.02 MPa

5. Tensile adhesion strength after water immersion ISO 13007-2:4.4.4.3, 0.75 MPa.

B. Provide setting materials made by the same manufacturer as grout.

C. Latex-Portland Cement Mortar Bond Coat: ANSI A118.12 tested to ASTM E2179, ASTM E492, and ASTM C627 conforms to ISO 13007-1 classification.

2.4 GROUTS:

A. LATICRETE; SPECTRALOCK urethane grout or equal; Color: Parchment #61; 3/16-inch grout joint or as recommended by tile manufacturer. Grout to provide superior resistance to chemicals and staining.

B. Other acceptable manufacturers:

1. ARDEX Engineered Cements: www.ardexamericas.com.

2. ProSpec, an Oldcastle brand; ProColor Sanded Tile Grout: www.prospec.com.

3. BOSTIK International, Inc; QUARTZLOCK 2 Urethane grout: www.laticrete.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.

C. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by tile manufacturer and setting materials manufacturer.

3.2 INSTALLATION - GENERAL

A. Install tile, thresholds, and grout in accordance with applicable requirements of ANSI A108.1A thru A108.13, manufacturer's instructions, and TCNA (HB) recommendations.

B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.

C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor, base, and wall grout lines.

D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.

E. Form internal angles square and external angles bullnosed.

F. Install ceramic accessories rigidly in prepared openings.

G. Sound tile after setting. Replace hollow sounding units.

H. Keep expansion joints free of adhesive or grout. Apply sealant to joints.

I. Prior to grouting, allow installation to completely cure minimum of 48 hours.

J. Grout tile joints. Use grout as indicated or equal.

K. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.

END OF SECTION 09 30 00

SECTION 09 51 00 - ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Suspended metal grid suspension ceiling system.

B. Wire Hangers, fasteners, main runners, cross tees, and wall angle moldings.

C. Acoustical mineral fiber ceiling panels.

D. Acoustical Perforated metal ceiling panels.

1.2 RELATED REQUIREMENTS

A. Section 26 51 00 - Interior Lighting: Light fixtures in ceiling system.

1.3 REFERENCE STANDARDS

A.	ASTM A641	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2014.
B.	ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
C.	ASTM C 423	Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
D.	ASTM C 635	Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
E.	ASTM C636	Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels; 2008.
F.	ASTM E580	Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2011.
G.	ASTM E1264	Standard Classification for Acoustical Ceiling Products; 2008e1.
H.	ASTM E1414	Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
I.	ASTM E1477	Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers; 2013.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Shop Drawings: Indicate grid layout and related dimensioning.

C. Product Data: Provide data on proposed acoustical ceiling panels, perforated metal ceiling panels, and grid and suspension system components.

D. Samples: Submit two samples of each acoustical panel type illustrating material and finish, 4-inch x 4-inch in size.

E. Samples: Submit two samples each, 12 inches long, of suspension system main runner illustrating material and finish.

1.5 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 - PRODUCTS

2.1 ACOUSTICAL UNITS

A. Manufacturers:

1. Armstrong World Industries, Inc: www.armstrong.com.

2. Hunter Douglas Contract: www.hunterdouglascontract.com.

3. USG: www.usg.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Acoustical Units - General: ASTM E1264, Class A.

C. Mineral Fiber Acoustical Ceiling Panels: Armstrong Commercial Ceilings; Mesa Square Lay-In Tile #680; ASTM E1264 Type III, Form 2, Pattern C E with the following characteristics:

1. Size: 24 x 24 inches.

2. Thickness: 3/4 inches.

3. Composition: Wet Formed Mineral fiber, factory painted.

4. Light Reflectance: ASTM E1477; 0.85.

5. Noise Reduction Coefficient (NRC): ASTM C423; 0.60.

6. Ceiling Attenuation Class (CAC): ASTM E1414; 33.

7. Edge Profile: Square.

8. Surface Color: White.

9. Surface Texture: Fine.

10. Suspension System: 15/16-inch exposed tee grid.

11. Flame spread: ASTM E1264; Class A.

12. Dimensional stability: Humiguard Plus for sag resistance in high humidity conditions.

D. Perforated Metal Acoustical Ceiling Panels with Acoustical Fleece Backing: Electrogalvanized steel panel, factory- applied powder-coated finish, perforated; Armstrong Commercial Ceilings; Metal Works Tegular Tile #6462 M2; ASTM E1264 Type XX, Pattern C with the following characteristics:

1. Size: 24 x 24 inches.

2. Thickness: 0.313 inch.

3. Composition: Wet Formed Mineral fiber, factory painted.

4. Light Reflectance: ASTM E1477; 0.61.

5. Noise Reduction Coefficient (NRC): ASTM C423; 0.70.

6. Ceiling Attenuation Class (CAC): ASTM E1414; 38.

7. Edge Profile: Square Tegular.

8. Surface Color: Gun Metal Gray (MY).

9. Surface Texture: Smooth, Micro Perforated (M2).

10. Suspension System: 15/16-inch exposed tee grid.

11. Flame spread index of 25 or less per ASTM E1264; Class A (FM).

12. Dimensional stability: Humiguard Plus for sag resistance in high humidity conditions.

2.2 SUSPENSION SYSTEM(S)

A. Manufacturers:

1. Same as acoustical ceiling panels.

2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Suspension Systems - General: Complying with ASTM C635; main beams and cross tees, base metal and end detail, fabricated from commercial quality hot dipped galvanized steel

complying with ASTM A653. Main beams and cross tees are double-web steel construction with exposed flange design. Exposed surfaces chemically cleansed, capping prefinished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching. Provide die cut and interlocking components with stabilizer bars, clips, splices, perimeter moldings and hold down clips as required.

1. Structural classifications: ASTM C635 normal duty.

2. Color: White and match the color of the selected ceiling panel.

C. Suspension System for Acoustical Ceiling Panels: Armstrong Commercial Ceilings; Prelude XL 15/16 Grid System, or equal, including trim pieces and accessories; Color: White to coordinate with ceiling panels.

D. Suspension System for Perforated Metal Acoustical Ceiling Panels: Armstrong Commercial Ceilings; Metalworks Flush Tegular 15/16 Grid System, or equal, including trim pieces and accessories; Color: Gunmetal Gray (MY) to coordinate with ceiling panels.

E. Attachment Devices: Size for five times design load indicated in ASTM C635, Table 1, Direct Hung.

F. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft annealed, with yield stress load of at least three times design load, but not less than 12 gauge.

2.3 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

PART 3 - EXECUTION

3.1 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C636, ASTM E580, and manufacturer's instructions and as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

D. Suspension system shall not be supported from underside of metal roof deck.

E. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

H. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

I. Do not eccentrically load system or induce rotation of runners.

3.2 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Framing shall be suspended from metal roof deck.

D. Fit border trim neatly against abutting surfaces.

E. Install units after above-ceiling work is complete.

F. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

G. Cutting Acoustical Units:

1. Make field cut edges of same profile as factory edges.

END OF SECTION 05 51 00

SECTION 09 65 00 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Resilient Vinyl Tile Flooring and Accessories

B. Resilient Rubber Wall Base

C. Rubber Tile

D. Rubber Stair Tread with Integral Riser

E. Installation accessories

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

A. ASTM D2047 Standard Test Method For Static Coefficient Of Friction Of Polish-Coated Flooring Surfaces As Measured By The James Machine; 2011

B. ASTM D2240 Standard Test Method For Rubber Property - Durometer Hardness; 2010

C. ASTM E492 Standard Test Method For Laboratory Measurement Of Impact Sound Transmission Through Floor-Ceiling Assemblies Using The Tapping Machine, 2009

D. ASTM E648 Standard Test Method For Critical Radiant Flux Of Floor-Covering Systems Using A Radiant Heat Energy Source; 2014

E. ASTM E662 Standard Test Method For Specific Optical Density Of Smoke Generated By Solid Materials; 2014

F. ASTM F970 STANDARD TEST METHOD FOR STATIC LOAD LIMIT; 2011

G. ASTM F1941 Standard Specification For Electrodeposited Coatings On Threaded Fasteners (Unified Inch Screw Threads (Un/Unr)); 2010

H. ASTM F1066 Standard Specification for Vinyl Composition Floor Tile; 2004 (Reapproved 2010)e1.

I. ASTM F1344 Rubber Floor Tile (2012)

J. ASTM F1700 Solid Vinyl Floor Tile (2008)

K. ASTM F2169 Resilient Stair Treads (2012)

L. ASTM F1861 Resilient Wall Base; 2008 (Reapproved 2012)

M. ASTM F710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring

N. ASTM G21 Standard Practice For Determining Resistance Of Synthetic Polymeric Materials To Fungi; 2013

1.4 SUBMITTALS

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

B. Samples: For each product indicated, in Manufacturer's standard size for each product to represent true texture, pattern and color required.

PART 2 - PRODUCTS

2.1 RESILIENT TILE FLOORING

A. Resilient Tile, commercial grade floating luxury vinyl tile; Mohawk, Hot and Heavy, Bolder #C0010 Pebble #925, or equal.

1. Size: 36 inches x 36 inches

2. Wear Layer: 20 mil minimum

3. Finish: Enhanced urethane

4. Classification: ASTM F1700-Class III, type A

5. Static Load Limit: ASTM F970 passes

6. Residual Indentation: ASTM F1914 passes

7. Slip Resistance: 0.7 dry / 0.8 wet minimum

8. IIC Rating: 57 without underlayment

9. Floor Score Certified with pre-consumer and post-consumer recycled content

2.2 RESILIENT BASE

A. Resilient Base: ASTM F1861, Type TS rubber, Vulcanized Thermoset; Top Set Style B, Cove; Johnsonite, Traditional Rubber Base, Gray #48, or equal, provided in 120 foot coiled rolls.

1. Height: 4 inch.

2. Thickness: 0.125 inch thick.

3. Finish: Satin.

4. Meets performance requirements for ASTM F1861 standard specification for resilient wall base, type TS, Group 1.

5. ASTM E648, standard test method for critical radiant flux of D.45 watts/cm^2 or greater, class I.

2.3 RUBBER TILE

A. Rubber Tile: Type I antimicrobial and antifungal tile; Johnsonite, Hammered Finish Rubber Tile, Gray #48, or equal

1. Gauge: low 0.080-inch, high 0.118-inch

2. Size: 35 ½-inch x 35 ½-inch

3. ASTM D2047 – Static coefficient of friction: ≥ 0.8

4. ASTM D 2240 – Hardness (shore A); ≥ 85

5. ASTM E 648 – Critical Radiant Flux: ≥ 0.45

6. ASTM E 662 – Smoke Density: ≤ 450

7. ASTM G21 – Antimicrobial/Antifungal resistance test: Pass

8. Floor Score Certified

2.4 RUBBER STAIR TREAD WITH INTERNAL RISER

A. Type TS Rubber vulcanized thermoset one-piece riser/tread with visually impaired safety strip, non-grit (#55 Silver Grey). Johnsonite, Hammered Finish Tread/Riser, Gray #48, or equal

1. Gauge: 1/8- inch

2. Size: 48-inch x 19 inch

3. Nosing Depth: 1-7/8-inch ADA compliant

4. Nosing Radius: 1/4- inch ADA compliant

5. ASTM D2047 – Static coefficient of friction: ≥ 0.8

6. ASTM E492 – Impact sound transmission: 16 db

7. ASTM E648 – Critical radiant flux: ≥ 0.5

8. ASTM E 662 – Smoke Density: ≤ 450

2.5 ACCESSORIES

A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.

B. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.

C. Moldings, Transition and Edge Strips: Same manufacturer and color as resilient wall base.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

B. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.

1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.2 PREPARATION

A. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.

B. Prohibit traffic until filler is cured.

C. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

D. Vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 INSTALLATION

A. Starting installation constitutes acceptance of sub-floor conditions.

B. Install in accordance with manufacturer's instructions.

C. Spread only enough adhesive to permit installation of materials before initial set.

D. Fit joints tightly.

E. Set flooring in place, press with heavy roller to attain full adhesion.

F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.

H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.4 TILE FLOORING

A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless manufacturer's instructions say otherwise.

3.5 RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 48 inches between joints.

B. Install base on solid backing. Bond tightly to wall and floor surfaces.

C. Do not stretch resilient base during installation.

END OF SECTION 09 65 00

SECTION 09 68 13 - TILE CARPETING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Carpet tile, loose laid with edges and control grid adhered.

1.2 RELATED REQUIREMENTS

A. Section 09 65 00 – RESILIENT FLOORING

b. Section 03 30 00 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors.

1.3 REFERENCE STANDARDS

A. ASTM D2859	Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2006 (Reapproved 2011).
B. ASTM E648	Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2010e1.
C. ASTM F710	Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2011.
D. CRI (CIS)	Carpet Installation Standard; Carpet and Rug Institute; 2009.
E. CRI (GLA)	Green Label Testing Program - Approved Adhesive Products; Carpet and Rug Institute; Current Edition.
F. CRI (GLC)	Green Label Testing Program - Approved Product Categories for Carpet; Carpet and Rug Institute; Current Edition.
G. CRI (GLP)	Green Label Plus Carpet Testing Program - Approved Products; Carpet and Rug Institute; Current Edition.
H. NFPA 253	Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; National Fire Protection Association; 2011.

1.4 SUBMITTALS

A. Shop Drawings: Indicate direction of carpet tile installation and transition to alternate floor finish material.

B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.

C. Samples: Submit two full size carpet tiles illustrating color and pattern design for each carpet style, pattern and color selected.

D. Submit data documenting VOC content of carpet tile and adhesives; copy of current CRI Approved Products Listing is acceptable.

E. Manufacturer's Installation Instructions: Indicate special procedures.

F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum five years documented experience.

B. Installer Qualifications: Company specializing in installing carpet approved by manufacturer.

1.6 FIELD CONDITIONS

A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Mohawk; Modular Walk Off Tile, Tuff Stuff Collection, GT066 Step In Style, Blarney Stone #00518, www.mowhawkgroup.com, or equal.

B. Other Acceptable Manufacturers:

1. Tandus: www.tandus.com.

2. Interface, Inc: www.interfaceinc.com.

3. Lees Carpets: www.leescarpets.com.

4. Milliken & Company: www.milliken.com.

5. Mannington: www.mannington.com.

6. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MATERIALS

A. Modular Walk-Off Carpet Tile:

1. Fiber/Construction/Texture: Type 6,6 Nylon Fiber, Tufted, Textured Patterned Cut And Loop.

2. Color: Blarney Stone 00518.

3. Tile Size: 24 x 24 inch, nominal.

4. Thickness: 0.129 inch.

5. Face Weight: 32 oz/sqyd.

6. Density Factor: 8930 kilotex.

7. Total Weight: 4090 oz/sq yd.

8. Rows: 47 rows per inch.

9. Gage: 1/2 inch.

10. Stitches: 10 per inch.

11. Foot Traffic recommendation TAR: Severe.

12. Light Fastness: ≥ 4.0 @ 40 AFU's.

13. Primary Backing Material: Nonwoven Tufting with Embedded Fiberglass Scrim.

14. Secondary Backing Material: Vinyl Ecoflex 1 CT.

15. ASTM E-648 Radiant Panel: Class 1.

16. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

17. VOC Content: Comply with Section 01 61 16.

18. VOC Content: Provide CRI Green Label Plus 1089 certified product.

19. Static Control Fiber: Less than 2.5 kv when tested under the standard shuffle test 70 degrees Fahrenheit (-21 degrees celsius) - 20% R.H.

20. Max. Electrostatic Charge: ≤ 3.5 Kv. at 20 percent relative humidity.

21. Installation Method: Quarter-Turn.

2.3 ACCESSORIES

A. Sub-Floor Filler: type recommended by flooring material manufacturer.

B. Rubber Base: As noted on drawings. See 09 65 00 Resilient Flooring.

C. Adhesives: Acceptable to carpet tile manufacturer, compatible with materials being adhered; maximum VOC content as specified in Section 01 61 16, maximum VOC of 50 g/L; CRI Green Label Certified.

D. Adhesives: Acceptable to carpet tile manufacturer, compatible with materials being adhered; maximum VOC of 50 g/L; CRI Green Label certified.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that sub-floor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.

C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.

D. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for flooring installation by testing for moisture and pH.

1. Test in accordance with Section 09 05 61.

2. Test in accordance with ASTM F710.

3. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.

E. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

C. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.

D. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.

E. Vacuum clean substrate.

3.3 INSTALLATION

A. Starting installation constitutes acceptance of sub-floor conditions.

B. Install carpet tile in accordance with manufacturer's instructions and CRI Carpet Installation Standard.

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Lay carpet tile in square pattern, with pile direction parallel in brick ashlar pattern.

F. Locate change of material between rooms under door centerline.

G. Fully adhere carpet tile to substrate.

H. Adhere carpet tile to substrate along centerline of rooms, at perimeter of rooms, where tiles are cut, and at 15 foot intervals throughout rooms. Lay remainder of tile dry over substrate.

I. Adhere rubber base as cove base finish up vertical surfaces.

J. Trim carpet tile neatly at walls and around interruptions.

3.4 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

END OF SECTION 09 68 13

SECTION 09 90 00 - PAINTING AND COATING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish all interior and exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.

D. Do Not Paint or Finish the Following Items:

1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
2. Items indicated to receive other finishes.
3. Items indicated to remain unfinished.
4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
5. Floors, unless specifically so indicated.
6. Concealed pipes, ducts, and conduits.

1.2 RELATED REQUIREMENTS

A. Section 01 81 13 Sustainable Design Requirement

B. Section 05 12 00 Structural Steel Framing: shop primed items

C. Section 05 21 00 Steel Joist Framing: shop primed items

D. Section 05 31 00 Steel Decking: shop primed items

E. Section 05 50 00 - Metal Fabrications: Shop-primed items.

F. Section 05 51 00 - Metal Stairs: Shop-primed items.

1.3 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D — National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

B. ASTM D16 — Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2012.

C. SSPC (PM1) — Good Painting Practice: SSPC Painting Manual, Vol. 1; Society for Protective Coatings; Fourth Edition.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide complete list of all products to be used, with the following information for each:

1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
2. MPI product number (e.g. MPI #47).
3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.

C. Samples: Submit two paper chip samples, 3 x 3 inch in size illustrating range of colors available for each surface finishing product scheduled.

D. Certification: By manufacturer that all paints and coatings comply with VOC limits specified.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum 10 years documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum five (5) years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

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.

1.7 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.

B. Paints:

1. Duron, Inc: www.duron.com.
2. Glidden Professional: www.gliddenprofessional.com.
3. Benjamin Moore & Co: www.benjaminmoore.com.
4. Sherwin-Williams Company: www.sherwin-williams.com.

C. Primer Sealers: Same manufacturer as top coats.

D. Block Fillers: Same manufacturer as top coats.

E. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PAINTS AND COATINGS - GENERAL

A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.

1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
2. Supply each coating material in quantity required to complete entire project's work from a single production run.
3. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.

B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.

C. Volatile Organic Compound (VOC) Content:

1. Provide coatings that comply with the most stringent requirements specified in the following:
   a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

2.3 PAINT SYSTEMS - EXTERIOR

A. All Exterior Masonry Surfaces Indicated to be Painted, Unless Otherwise Indicated:

1. Preparation as specified by manufacturer.
2. Two top coats and one coat primer recommended by manufacturer.
3. Top Coat(s): MPI Exterior Pigmented Elastomeric, Water Based (MPI #113), flat.
4. Top Coat(s): MPI Exterior Light Industrial Coating, Water Based (MPI #161, 163, 164).
5. Flat: MPI gloss level 1; use this sheen at all locations.
6. Primer on Concrete Masonry: One heavy coat latex block filler (100 percent acrylic) squeegeed into pores.

B. Galvanized Metals, Alkyd, 3 Coat:

1. One coat galvanize primer.
2. Semi-gloss: Two coats of alkyd enamel.

2.4 PAINT SYSTEMS - INTERIOR

A. All Interior Surfaces Indicated to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry, uncoated steel, shop primed steel, and galvanized steel.

1. Two top coats and one coat primer.
2. Top Coat(s): MPI Institutional Low Odor/VOC Interior Latex; MPI #143-148.
3. Eggshell: MPI gloss level 3; use this sheen at all locations.
4. Primer(s): As recommended by manufacturer of top coats.

B. Heavy Duty Vertical and Overhead: Including gypsum board, concrete, and concrete masonry.

1. Applications: See Finish Schedule.
2. Two top coats and one coat primer; primer may be omitted if top coat manufacturer approves.
3. Top Coat(s): MPI Epoxy, Semi-Gloss; MPI #177.
4. Semi-Gloss: MPI gloss level 5; use this sheen at all locations.
5. Primer(s): As recommended by manufacturer of top coats.

C. Dry Fall: Metals; exposed structure and overhead-mounted services, including shop primed steel deck, structural steel, metal fabrications, galvanized ducts, galvanized conduit, and galvanized piping.

1. Shop primer by others.
2. One top coat; white.
3. Top Coat: MPI Alkyd Dry Fall; MPI #55, 89, 225.
4. Flat: MPI gloss level 1; use this sheen at all locations.

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. Report any condition that may potentially affect proper application.

D. Test shop-applied primer for compatibility with subsequent cover materials.

3.2 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to coating application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

3.3 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance.

D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

END OF SECTION 09 90 00

SECTION 10 11 01 - VISUAL DISPLAY BOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Markerboards

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Blocking and supports.

B. Section 09 21 16 - Gypsum Board Assemblies: Concealed supports in metal stud walls.

1.3 REFERENCE STANDARDS

American Society for Testing materials:

A. ASTM E84 Standard Test Method for surface burning characteristics for Building Materials.

B. ASTM B221 Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wires, Profiles and Tubes.

Porcelain Enamel Institute:

A. PEI-1002 Manual and Performance Specification for Porcelain Enamel Writing Surfaces.

Greenguard Environmental Institute:

A. Greenguard Indoor Air Quality Certified.

B. Greenguard Children and Schools Indoor Air Quality Certified.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Shop Drawings: Provide manufacturer data sheets for each type of markerboard required.

C. Product Data: Provide technical data for materials specified. Include Material Safety Data Sheets, when applicable.

D. Samples: Provide Manufacturer's color charts.

E. Manufacturer's Instructions: Provide Manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer shall be a firm engaged in the manufacture of visual display boards in the United States.

2. Manufacturer shall have a minimum of 5 (five) years experience in the manufacture of visual display boards.

3. Operation and Maintenance: Include data on regular cleaning, stain removal, and precautions.

1.6 PROJECT CONDITIONS

A. Field measure prior to preparation of product order to ensure proper fit.

B. Comply with manufacturer's recommendations for acclimating area for interior moisture and temperature to approximate normal occupied conditions.

1.7 DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Product Data: Provide manufacturer's data on markerboard.

1.8 WARRANTY

A. Submit a "Life of the Building" Warranty, stating that under normal usage and maintenance, and when installed in accordance with manufacturer's instructions and recommendations, porcelain enamel steel markerboard writing surfaces are guaranteed for the life of the building. Guarantee covers replacement of defective boards but does not include cost of removal or reinstallation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Visual Display Boards: Claridge Products, Concept Series, Aluminum frame boards, or equal. www.claridgeproducts.com

1. Moore Co, Inc: www.moorecoinc.com.

2. Egan Visual, www.egan.com

3. Polyvision Corporation (Nelson Adams): www.polyvision.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 VISUAL DISPLAY BOARDS

A. Markerboards: Writing Surface Face Sheet – Manufactured in accordance with Porcelain Enamel Institute's specification.

1. Shall be enameling grade cold rolled steel manufactured from a minimum of 30 percent post-consumer and post-industrial waste.

2. Enameling grade steel shall be coated with LCS-II, or equal Porcelain Enamel.

a. 3-Coat process shall include:

i. Bottom Ground Coat – 1.5 to 2.2 mils

ii. Top Ground Coat – 2.0 to 2.8 mils

iii. Top Cover (Color) Coat – 3.0 to 4.0 mils

3. Firing Temperature: Enamel shall be fired at lowest possible temperature to reduce steel and porcelain stresses and achieve superior enamel hardness.

4. Substitutions: See Section 01 60 00 – Product Requirements.

B. Factory Framed Markerboards

1. Metal Face Sheet: porcelain enamel steel markerboard.

2. Core material: 7/16 inch MDF of 7/16 Duracore.

3. Backing: Steel back.

4. Size: As indicated on drawings.

5. Color: As indicated on drawings.

2.3 ALUMINUM TRIM

A. Trim shall be 6063 alloy grade aluminum with T5 tempering in accordance with ASTM B221, and shall have 201-R1 satin anodized finish.

B. Accessories:

1. Marker tray: Standard continuous, solid, blade-type aluminum tray with ribbed section and injection molded end closures at bottom of each markerboard.

2. Map rail: Standard continuous 1-inch map rail with cork insert and end stops at the top of each markerboard.

a. Map hooks: One map hook furnished for every two feet of map rail on factory-framed units,

2.4 FABRICATION

A. Shop Assembly: Specify factory assembled or field assembled markerboard units.

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

A. Verify before installation that interior moisture and temperature approximate normal occupied conditions.

B. Verify that wall surfaces are true and plumb and are prepared and ready to receive boards.

3.2 INSTALLATION

A. Deliver factory built units completely assembled and of dimensions shown in details and in accordance with manufacturer's shop drawings as approved by the CTDOT PM.

B. Follow manufacturer's instructions for storage and handling of units before installation.

C. Do not install boards on damp walls or in damp and humid weather without heat in the building.

3.3 ADJUST AND CLEAN

A. Verify that all accessories are installed as required for each unit.

B. At completion of work, clean surfaces and trim in accordance with manufacturer's recommendations, leaving all materials ready for use.

END OF SECTION 10 11 01

SECTION 10 14 00 - SIGNAGE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Interior Identification and Directional Signage.

B. Exterior Building Signage

1.2 REFERENCE STANDARDS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

A. ASTM B209 (2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

B. ASTM B221 (2012) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

INTERNATIONAL CODE COUNCIL (ICC)

A. ICC A117.1 (2009) Accessible and Usable Buildings and Facilities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

A. 36 CFR 1191 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

A. NFPA 101 (2012) Life Safety Code.

1.3 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, finish and color options, locations, overall dimensions of each sign.

C. Signage Schedule and Detail Drawings: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors. For exterior building signage include text indicated on design drawings.

1. When room numbers to appear on signs differ from those on the drawings, include the drawing room number on schedule.

2. Submit for approval by CTDOT PM prior to fabrication.

D. Samples: Submit one sample of each type of sign, full size, illustrating typical quality, workmanship, sign style, font, method of attachment and proposed finishes/colors.

E. Selection Samples: Submit two sets of Manufacturer's color selection charts or chips for review. Indicated proposed selections based on finish/color indicated in drawings.

1.4 EXTRA MATERIALS

Provide 1 extra frame and extra stock of all sign types, including blank plates of each color and size changeable message strips, paper inserts, one copy of the software for user produced signs and inserts after project completion and equipment necessary for removal of signage parts and pieces.

1.5 QUALITY ASSURANCE

A. Field Conditions

1. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.

2. Maintain this minimum temperature during and after installation of signs.

B. Delivery, Storage And Handling

1. Materials shall be packaged to prevent damage and deterioration during shipment, handling, storage and installation. Product shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

C. Warranty

1. Warrant the interior signage for a period of 2 years against defective workmanship and material. Warranties shall be signed by the authorized representative of the manufacturer. Submit warranty accompanied by the document authenticating the signer as an authorized representative of the guarantor. Guarantee that the signage products and the installation are free from any defects in material and workmanship from the date of delivery.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Interior Room Identification and Directional Signage

1. Takeform: www.takeform.net.
2. 20/90 Sign Systems: www.290signs.com.
3. Cosco Industries (ADA signs); ADA Series 1: www.coscoarchitecturalsigns.com.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Exterior Building Signage

1. Signlite, Inc.: 6 Corporate Drive, North Haven, CT
   www.signlite.net
2. Howard Industries, Fairview, PA
3. Sign Comp, Comstock Park, Michigan

2.2 STANDARD PRODUCTS

A. Signs, plaques, and directories shall be the standard product of a manufacturer regularly engaged in the manufacture of such products that essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening. Obtain signage from a single manufacturer with edges and corners of finished letterforms and graphics true and clean.

2.3 ROOM IDENTIFICATION/DIRECTIONAL SIGNAGE SYSTEM

A. Standard Room Signs

Signs shall consist of laminated thermosetting Type MP plastic (three-ply melamine plastic laminate with phenolic core) 6063-T5 extruded aluminum in accordance with ASTM B221 and ASTM B209 and shall conform to the following:

1. Frames shall be aluminum, flat 1/4-inch thick.
2. End caps shall be aluminum with square style corners.
3. Corners of signs shall be squared.

B. Changeable Message Strip Signs

1. Changeable message strip signs shall be of same construction as standard room signs to include a clear sleeve that will accept a paper or plastic insert identifying changeable text. The insert shall be prepared typeset message mounted on paper card stock. Provide paper and software for creating text and symbols for computers identified by owner for Owner production of paper inserts after project completion. Furnish one suction device to assist in removing face sheet. Sliding inserts or slide knobs that slide horizontally exposing

different graphic information shall be provided as identified in the signage placement schedule and drawings

C. Type of Mounting For Signs

1. Provide extruded aluminum brackets for hanging, projecting, and double-sided signs. Mounting for framed, hanging, and projecting signs shall be by mechanical fasteners. Surface mounted signs shall be mounted with countersunk mounting holes in plaques and mounting screws for all surfaces except where signage is mounted to glass, use 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam, provide solid backplate to conceal vinyl foam tape.

D Graphics

Signage graphics for modular signs shall conform to the following:

1. Subsurface copy: Copy is transferred to the back face of clear acrylic sheeting forming the panel face to produce precisely formed opaque image. This method bonds all sign elements (color, graphics, lettering, Braille and substrate) into a single unit.

2. Surface Applied Photopolymer: Integral graphics and Braille achieved by photomechanical stratification processes. Photopolymer used for ADA compliant graphics shall be of the type that has a minimum durometer reading of 90. Tactile graphics shall be raised 1/32-inch from the front surface of plaque by photomechanical stratification process.

3.. Embossed: Methods other than sandblasting such as vacuum formed to create ADA compliant projected graphics.

E. Character Proportions and Heights

1. Letters and numbers on signs conform to 36 CFR 1191.

F. Tactile Letters, Symbols and Braille

1. Raised letters and numbers on signs shall conform to 36 CFR 1191. Grade II Braille inlaid strip to match sign background color.

2.4 STAIR SIGNAGE

A. Provide signs on stairs serving three or more stories with special signage within the enclosure at each floor landing conforming to NFPA 101. Indicate the floor level, the terminus of the top and bottom of the stair enclosure, and the identification of the stair enclosure. Also, state the floor level of, and the direction to, exit discharge. Locate the signage inside the enclosure in a position that is visible when the door is in the open or closed position and install in conformance with 36 CFR 1191. The floor level designation shall also be tactile in accordance with ICC A117.1.

2.5 BUILDING DIRECTORIES

Building directories shall be lobby directories or floor directories, and shall be provided with a changeable directory listing consisting of the areas, offices and personnel located within the facility or other graphical information as requested by the Activity. Dimensions, details, and materials of sign and message content shall be as shown on the drawings.

A. Header Panel

1. Header panel shall have background metal to match frame with raised letters.

B. Non-Illuminated Unit

1. Directory shall consist of a non-illuminated unit with printed removable documents inserted into clear acrylic sleeves. Design of unit shall be as shown in the drawings.

a. Construction

The directory shall be constructed of an aluminum 2-inch deep frame with satin anodized finish. Unit shall be surface mounted. Unit shall have a 2-inch high header lettering as shown.

b. Message Strips

Message strips shall be updatable by user. Message strips shall be sized in accordance with manufacturer's standard. Letters and numbers shall be provided in accordance with the drawings and as coordinated with the user.

2.6 FABRICATION AND MANUFACTURE

A. Factory Workmanship

Holes for bolts and screws shall be pre- drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

B. Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

2.7 COLOR, FINISH, AND CONTRAST

A. Color shall be selected from manufacturer standard finish and material options. Finish of all signs shall be eggshell, matte, or other non-glare finish as required in handicapped-accessible buildings.

B. Color and Font: ADA compliant

1. Character Font: Trebuchet MS, Helvetica, Arial, or other sans serif font, as approved by the CTDOT PM.

2. Character Case: Upper case only.

3. Background Color: To match paint color as indicated on drawings.

4. Character Color: Black or other contrasting color.

2.8 EXTERIOR BUILDING SIGNAGE

A. Materials

1. Aluminum sheet shall be of thickness and sizes shown, constructed of alloy and temper recommended by the aluminum producer or finisher for the type of use and finish indicated with not less than the strength and durability properties specified in ASTM B 209 for 5005-H15, or as noted on drawings.

2. Aluminum extrusions shall be of alloy and temper recommended by the manufacturer for the type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B 221 for 6063-T52 ST, or as noted on drawings.

B. Paint

1. Paint required for painted letters and surfaces to be a type recommended by the manufacturer for the surface to which it is applied. Colors to match as follows.

   a. Red = to match Pantone Coating #186C

   b. White = Matthews Paint Company Natural White # 42-202, VOC282-202

2. Exact identification of all paints to be noted on the shop drawings, with data describing method of application if other than air-drying. Paint finish on signs shall be surface sprayed and have a consistent satin finish, free of dirt, grit, mottling, etc. Each paint coat shall contain ultra-violet inhibitors and shall be applied with sufficient time allowed between applications for proper curing. Provide barrier coats over incompatible primers or remove and reprime as required.

C. Mounting materials

1. Mechanical Mounting: Corrosion resistant fasteners of a type recommended by the manufacturer for use in the type of substrate encountered at each location.

2. Silicone Adhesive: Holes drilled to accept signs with factory installed mounting studs shall be filled with a silicone adhesive prior to mounting sign.

D. Welding

1. Fabrication shall be accomplished using the highest standards of workmanship. All pieces shall be cut and carefully fit together. All visible connections shall be full welded and ground smooth. All visible surfaces and connections shall be without visible grounding marks, surface differentiation or variation.

2. All metal to be free of stain, warpage and any defects impairing strength, durability and appearance.

3. All welds to comply with the recommendations of the AWS.

E. Fasteners

1. Use concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surface.

F. Anchors and inserts

2. Use nonferrous metal or hot-dipped galvanized anchors and inserts as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

G. Graphic requirements

1. Typeface: The typeface shall conform with the details on the drawings

H. Fabrication

1. Fabricate Sign Units with graphic process, design, copy, dimensions and color indicated on drawings.
2. All sign face panels shall be of a single sheet. Joined pieces will not be accepted.
3. Design components to allow for expansion and contraction for temperatures ranging between -20°F and +100°F, without causing buckling, opening of joints, or overstressing of welds and fasteners.
4. Comply with AWS D1.2 for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of all welding flux and dress on all exposed and contact surfaces.
5. Mill joints to a tight, hairline fit. Cope or miter corner joints.

I. Additional signage

1. Provide 30 square feet of additional aluminum signage with size, text, graphics, quantity, and location to be determined by CTDOT.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Signs shall be installed plumb and true and in accordance with approved manufacturer's instructions at locations shown on the signage drawings. Submit six copies of operating instructions outlining the step-by-step procedures required for system operation. The instructions shall include simplified diagrams for the system as installed, the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the facility, name of the Trade Contractor, and trade contract number. Mounting height and mounting location shall conform to 36 CFR 1191. Required blocking shall be installed. Signs on doors or other surfaces shall

not be installed until finishes on such surfaces have been installed. Signs installed on glass surfaces shall be installed with matching blank back-up plates in accordance with manufacturer's instructions.

B. Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish.

1. Signs mounted to painted gypsum board surfaces shall be removable for painting maintenance.

C. Protection and Cleaning

Protect the work against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Frames and other sign surfaces shall be cleaned at completion of sign installation in accordance with the manufacturer's approved instructions and the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, Package 1. Submit six copies of maintenance instructions listing routine procedures, repairs, and guides.

END OF SECTION 10 14 00

SECTION 10 14 53 – TRAFFIC SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sign Face Sheet Aluminum: shall consist of furnishing and installing sign face-sheet aluminum signs of the type specified, metal sign posts, mast arm-mounted sign brackets or parapet-mounted sign supports at locations indicated on the plans or as ordered by Engineer and in conformance with the plans and these specifications. Bright Wide Angle Retroreflective sheeting may be required as indicated on the plans or as ordered by Engineer.

B. Signs with Type I, II and III Reflective sheeting: Under this item the Trade Contractor shall furnish the required portable supports or metal sign posts on the Project to conform to conform to the requirements of NCHRP Report 350 (TL-3) and the signing requirements stated in the specification Section 01 55 26 Traffic Control as shown on the plans and/or as directed by the Engineer. The Trade Contractor shall furnish a sufficient number of signs to provide the signing patterns for all operations which are being undertaken concurrently.

1.2 SUBMITTALS

A. See Section 01 33 00 Submittal Procedures and Section 01 33 00.13 – Document Control for submittal procedures.

B. Certificate: A materials certificate is required for materials specified in the specification.

1.3 RELATED REQUIREMENTS

A. Section 01 55 26 Traffic Control for traffic protection related requirements.

PART 2 PRODUCTS

2.1 MATERIALS

A. The materials for Sign Face Sheet Aluminum and Bright Wide Angle Signs shall conform to the following requirements:

1. Reflective sheeting shall conform to the requirement: Reflective sheeting materials shall appear on the Department's Qualified Product List for the application intended, Type I, II or III.

2. Where required, the retroreflective sheeting as supplied shall be of good appearance, free from ragged edges, cracks and extraneous materials, and furnished in either rolls or sheets

Where required, the retroreflective sheeting shall have a smooth surface with a distinctive interlocking diamond seal patter and datum orientation marks visible from the face. The sheeting shall be precoated with a pressure sensitive adhesive backing protected by a removable liner.

3. Sheet aluminum sign blanks shall be constructed of sheet aluminum, alloy 6061-T6 or alloy 5052-H38. Sheet aluminum sign blanks shall conform to ASTM B 209. They shall be degreased and etched in accordance with the recommendations of the sheeting manufacturer or treated with a light, tightly adherent chromate conversion coating, free of any powdery residue, ranging in color from silvery iridescent to a pale yellow, conforming to ASTM B 449, Class 2 (10-35 milligrams/square foot) (108-377 milligrams/square foot) with 25 milligrams/square foot (269 milligrams/square meter) as the optimum coating. The thickness shall be as specified on the plans.

4. Silk screening of Type I, Type II or Type III reflective sheeting shall conform to the requirements specified by the reflective sheeting manufacturer.

5. Metal sign posts, square tubular supports and parapet mounted sign supports shall conform to the requirements as noted on the plans. The size, shape and mass of posts and supports shall be as specified in the plans.

   After fabrication of the posts and supports, including hole punching or drilling, they shall be galvanized as noted on the plans.

6. Sign mounting bolts shall conform to the following requirements: Bolts used for sign mounting shall be of aluminum alloy 2024-T4. Self-locking nuts shall be of aluminum alloy 2011-T3, 2014-T4 or 2017-T4. Aluminum alloys shall conform to the requirements of ASTM B 211.

B. The materials for Signs Construction – Type III Reflective sheeting shall conform to the following requirements:

1. Prior to using the construction signs and their portable supports, the Trade Contractor shall submit to the Engineer a copy of the Letter of Acceptance issued by the FHWA to the manufacturer documenting that the devices (both sign and portable support tested together) conform to NCHRP Report 350 (TL-3).

2 Portable sign supports shall be designed and fabricated so that the signs do not blow over or become displaced by the wind from passing vehicles. Portable sign supports shall be approved by the Engineer before they are used.

3. Mounting height of signs on portable sign supports shall be a minimum of 1 foot and a maximum of 2 feet, measured from the pavement to the bottom of the sign.

4. All sign faces shall be rigid and reflectorized. Reflective sheeting shall appear on the Department's Qualified Product List for the application intended (Type III).

5. Sheet aluminum sign blanks shall be constructed of sheet aluminum, alloy 6061-T6 or alloy 5052-H38. Sheet aluminum sign blanks shall conform to ASTM B 209. They shall be degreased and etched in accordance with the recommendations of the sheeting

manufacturer or treated with a light, tightly adherent chromate conversion coating, free of any powdery residue, ranging in color from silvery iridescent to a pale yellow, conforming to ASTM B 449, Class 2 (10-35 milligrams/square foot) (108-377 milligrams/square foot) with 25 milligrams/square foot (269 milligrams/square meter) as the optimum coating. The thickness shall be as specified on the plans..

6. Metal sign posts shall conform to the requirements as noted on the plans. The size, shape and mass of posts and supports shall be as specified in the plans. After fabrication of the posts and supports, including hole punching or drilling, they shall be galvanized as noted on the plans..

7. Application of reflective sheeting, legends, symbols, and borders shall conform to the requirements specified by the reflective sheeting manufacturer. Attachments shall be provided so that the signs can be firmly attached to the portable sign supports or metal posts without causing damage to the signs.

8. The following types of construction signs shall not be used: mesh, non-rigid, roll-up.

9. The following portable sign support systems or equivalent systems that meet the above requirements may be used:

•Korman Model #SS548 flexible sign stand with composite aluminum sign substrate (APOLIC)

•Traffix “Little Buster” dual spring folding sign stand with corrugated polyethylene (0.4 in. thick) sign substrate (InteCel)

C. All sign faces shall be reflectorized. Reflective sheeting shall conform to the requirements of shall appear on the Department's Qualified Product List for the application intended (Type III). Sheet aluminum sign blanks, metal sign posts and silk screening of sign faces shall conform to the requirements in this specification.

D. Where required, Bright wide angle retroreflective sheeting material shall appear on the Department’s Qualified product list for the application intended and conform to the requirements in this specification.

E. Bright wide angle retroreflective sheeting shall meet the following requirements:

1. The retroreflective sheeting shall have a smooth surface with a distinctive interlocking diamond seal patter and datum orientation marks visible from the face. The sheeting shall be precoated with a pressure sensitive adhesive backing protected by a removable liner. Bright wide angle retroreflective sheeting materials shall appear on the Department’s Qualified Products List for the application intended.

2. The retroreflective sheeting as supplied shall be of good appearance

When furnished in continuous rolls, the average number of splices shall not be more than 3 per 54.7 yards of material with a maximum of 4 pieces in any 54.7 yard length. Splices shall be butted or overlapped and shall be suitable for continuous application as furnished. When furnished as cut sheets or sign faces, the sheeting shall be packaged flat in

accordance with commercially accepted standards. Each carton shall clearly stipulate the brand, quanity, size, or lot or run number and color. Stored under normal conditions the retroreflective sheeting as furnished shall be suitable for use for a minimum period of one (1) year.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that construction area for permanent signs are to the lines and grades indicated on the plans and ready for the Work as indicated.

B. Verify that construction area for temporary signs are free from obstructions in the areas indicated on the plans and ready for the Work as indicated.

3.2 PREPARATION

A. Layout the location indicated on the plans for sign placement and installation prior to construction.

3.3 CONSTRUCTION METHOD

A. Placement and dimensions of copy, border and mounting holes shall conform to details of the Department of Transportation for Regulatory Warning and Guide signs which are available for inspection at the Department of Transportation office. Non-reflective copy, border and background shall be applied by the silk-screen process in a manner specified by the reflective sheeting manufacturer. The silk screening of all copy, border and background on Type III reflective sheeting shall be accomplished prior to the application of the reflective sheeting to the finished aluminum sign blank. Type III reflective sheeting shall be of the heat activated adhesive type and shall be applied in a manner specified by the reflective sheeting manufacturer.

B. Reflective sheeting shall be applied in such a manner that the finished sign will be wrinkle and bubble free. No splices of the reflective sheeting will be permitted on any sign face under 30 square feet in area with one dimension of 4 feet or less and no more than one splice will be permitted on any one sign without the approval of the Engineer.

C. Direct application of cutout Type I, II or III reflective sheeting copy and border shall conform to the requirements specified by the reflective sheeting manufacturer. Cutout copy and border shall be applied directly to clean, dust free reflective sheeting background panels. Borders shall be cut neatly and butt-joined at corners and panel joints. Type I or Type II reflective sheeting used for direct applied cutout copy and border shall be uniform in brightness and color.

D. The fabrication of aluminum sign blanks including cutting to size and shape and the punching of mounting holes shall be completed prior to metal degreasing and the application of reflective sheeting. Aluminum sign blanks shall be free of buckles, warp, dents, cockles, burrs and

defects resulting from fabrication. Span-mounted sign brackets and mast arm-mounted sign brackets shall be installed as shown on the plans.

E. After complete fabrication of the sign as indicated on the plans and in conformance with the requirements contained in the specifications, the sign shall be mounted on the type of support designated on the plans after the support has been satisfactorily installed at its proper location. The reinforcing plate shall be installed as shown on the plans.

F. Metal sign posts shall be driven or the holes augered and the backfill thoroughly tamped after the posts have been set level and plumb. Parapet-mounted sign supports shall be installed as shown on the plans and shall be level and plumb.

G. Ineffective signs, as determined by the Engineer and in accordance with the ATSSA guidelines contained in “Quality Standards for Work Zone Traffic Control Devices”, shall be replaced by the Trade Contractor at no cost to the State.

H. Signs and their portable supports or metal posts that are no longer required shall be removed from the project and shall remain the property of the Trade Contractor.

I. The signs and their portable supports or metal posts shall conform to the requirements as shown on the plans and the latest edition of the "Manual on Uniformed Traffic Control Devices." Drawings of the signs, showing placement and dimensions of legend and border, are available for inspection at the Division of Traffic, Connecticut Department of Transportation.

J Various types of portable sign supports may be used for construction signs. These portable supports shall be fabricated in such a manner as to minimize the possibility of the signs being blown over or displaced by the wind from passing vehicles and are to be of a yielding type to withstand impact with minimal damage to the signs, supports, or vehicles. Portable sign supports shall be approved by the Engineer before they are utilized on the Project.

K. Construction signs in other than good condition shall be replaced with acceptable signs as determined by the Engineer.

L. Suitable attachments shall be provided so that the signs can be firmly attached to the portable sign supports or metal posts without causing damage to the signs.

M. Ineffective signs, as determined by the Engineer and in accordance with the ATSSA guidelines contained in “Quality Standards for Work Zone Traffic Control Devices”, shall be replaced by the Trade Contractor at no cost to the State.

N. Signs and their portable supports or metal posts that are no longer required shall be removed from the project and shall remain the property of the Trade Contractor.

END OF SECTION 10 14 53

SECTION 10 21 13.16 – SOLID PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Solid Plastic toilet compartments.

B. Urinal screens.

1.2 RELATED REQUIREMENTS

A. Section 05 12 00 - Structural Steel Framing: Concealed steel support members.

B. Section 05 50 00 - Metal Fabrications: Concealed steel support members.

C. Section 06 10 00 - Rough Carpentry: Blocking and supports.

D. Section 10 28 00 - Toilet, Bath, and Laundry Accessories.

1.3 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A167 Standard Specification for Stainless and Heat-Resisting Chromium – Nickel Steel Plate, Sheet and Strip.

2. B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.

3. E84 Standard Test Method for Surface Burning Characteristics of Building Materials.

B. National Fire Protection Association (NFPA) 286 – Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.

C. Product Data: Provide data on panel construction, hardware, and accessories.

D. Samples: Submit two samples of partition panels, 4 x 6 inch in size illustrating panel finish, color, and sheen.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Solid Plastic (HDPE) Toilet Partitions and Urinal Screens: Scranton Products; Hiny Hiders, Solid Plastic, Stainless Rotary Finish and Pattern; or equal.

B. Other Acceptable Manufacturers:

1. General Partitions Mfg. Corp: www.generalpartitions.com.

2. Global Steel Products Corp: www.globalpartitions.com.

3. Metpar Corp: www.metpar.com.

4. Bradley Corp: www.bradleycorp.com.

5. Substitutions: Section 01 60 00 - Product Requirements.

2.2 MATERIALS

A. Doors, Panels and Pilasters:

1. High Density polyethylene (HDPE) fabricated from polymer resins compounded under high pressure, forming single thickness panel.

2. Waterproof and nonabsorbent, with self-lubricating surface, resistant to marks by pens, pencils, markers and other writing instruments.

3. 1-inch thick with edges round to ¼-inch radius.

4. Impact, dent and scratch resistant.

5. Rust resistant.

6. Impermeable to moisture.

7. Common chemical resistance.

B. Aluminum Hardware: ASTM B221, 6463-T% alloy and temper.

C. Stainless Steel: ASTM A 167, Type 304.

2.3 COMPONENTS

A. Toilet Compartments: Solid Plastic, Floor-mounted headrail-braced.

B. Doors and Dividing Panels: 55-inches high, mounted 14-inches above finished floor with aluminum heat-sinc fastened to bottom edges.

1. Thickness: 1 inch.

2. Door Width: 24 inch.

3. Door Width for Wheelchair Accessible: 36 inch, out-swinging, and self closing.

4. Height: 58 inch.

C. Pilasters: 82-inches high, fastened to pilaster sleeves with stainless steel tamper resistant Torx head sex bolt.

D. Pilaster Sleeves: 3 inches high one piece molded HDPE secured to pilaster with stainless steel tamper resistant Torx head sex bolt.

E. Wall Brackets: 54 inches long, heavy duty aluminum, bright dip anodized finish fastened with stainless steel tamper resistant Torx head sex bolt and at top of pilaster with stainless steel tamper resistant Torx head screws.

F. Headrail Brackets: 20 gage stainless steel, satin finish, secured to wall with stainless steel tamper resistant Torx head screws.

G. Urinal Screens: Wall mounted with two panel brackets, and floor-to-ceiling vertical upright consisting of pilaster anchored to floor and ceiling. Size as indicated on drawings.

H. Hardware: Polished stainless steel:

1. Hinges: 8 inches long, fabricated from heavy-duty extruded aluminum with bright dip anodized finish, wrap-around flanges, adjustable on 30-degree increments, through bolted to doors and pilasters with stainless steel Torx head sex bolts. Hinges operate on field-adjustable nylon cams, field adjustable in 30 degree increments. Provide self-closing hinges on wheelchair accessible compartments.

2. Thumb turn or sliding door latch.

3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.

4. Coat hook with rubber bumper; one per compartment, mounted on panel.

5. Provide door pull for outswinging doors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that field measurements are as indicated on shop drawings.

C. Verify correct spacing of and between plumbing fixtures.

D. Verify correct location of built-in framing, anchorage, and bracing.

3.2 INSTALLATION

A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.

B. Maintain uniform 3/8 vertical clearance between wall and panels, between wall and end pilasters and between door and pilasters.

C. Attach panel brackets securely to walls using anchor devices.

D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

3.3 TOLERANCES

A. Maximum Variation From True Position: 1/4 inch.

B. Maximum Variation From Plumb: 1/8 inch.

3.4 ADJUSTING

A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.

B. Adjust hinges to position doors in partial opening position when unlatched. Return out swinging doors to closed position.

END OF SECTION 10 21 13.16

SECTION 10 22 13 - WIRE MESH PARTITIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wire mesh system for walls.

B. Access door, in wire mesh walls.

1.2 REFERENCE STANDARDS

A. ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coating on Iron and Steel Products; 2013.
B. ASTM A500/A500M	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.
C. ASTM A510/A510M	Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel; 2013.
D. ASTM A510M	Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel (Metric); 2008.
E. AWS D1.1/D1.1M	Structural Welding Code - Steel; American Welding Society; 2010.
F. SSPC-Paint 15	Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).
G. SSPC-Paint 20	Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).

1.3 DESIGN REQUIREMENTS

A. Design partition system to provide for movement of components without damage, undue stress on fasteners or other detrimental effects, when subject to design loads.

B. Design system to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide data for screen materials, finishes.

C. Shop Drawings: Indicate plan and vertical dimensions, elevations, component details; head, jamb, and sill details; location of doors, and hardware. Provide component details, anchorage, type and location of fasteners, and accessories or items required of related work.

1. Show field measurements on shop drawings.

D. Samples: Submit two panels, 24 x 24 inch in size, illustrating screen material. Submit samples of door hinge and latchset illustrating style, color, and finish.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five (5) years of documented experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Wire Mesh Partitions:

1. Acorn Wire and Iron Works, Inc: www.acornwire.com.

2. The G-S Company: www.g-sco.com.

3. Miller Wire Works, Inc: www.millerwireworks.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 WIRE MESH PARTITIONS

A. Wire Mesh Partitions: Factory-fabricated modular assemblies of wall panels, doors, anchors, and accessories as required to provide a complete system and as indicated.

2.3 MATERIALS

A. Framing Members: ASTM A500/A500M, Grade B cold-formed steel tubing, square and rectangular shaped.

B. Woven Screen Wire: ASTM A510 (ASTM A510M) uncoated crimped steel wire; conforming to the following:

1. Fill Wire Size: 6 gage.

2. Mesh Size: 2 x 2 inch.

3. Mesh Weave Design: Plain weave, double crimp design.

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

2.4 FASTENERS

A. Bolts, Nuts and Washers: Hot dip galvanized.

B. Anchorage Devices: Provide drilled expansion bolts.

C. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, unobtrusively located, consistent with design of structure.

2.5 ACCESSORIES

A. Bracing: Formed sheet steel, thickness determined for conditions encountered, manufacturer's standard shapes, same finish as framing members.

B. Plates, Gussets, Clips: Formed sheet steel, thickness determined for conditions encountered, manufacturer's standard shapes, same finish as framing members.

C. Post Caps: Manufacturer's standard.

D. Floor and Ceiling Pilaster Shoe: Manufacturer's standard.

E. Floor Base: Manufacturer's standard.

F. Shop and Touch-Up Primer:

1. Ferrous Surfaces: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2. Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.6 HARDWARE

A. Provide the following:

1. Door Hinges

2. Latch set

3. Mortis Type Lock with key operation outside.

2.7 COMPONENTS

A. Corner Posts: 1 3/4 -inch x 1 3/4-inch x 1/8-inch angle

B. Frame: 1 3/4- inch x 3/4-inch Channel with 1/4-inch bolt.

C. Center Reinforcement: Two 1 1/4-inch x 5/8-inch channels

D. Intermediate Post: 2 1/2-inch x 3/8-inch flat bar.

E. Top Bar: 3-inch Channel with 1/4-inch “U” bolts.

F. Floor Sockets: 2 1/2-inch x 3/8-inch with set screw adjustment.

G. Hinged Door Frames: 1 1/2-inch x 3/4-inch channel.

2.8 FABRICATION

A. Fit and assemble in largest practical sections for delivery to site, ready for installation.

B. Make exposed joints flush or tight.

C. Frame openings made for penetrating mechanical or electrical components.

2.9 FINISHES

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Prime paint items with one coat. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Galvanizing: In accordance with ASTM A123/A123M.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install items plumb and level, accurately fitted, free from distortion or defects.

3.2 ADJUSTING

A. Adjust hinged doors to achieve free movement.

3.3 CLEANING

A. Remove temporary protection to prefinished surfaces.

END OF SECTION 10 22 13

SECTION 10 26 01 - WALL AND CORNER GUARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Corner guards.

1.2 SUBMITTALS

A. Product Data: Indicate physical dimensions and anchorage details.

B. Samples: Submit two sections of corner guard, 12 inch long, illustrating component design, configuration, color and finish, as noted on drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Koroseal, Korogard Stainless Steel Corner Guards: Korogard,com.

B. Other Acceptable Manufacturers:

1. Arden Architectural Specialties, Inc: www.ardenarch.com.

2. Construction Specialties, Inc: www.c-sgroup.com.

3. InPro Corporation: www.inprocorp.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 COMPONENTS

A. Corner Guards - Surface Mounted: 90 ^{o} angle, extruded one-piece unit without splices, installed with screws.

1. Material: 16-gauge stainless steel, No. 4 satin finish.

2. Width of Wings: 2 inches.

3. Class 1/A fire rated

4. Height as noted on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.

END OF SECTION 10 26 01

SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Accessories for toilet rooms, showers, and janitor rooms.

1.2 RELATED REQUIREMENTS

A. Section 01 78 30 Warranties and Bonds.

B. Section 10 21 13.16 – Solid Plastic Toilet Compartments.

1.3 REFERENCE STANDARDS

A. ASTM A269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2013.

B. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.

C. ASTM C1036 Standard Specification for Flat Glass; 2011e1.

D. ASTM C1503 Standard Specification for Silvered Flat Glass Mirror; 2008.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.5 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide data on accessories describing size, finish, details of function, attachment methods.

1.6. DELIVERY, STORAGE AND HANDLING

A. Wrap toilet accessories for shipment and storage, then deliver to the jobsite in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism.

1.7 WARRANTY

A. Provide manufacturer's standard performance guarantees or warranties that extend beyond an eighteen month period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Toilet Accessories:

1. Bobrick Washroom Equipment, Inc.: www.bobrick.com

2. American Specialties, Inc: www.americanspecialties.com

3. Bradley Corporation: www.bradleycorp.com.

4. Substitutions: Section 01 60 00 - Product Requirements.

B. Electric Hand Dryers:

1. Excel Dryer: www.exceldryer.com

2. Substitutions: Section 01 60 00 Product Requirements.

C. All items of each type to be made by the same manufacturer.

2.2 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.

B. Keys: Provide 2 keys for each accessory to Owner; master key all lockable accessories.

C. Stainless Steel Sheet: ASTM A666, Type 304.

D. Stainless Steel Tubing: ASTM A269, Type 304 or 316.

E. Mirror Glass: Float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.

F. Fasteners, Screws, and Bolts: Hot dip galvanized, tamper-proof, security type.

2.3 FINISHES

A. Stainless Steel: No. 4 satin brushed finish, unless otherwise noted.

2.4 TOILET ROOM ACCESSORIES

A. Grab Bar (GB):

1. Provide an 18 gauge, 1-1/4 inch grab bar OD Type 304 stainless steel. Provide form and length for grab bar as indicated. Provide concealed mounting flange. Provide grab with satin finish. Furnish installed bars capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Allow 1-1/2 inch space between wall and grab bar.

2. Basis of Design: Bobrick B-6806, B-6861 (Shower) and B-4998 (Swing Up) series or equal, size as indicated on drawings

B. Mirrors and Glass

1. Provide Type I transparent flat type, Class 1-clear glass for mirrors. Glazing Quality q1 1/4 inch thick conforming to ASTM C1036. Coat glass on one surface with silver coating, copper protective coating, and mirror backing paint. Provide highly adhesive pure silver coating of a thickness which provides reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, free of pinholes or other defects. Provide copper protective coating with pure bright reflective copper, homogeneous without sludge, pinholes or other defects, of proper thickness to prevent "adhesion pull" by mirror backing paint. Provide mirror backing paint with two coats of special scratch and abrasion-resistant paint and baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2. Basis of Design: Bobrick B-290 series or equal, size as indicated on drawings.

B. Combination Paper Towel Dispenser/Waste Receptacle (PTDWR)

1. Provide semi-recessed dispenser/receptacle with a capacity of 400 sheets of C-fold, single-fold, or quarter-fold towel. Design waste receptacle to be locked in unit and removable for service. Provide tumbler key locking mechanism. Provide waste receptacle capacity of 12 gallons. Fabricate a minimum 0.03 inch stainless steel welded construction unit with all exposed surfaces having a satin finish. Provide waste receptacle that accepts reusable liner standard for unit manufacturer.

2. Basis of Design: Bobrick B-3942 or equal.

D. Sanitary Napkin Disposer (SND)

1. Construct a Type 304 stainless steel sanitary napkin disposal with removable leak-proof receptacle for disposable liners. Provide fifty disposable liners of the type standard with the manufacturer. Retain receptacle in cabinet by tumbler lock. Provide disposer with a door for inserting disposed napkins, partition mounted, double access and surface mounted where indicated.

2. Basis of Design: Bobrick B270 or equal.

E. Shower Curtain and Hooks

1. Provide shower curtain, size to suit conditions. Provide anti-bacterial and flame resistant nylon/vinyl fabric curtain with nickel plated brass grommets every 6 inches and hemmed at bottom and sides. Provide stainless steel curtain hooks.

2. Basis of Design: Bobrick 204-1 and 204-2 or equal. Color shall be white.

F. Shower Curtain Rods (SCR)

1. Provide Type 304 stainless steel shower curtain rods 1-1/4 inch OD by 0.049 inch minimum straight to meet installation conditions.

2. Basis of Design: Bobrick B-6047 or equal.

G. Soap Dispenser

1. Provide soap dispenser surface mounted, liquid type consisting of a vertical Type 304 stainless steel tank with holding capacity of 40 fluid ounces with a corrosion-resistant all-purpose valve that dispenses liquid soaps, lotions, detergents and antiseptic soaps.

2. Basis of Design: Bobrick B-2111 or equal.

H. Shelf and Mop Hook Metal, Light Duty (SMLD)

1. Support light duty metal shelf with mop hooks between brackets or on brackets. Purpose of brackets is to prevent lateral movement of the shelf. Furnish 36 inch long shelf with mop and rag hooks. Provide stainless steel shelf and brackets.

2. Basis of Design: Bobrick B-224 or equal.

I. Robe Hook

1. Provide robe hook with concealed wall fastenings, and a pin integral with or permanently fastened to wall flange with maximum projection of 2 inch. Provide satin finish.

2. Basis of Design: Bobrick B-670 or equal.

J. Toilet Tissue Dispenser

1. Furnish Type II - surface mounted toilet tissue holder with two rolls of standard tissue stacked vertically. Provide stainless steel, satin finish cabinet.

2. Basis of Design: Bobrick B-2888 or equal.

K. Electric Hand Dryer

1. Provide wall mount and electric hand dryer designed to operate at 110/125 volts, 60 cycle, single phase alternating current with a heating element core rating of a maximum 2100 watts. Provide dryer housing of single piece construction and of chrome plated steel. Submit 4 complete copies of maintenance instructions listing routine maintenance

procedures and possible breakdowns. Include repair instructions for simplified wiring and control diagrams and other information necessary for unit maintenance.

2. Basis of Design: Excel xlerator or equal.

L Folding Shower Seat (FSS)

1. Folding shower seat shall have a frame constructed of type-304 satin finish stainless steel, 16-gauge, 1-1/4 inch square tubing, and 18-gauge, 1 inch diameter seamless tubing. Seat shall be constructed of one-piece, 1/2 inch thick water-resistant, ivory colored solid phenolic with black edge. Clearance between back of shower seat and wall shall be 1-1/2 inches to comply with ADA Accessibility Guidelines (ADAAG). Seat supports shall not come into contact with the floor. Seat shall be able to lock in upright position when not in use. Seat shall be attached to wall by two 3 inch diameter mounting flanges constructed of type-304, 3/16 inch thick stainless steel with satin finish. Manufacturer's service and parts manual shall be provided to building owner/manager upon completion of project.

2. Basis of Design: Bobrick B-518 or equal.

M. ADA Wall Mounted Locker Bench

1. Locker bench shall be 42 inch long by 20 inch deep 1- 1 1/2 inch thick industrial grade maple hardwood with two coat lacquer finish with radius corners and sides. Bench shall be provided with steel pedestals for fastening bench to floor. Heavy duty pedestals shall be heavy duty steel tube welded to top and bottom flanges and floor anchored.

2. Basis of Design: Penco or equal.

N. Towel Bar (TB):

1. Provide an 18 gauge, 1-inch grab bar OD Type 304 stainless steel. Provide form and length for grab bar as indicated. Provide concealed mounting flange. Provide grab with satin finish. Furnish installed bars capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Allow 1-1/2 inch space between wall and grab bar.

2. Basis of Design: Bobrick B-530 x 24 series or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions in locations indicated on the drawings.

B. Install plumb and level, securely and rigidly anchored to substrate.

C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.2 PROTECTION

A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 28 00

SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fire extinguishers.

B. Fire extinguisher cabinets.

C. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

1.3 REFERENCE STANDARDS

A. NFPA 10 - Standard for Portable Fire Extinguishers; 2013.

B. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.4 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Shop Drawings: Indicate cabinet physical dimensions.

C. Product Data: Provide extinguisher operational features.

D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fire Extinguishers:

1. Ansul, Inc: www.ansul.com.

2. Pyro-Chem: www.pyrochem.com.

3. Strike First Corporation of America: www.strikefirstusa.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Fire Extinguisher Cabinets and Accessories:

1. Ansul, Inc.: www.ansul.com.

2. JL Industries, Inc: www.jlindustries.com.

3. Pyro-Chem: www.pyrochem.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.

1. Provide extinguishers labeled by UL for the purpose specified and indicated.

B. Dry Chemical Type Fire Extinguishers: Aluminum tank, with pressure gage.

1. Class: A: B: C

2. Size: 2.5 pound.

3. Finish: Baked polyester powder coat, red color.

2.3 FIRE EXTINGUISHER CABINETS

A. Metal: Formed primed steel sheet; 0.036 inch thick base metal.

B. Cabinet Configuration: Semi-recessed type.

1. Sized to accommodate accessories.

2. Trim: Flat, 1 inch wide face.

C. Door: 0.036 inch thick, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with two butt hinge. Provide nylon catch.

D. Door Glazing: Glass, clear, 1/8 inch thick tempered. Set in resilient channel gasket glazing.

E. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.

F. Finish of Cabinet Exterior Trim and Door: Baked Enamel-white.

G. Finish of Cabinet Interior: White enamel.

2.4 ACCESSORIES

A. Extinguisher Brackets: Formed steel, galvanized and enamel finished.

B. Cabinet Signage: FIRE EXTINGUISHER.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install cabinets plumb and level in wall openings, 48 inches from finished floor to center of door handle.

C. Secure rigidly in place.

D. Place extinguishers and accessories in cabinets.

E. Position cabinet signage at or above each extinguisher.

END OF SECTION 10 44 00

SECTION 10 51 00 - LOCKERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Metal lockers.

1.2 REFERENCE STANDARDS

A. ASTM A653/A653M — Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.

B. ADAAG — Americans with Disabilities Act, Accessibility Guidelines

1.3 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Manufacturer's published data on locker construction, sizes and accessories, preparation instructions, storage and handling instructions, and installation methods.

C. Shop Drawings: Indicate locker plan layout, numbering plan and combination lock code and location of ADA compliant lockers.

D. Samples: Submit two samples 3 x 6 inches in size, of each color scheduled.

PART 2 - PRODUCTS

2.1 **MANUFACTURERS**

A. Single tier metal locker with powder coated baked enamel finish; Penco Products, Vanguard: www.pencoproducts.com

B. Other Acceptable Manufacturers:

1. Art Metal Products: www.artmetalproducts.com.

3. Republic Storage Systems Co: www.republicstorage.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

5. Provide metal lockers fabricated in the United States by a single domestic manufacturer.

2.2 **LOCKER APPLICATIONS**

A. Wardrobe: Single tier metal lockers, surface mounted.

1. Width: 15 inches.

2. Depth: 24 inches.

3. Height: 72 inches.

4. Fittings: Hat shelf, 1 coat road, 2 coat hooks.

5. Sloped top with finished ends.

6. Provide concrete base, as detailed on drawings.

7. Louvered ventilation.

8. Die-cast door handle.

2.3 METAL LOCKERS

A. Lockers: Factory assembled, made of formed sheet steel, ASTM A653/A653M SS Grade 33/230, with G60/Z180 coating, stretcher leveled; metal edges finished smooth without burrs; baked enamel finished inside and out.

1. Color: As noted on drawings.

B. Locker Body: Formed and flanged; with steel stiffener ribs; electric spot welded.

1. Top, bottoms, backs, sides and shelves: 24 gauge sheet steel.

2. 15-inch w doors: 16 gauge, 0.06 inch, minimum.

C. Frames: Formed channel shape, welded and ground flush, welded to body, resilient gaskets and latching for quiet operation.

1. Door Frame: 16 gage, 0.060 inch, minimum.

D. Locker Doors: One piece sheet steel

1. Multi-point latch doors: Full channel formation of adequate depth to conceal lock bar on lock side, channel formation on hinge side, right angle formations across top and bottom , with holes for attaching number plates.

2. 15-inch W x 72-inch H doors: Provide 3-inch wide 20 gauge full height reinforcing pan welded to inside face of door at 6-inch centers.

E. Hinges: Three for doors over 42 inches high; two inch high 0.074-inch thick sheet steel, double spun, full loop, tight pin, projection welded to door frame and securely fastened to door with steel rivets.

F. Sloped Top: continuous; 18 gauge, slope rise equal to 1/3 of locker depth, plus 1-inch vertical rise at front, slip joints without visible fasteners at splice locations, provide end closures, finish to match lockers.

G. Number Plates: Provide each locker with polished aluminum number plate, 2-1/4-inch W x 1-inch H, with black numerals not less than 3/8-inch H, attach to face of door with aluminum rivets.

H. Filler strips: Provide 20 gauge steel filler strips as required to complete full wall to wall span.

I. ADA – Compliant Lockers (Recessed Handles with Multi-Point Latch):

1. Single Tier Lockers: Hat shelf 48 inches maximum off the floor.

2. Locker Bottom: Minimum of 9 inches off the floor, or an extra shelf placed 9 inches off the floor for side success or minimum of 15 inches off the floor for front access.

3. Handicapped symbol attached to door.

4. Hooks and rods as specified for other lockers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install lockers plumb and square.

C. Place and secure on prepared concrete base.

D. Install end panels, filler panels, and sloped tops.

E. Install accessories.

F. Replace components that do not operate smoothly.

3.2 CLEANING

A. Clean locker interiors and exterior surfaces.

END OF SECTION 10 51 00

SECTION 10 56 00 - STORAGE EQUIPMENT

PART 1 - GENERAL

The General Provisions of the Trade Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.1 WORK INCLUDED

A. Equipment items as listed below by Equipment Mark Number:

1. CABINET, FLAMMABLE MATERIALS, LARGE
   Equipment Mark Number: 1140

2. CABINET, STORAGE, SHOP, 18 INCH
   Equipment Mark Number: 1185

3. RACK, BULK STORAGE, WITH DECK
   Equipment Mark Number: 1456

4. RACK, GAS CYLINDER STORAGE
   Equipment Mark Number: 1491

5. RACK, PALLET, 42 INCH DEEP, 12 FOOT HIGH, 6000 POUND, WITH DECK
   Equipment Mark Number: 1531

6. SHELVING UNIT, 18 INCH
   Equipment Mark Number: 1680

B. Installation of equipment with labor, services, and incidentals necessary for complete and operational equipment installation.

C. Utilities to be roughed in at location recommended by manufacturer.

1.2 QUALITY ASSURANCE

A. Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.

1.3 STANDARD AND REGULATORY REQUIREMENTS

A. Equipment indicated within this specification section shall comply with all applicable national, state and local codes and regulations, including seismic, fire, and racking codes and regulations. Additional, more specific compliance requirements may be listed under individual equipment headings.

1.4 SUBMITTALS

A. Refer to Section 11 06 00 Equipment Schedule for submittal requirements listed in the "Submittals" column of the equipment list. In the event of conflict between Section 11 06 00 Equipment Schedule and the following expanded submittal descriptions, Section 11 06 00 Equipment Schedule is to govern.

B. Product Data:

1. Submit Product Data in accordance with Division 1 - General Requirements of these specifications.

2. All Product Data submittals shall identify proposed project specific items marked by arrow, circle, underline, reproducible highlight, or other markings clearly discernable by the reviewer, to show which specific items, parts and accessories are being submitted for the project product data review. Non-marked or generic product data submittals with no marks indicating specific items, parts and accessories will be a cause for rejection.

3. Restrict submitted material to pertinent data. For instance, do not include manufacturer's complete catalog when pertinent information is contained on a single page.

C. Operation and Maintenance Manual:

1. Provide a Complete parts list, operating instructions, and maintenance manual covering equipment at time of installation including, but not limited to:

a. Description of system and components.

b. Manufacturer's printed operating instructions.

c. Printed listing of periodic preventive maintenance items and recommended frequency required to validate warranties. Failure to provide maintenance information will indicate that preventive maintenance is not a condition for validation of warranties.

d. List of original manufacturer's parts, including suppliers' part numbers and cuts, recommended spare parts stockage quantity and local parts and service source.

2. Assemble and provide copies of manual in 8-1/2 by 11 inch format. Foldout diagrams and illustrations are acceptable. Manual to be reproducible by dry copy method. Provide copies per provisions of Division 1 - General Requirements.

D. Shop Drawings: Submit shop drawings in accordance with Division 1 -General Requirements of these specifications. Refer to Section 11 06 00 Equipment Schedule for the equipment mark numbers requiring shop drawings.

1. Submitted shop drawings shall be project specific and shall include a minimum 1/8 inch to 1 foot scaled (or larger standard architectural imperial scale), dimensioned,

graphical representation of the size, orientation, and location for the submitted equipment. The drawings shall further include dimensions from structural elements or architectural grid lines, operational clearances, locations of any utility service connection points, mounting requirements, and structural supports required for the submitted equipment.

E. Required Documents for Permit and Local Jurisdictional Approval: Where required by local jurisdiction and/or code officials, the trade contractor/supplier shall be responsible for producing and submitting all documentation required for obtaining any and all applicable approvals related to the specified equipment. This documentation may include, but may not be limited to, engineered signed and stamped plans, details, anchorage layouts for storage equipment, as well as racks to show compliance with locally adopted ASCE, seismic, fire, and other codes. A copy of these required documents shall be included with the product submittal to CTDOT PM for their review.

1.5 PRODUCT SUBSTITUTIONS

A. Follow requirements specified in Division 1 - General Requirements.

B. Additional costs resulting from substitution of products other than those specified, including drawing changes and construction, will be at the expense of the Trade Contractor.

C. Substitution Approval: Manufacturers listed for each equipment item may bid without submittal for that item. Manufacturers not listed shall submit for approval in accordance with "Instructions to Bidders". Prior to procurement, submittals for each equipment item by Mark Number shall be provided in accordance with Division 1 - General Requirements.

1.6 WARRANTY

A. Warrant work specified herein for eighteen months from substantial completion against defects in materials, function and workmanship.

B. Warranty shall include materials and labor necessary to correct defects.

C. Defects shall include, but not be limited to loose, damaged and missing parts and abnormal deterioration of finish.

D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.

E. All parts shall be readily available locally in the United States.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during shipment and storage in humid, dusty conditions. Equipment shall be stored per manufacturer's recommendation.

B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Mark Number of this specification.

C. Provide equipment and materials specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.8 LABELING

A. Manufacturer shall securely attach in a prominent location on each major item of equipment a non-corrosive nameplate showing manufacturer's name, address, model number, serial number, and pertinent utility or operating data.

B. All electrical equipment and materials shall be new and shall be listed by Underwriter's Laboratories, Inc. (U.L.), or other National Recognized Testing Laboratory (NRTL), in categories for which standards have been set by that agency and labeled as such in the manufacturer's plant.

PART 2 – PRODUCTS

2.1 CABINET, FLAMMABLE MATERIALS, LARGE
Equipment Mark Number: 1140

A. General:

1. Description: An upright cabinet with adjustable interior shelves and closeable, lockable doors and handles, designed for the purpose of storing flammable liquids in containers.

2. Compliance: The storage cabinet shall comply with the latest edition of all applicable local, state, and federal codes, including OSHA safety requirements. The storage cabinet shall also comply with the latest editions of the following:

a. NFPA 30: Flammable and Combustible Liquids Code.

b. NFPA 1: Fire Code.

c. International Fire Code.

B. Capacities and Dimensions:

1. Storage capacity: Up to nine each, 5 gallon containers.

2. Overall dimensions, nominal:

a. Width: 43 inches.

b. Depth: 18 inches.

c. Height: 65 inches.

3. Shipping weight, nominal: 310 pounds.

C. Features and Construction:

1. Walls and doors: Construction shall consist of double wall 18 gauge sheet steel with 1-1/2 inch air space between inner and outer walls. Doors shall be self-closing at high ambient temperatures.

2. Containment: Cabinet shall have a 2 inch pan-type bottom.

3. Screened flame arrester vent: Two vents per cabinet, one each at left side bottom and right side top, shall be threaded for and provided with 2 inch NPT steel plugs.

4. Adjustment: Leveling feet shall be provided at all four corners.

5. Ground: Electrical grounding attachments shall be provided on each side.

6. Closure: Double doors with full-length piano hinges and 3-point latch mechanism with key lock.

7. Shelf: Two each adjustable shelves shall be provided between 5-3/8 inches from top and 7-5/16 inches from bottom on 1/2 inch centers.

D. Finish: Durable enamel in safety yellow with "FLAMMABLE - KEEP FIRE AWAY" in minimum 4 inch bright red letters across doors.

E. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Lyon Workspace Products
420 North Main
Montgomery, IL 60538
Phone: (630) 892-8941, (800) 433-8488
Fax: (800) 367-6681
Website: www.lyonworkspace.com

b. Model: 5445N

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Equipto
225 Main Street
Tatamy, PA 18085
Phone: (800) 323-0801
Fax: (888) 859-2121
Website: www.equipto.com

b. Republic Storage Systems Company
1038 Beldon Avenue, Northeast
Canton, OH 44705
Phone: (330) 438-5800, (800) 477-1255
Fax: (330) 454-7772
Website: www.republicstorage.com

2.2 CABINET, STORAGE, SHOP, 18 INCH
Equipment Mark Number: 1185

A. General:

1. Description: An upright cabinet with adjustable interior shelves and closeable, lockable doors and handles, designed for the purpose of storing general items.

B. Capacities and Dimensions:

1. Shelving: Full width shelves, five each.

2. Shelf capacity: 200 pounds, minimum.

3. Overall dimensions:

a. Width: 36 inches.

b. Depth: 18 inches.

c. Height: 78 inches.

4. Weight: 140 pounds, nominal.

C. Features and Construction:

1. Shelves: Four box edge half-length shelves of 18 gauge steel construction shall be adjustable on maximum 2 inch centers without removing fasteners.

2. Doors: Three point box edge latching doors of 18 gauge steel construction shall have common locks and two keys for each cabinet. Doors shall open a full 180 degrees and be flush mounted when closed with latching actuated by grip-type satin chrome plated steel handle.

3. Base and Body: Base and Body of the cabinet shall be constructed of a minimum 18 gauge steel. The cabinet shall be pedestal mounted for protection from moisture.

4. Assembly: Back, front, and sides shall be flush with no bolt heads on front or sides.

5. Locks: All cabinets covered by this specification shall be keyed seperately.

D. Finish: Durable enamel in Owner's choice of manufacturer's standard colors.

E. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Equipto
225 Main Street
Tatamy, PA 18085
Phone: (610) 253 2775, (800) 323-0801
Fax: (888) 859-2121
Website: www.equipto.com

b. Model: 1710

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Lyon Workspace Products
420 North Main
Montgomery, IL 60538
Phone: (630) 892-8941, (800) 433-8488
Fax: (800) 367-6681
Website: www.lyonworkspace.com

b. Republic Storage Systems Company
1038 Beldon Avenue, Northeast
Canton, OH 44705
Phone: (330) 438-5800, (800) 477-1255
Fax: (330) 454-7772
Website: www.republicstorage.com

2.3 RACK, BULK STORAGE, WITH DECK
Equipment Mark Number: 1456

A. General:

1. Description: An assembled, free-standing, adjustable shelving unit composed of metal uprights, beams and decking, designed for the bulk storage of tools and supplies. Intended for medium duty usage.

B. Capacities and Dimensions:

1. Beams:

a. Minimum capacity: 1,600 pounds per pair of beams.

b. Dimensions:

1) Length: 72 inches.

2) Width: 1-1/2 inches.

3) Depth: 2-7/8 inches.

c. Quantity: 4 pair.

2. Uprights:

a. Capacity: 10,500 pounds per upright.

b. Dimensions:

1) Width: 1-5/8 inches.

2) Depth: 24 inches.

3) Height: 96 inches.

3. Decking:

a. Minimum capacity: 2,250 pounds.

b. Thickness: 5/8 inch (at corrugated ridge).

4. Overall dimensions, nominal:

a. Length: 72 inches.

b. Depth: 24 inches.

c. Height: 96 inches.

C. Features and Construction:

1. Beams:

a. Construction: Beams shall be welded 12 gauge steel, with 5/8 by 3/4 inch wide recess for decking.

b. Attachment: Beam hooks shall be provided for insertion into upright slots.

c. Tie bars: Two tie bars shall be provided for each pair of beams.

2. Uprights:

a. Construction: Uprights shall be welded 16 gauge steel with zee-shaped angle steel cross and integral diagonal bracing members.

b. Adjustment: Tapered slots on 1-1/2 inch centers shall be provided for vertical beam adjustment.

c. Row ends: Extra upright assembly shall be provided to finish each row.

3. Decking:

a. Decking shall be solid, corrugated steel construction.

D. Accessories:

1. Floor anchor: Equipto No. 7695L, one each per upright.

2. Floor anchor: Equipto No. 7695R, one each per upright.

3. Provide 10 percent additional rack ends for attic stock, to be used for future re-organization or fitting continuous rows between building columns and structures.

E. Finish: Durable enamel in Owner's choice of manufacturer's standard colors.

F. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Equipto
225 Main Street
Tatamy, PA 18085
Phone: (610) 253-2775, (800) 323-0801
Fax: (888) 859-2121
Website: www.equipto.com

b. Model: 1018D62S Rack with Accessories and 9316 Rack End as required

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Lyon Workspace Products
420 North Main
Montgomery, IL 60538
Phone: (630) 892-8941, (800) 433-8488
Fax: (800) 367-6681
Website: www.lyonworkspace.com

b. Republic Storage Systems Company
1038 Beldon Avenue, Northeast
Canton, OH 44705
Phone: (330) 438-5800, (800) 477-1255
Fax: (330) 454-7772
Website: www.republicstorage.com

2.4 RACK, GAS CYLINDER, PORTABLE
Equipment Mark Number: 1491

A. A. Capacities and Dimensions:

1. Overall assembled dimensions:

a. Depth: 14 inches.

b. Width: 52 inches.

c. Height: 30 inches.

d. Weight, nominal: 50 pounds.

B. Features and Construction:

1. Construction: All-welded 11 gauge plate steel. Handles one to four 12 inch diameter cylinders. Steel reinforced vinyl edge guards at all cylinder contact locations.

2. Straps: 1 1/2 inch polypropylene strap and cinch buckle. One for each cylinder.

C. Accessories: Steel chain sets. One for each cylinder.

D. Finish: Durable enamel in manufacturer’s standard color.

E. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. USA Safety
PO Box 44282
Madison, WI 53744-4282
Phone: (608) 630-1572
Fax: (866) 465-6101
Website: www.usasafety.com

b. Model: #GR475FS

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers,including the following, may be considered as equal.

a. Clinch-Tite Corporation
5264 e Street
5265 Sandy Lake, PA 16145
Phone: (724) 376-7315
Fax: (724) 376-2785
Website: www.clinchtite.com

b. BCI, Incorporated
5655 F Street, Suite 3
Omaha, NE 68117
Phone: (800) 331-7013, (402) 733-5995
Fax: (800) 338-3546, (402) 733-6116
Website: www.bciomaha.com

2.5 RACK, PALLET, 42 INCH DEEP, 12 FOOT HIGH, 6000 POUND, WITH DECK
Equipment Mark Number: 1531

A. General:

1. Description: An adjustable, sectional pallet type rack designed for the storage of materials on shelves. The rack consists of free standing vertical upright metal members, each one supported by two footings. Each vertical support is connected together by horizontal support bracing at the front and back, and strengthened by diagonal supports at the back. The horizontal support bracing shall also support secondary bracing and decking.

2. Compliance: The rack shall comply with all applicable local, state, and federal codes, including all OSHA requirements. The rack shall also comply with the following:

a. RMI (Rack Manufacturer Institute) / ANSI (American National Standards Institute) MH16.1 Specification for the Design, Testing and Utilization of Industrial Steel Storage Racks.

b. For seismic loading, the rack shall comply with the aforementioned RMI / ANSI MH16.1 Specification or with local building and structural seismic codes, whichever is greater.

c. RMI / ANSI MH26.2 Specification for the Design, Testing and Utilization of Welded Wire Rack Decking.

B. Capacities and Dimensions:

1. Uprights:

a. Capacity: 22,000 pounds.

b. Dimensions:

1) Thickness: 3 inches.

2) Depth: 42 inches.

3) Height: 144 inches.

2. Beams:

a. Minimum capacity: 6,000 pounds per pair of beams.

b. Dimensions:

1) Length: 108 inches, clear.

2) Depth: 4-1/2 inches.

3) Thickness: 2-3/4 inches.

c. Installed top of beam height from finished floor (Verify beam heights with Owner prior to installation):

1) First beams: 48 inches.

2) Second beams: 96 inches.

3) Top beams: 144 inches.

3. Overall dimensions:

a. Width: 114 inches.

b. Depth: 42 inches.

c. Height: 144 inches.

C. Features and Construction:

1. Uprights:

a. Construction: Upright frames shall be continuously arc welded, heavy gauge steel box section uprights with deep channel cross and diagonal members.

b. Adjustment: Tapered keyhole slots shall be punched on 2 inch centers on both sides for vertical beam adjustments.

c. Base plate: Heavy gauge steel plates with holes for anchoring to floor shall be arc welded to uprights.

2. Beams:

a. Construction: Beams shall be welded, step-type heavy gauge steel box channel.

b. Attachment: Three high tensile studs shall be provided on each end to engage tapered keyhole slots in uprights, locking flush by means of spring loaded lock snaps.

D. Accessories:

1. 52 inches wide by 42 inches deep wire decking with required support channels, Lyon No. WD5242H, two per shelf.

2. Provide 6 inch wall spacers and / or 8 inch row spacers as needed, Lyon No. LWS-6 / LRS-8, in quantities per manufacturer’s recommendations.

3. Provide 10 percent additional Uprights for attic stock, to be used for future re-organization or fitting continuous rows between building columns and structures.

E. Finish: Durable enamel in Owner's choice of manufacturer's standard colors.

F. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Lyon Workspace Products
420 North Main
Montgomery, IL 60538
Phone: (630) 892-8941, (800) 433-8488
Fax: (800) 367-6681
Website: www.lyonworkspace.com

b. Model: LU-323-42H144 Uprights and LBS-485-N108 Beams with Accessories.

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Republic Storage Systems Company
1038 Beldon Avenue, Northeast
Canton, OH 44705
Phone: (330) 438-5800, (800) 477-1255
Fax: (330) 454-7772
Website: www.republicstorage.com

b. Edsal Manufacturing Company
4400 South Packers Avenue
Chicago, IL 60609
Phone: (773) 254-0600
Fax: (773) 254-1303
Website: www.edsal.com

2.6 SHELVING UNIT, 18 INCH
Equipment Mark Number: 1680

A. Capacities and Dimensions:

1. Number of shelves: Seven total.

2. Shelf capacity: 1000 pounds per shelf.

3. Overall dimensions, nominal:

   a. Width: 36 inches.

   b. Depth: 18 inches.

   c. Height: 84 inches.

4. Installed shelf height from finished floor, nominal:

   a. Top shelf: 84 inches.

   b. Bottom shelf: 1 inch.

   c. Remaining shelves: Evenly spaced, approximately 12 inches center to center.

B. Features and Construction:

1. Shelf construction: Shelves shall be constructed of 18 gauge steel with double flanged, box-formed edges on all four sides and front and rear shelf edge reinforcing channels.

2. Uprights: Uprights shall be constructed of 16 gauge steel, double flanged, with tapered bracket slots punched on 1-1/2 inch centers for vertical shelf adjustment.

3. Shelf securement: Slip-in shelf brackets shall reinforce and securely lock shelf into place on all four corners.

4. Commonality: Units shall have the capability of sharing common end and back panels with adjoining units.

5. Assembly: Unit shall be designed for complete, rigid assembly and adjustment without tools.

C. Accessories:

1. Left floor anchor: Upright anchor for left side, Equipto No. 7695L, two each.

2. Right floor anchor: Upright anchor for right side, Equipto No. 7695R, two each.

3. Provide 10 percent additional End Panels for attic stock, to be used for future re-organization or fitting continuous rows between building columns and structures.

D. Finish: Durable enamel in Owner's choice of manufacturer's standard colors.

E. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Equipto
225 Main st.
Tatamy, PA 18085
Phone: (214) 443-9800, (800) 323-0801
Fax: (888) 859-2121
Website: www.equipto.com

b. Model: 773-7S shelving unit with 773-7A add-on as required with Accessories

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers may be considered as equal.

a. Lyon Workspace Products
420 North Main
Montgomery, IL 60538
Phone: (630) 892-8941, (800) 433-8488
Fax: (800) 367-6681
Website: www.lyonworkspace.com

b. Republic Storage Systems Company
1038 Beldon Avenue, Northeast
Canton, OH 44705
Phone: (330) 438-5800, (800) 477-1255
Fax: (330) 454-7772
Website: www.republicstorage.com

PART 3 - EXECUTION

3.1 INSPECTION

A. Coordinate location of rough-in work and utility stub-outs to assure match and/or non-interference with equipment to be installed.

B. Inspect delivered equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all items.

3.2 INSTALLATION

A. Perform work under direct supervision of Foreman or Construction Superintendent with authority to coordinate installation of scheduled equipment with CTDOT PM.

B. Install equipment in accordance with plans, shop drawings, and manufacturer's instructions:

1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level, plumb and at right angles to adjacent work.

2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.

3. Anchorage: Attach equipment securely to floor, per manufacturer's instructions and as directed by CTDOT PM, to prevent damage resulting from inadequate fastening. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces. Coordinate anchorage installation with radiant floor piping locations in the slab and under equipment.

4. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.

3.3 TESTING

A. After final installation is complete and prior to authorizing payment, specified equipment shall be checked for compliance with specifications in the presence of the CTDOT PM using acceptance procedures provided by the manufacturer.

3.4 CLEANUP

A. Touch-up damage to painted finishes.

B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.

C. Clean area around equipment installation and remove packing or installation debris from job site.

D. Notify CTDOT PM for acceptance inspection.

END OF SECTION 10 56 00

SECTION 10 75 00 – FLAGPOLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work includes design, furnishing and installing flagpole with foundations, complete in place, at the location specified as shown in the Contract Drawings or as directed by the Engineer in accordance with these specifications and approved Shop Drawings.

1.2 SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures and Section 01 33 00.13 Document Control.

B. Shop Drawings: Submit detailed Shop Drawings for each item required to be fabricated or installed under this Item. Include plans, design calculations, sections and details as required to show all materials, layout, dimensions, method of connection and assembly, fabrication and tolerances for types of materials, types and details of connections and openings, cuts, holes, bolts and painting for all items required. Take all necessary field dimensions and verify dimensions as required.

C. Product Data: Prior to ordering the flagpoles, submit product literature for all materials required to complete the work of flagpole installation and representative samples of the flagpole finish for approval. Do not order materials until Engineer's approval has been obtained. Delivered materials shall be the same as the approved samples.

1.3 RELATED SECTIONS

A. Division 03 Section 03 30 00 – Cast-in-Place Concrete.

B. Division 31 Section 31 23 23 – Fill

C. Division 32 Section 32 11 23 – Aggregate Base Courses

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flagpole shall be of the finished exposed height indicated below and shall be supplied by American Flagpole, Abingdon, VA, or approved equal by Sterner Lighting, Inc., Winsted, MN; or Babcock-Davis Associates, Arlington, MA. Submit product literature and Shop Drawings for approval prior to ordering the material. Flagpole shall be grounded and connect to the building ground system. Submit grounding plan for flagpole for review and approval.

Flagpole shall conform to the following materials:

B. Type: Anchor base cone tapered seamless cold drawn aluminum 6063-T6 tubing conforming to the requirements of ASTM B241, butt diameter six inches (6”), wall thickness 0.188 inches, top diameter three and one-half inches (3 ½”) top wall thickness 0.188 inches. No visible joints.

C. Size: Exposed height shall be 35 feet.

D. Finish: Factory applied anodized aluminum.

E. Packing: Poles shall be spiral wrapped with protective paper and shipped in a hard fiber tube.

F. Ball: Six inch (6”) seamless sphere of polished aluminum, with a ½” diameter solid mounting rod. Finish is anodized polished stainless.

G. Truck: Cast aluminum revolving, double halyard type, complete with nylon sheaves and permanently lubricated stainless steel ball bearings.

H. Halyards: Stainless steel aircraft cable with chrome plated bronze swivel snap hooks, plastic-covered counterweight and beaded sling. Halyards shall be internal.

I. Cleats: Two nine-inch (9”) cast aluminum, with 5/16” stainless steel mounting bolts. Provide cleat cover to match color of pole.

J. Base cover: Twenty-inch (20”) diameter by six-inch (6”) high spun aluminum to match pole color and finish.

K. Base: Cast aluminum anchor base complete with anchor nuts and bolts.

L. Foundation sleeve: Shall be fabricated from 16-gauge galvanized corrugated steel tubing with 3/16” thick steel base plate and support plate, 3/4”x 18” long ground spike and steel centering wedges.

M. Sand: Fine Aggregate shall be used where sand is called for by the manufacturer conforming to fine aggregates specified in Section 32 11 23 Aggregate Base Courses, processed aggregate base materials

N. Concrete: Concrete shall conform to Section 03 30 00 Cast-in-Place Concrete Class A concrete.

PART 3 - EXECUTION

A. Install concrete foundation to depth and diameter recommended by the flagpole manufacturer.

B. Install pole, the foundation sleeve, base plate, support plate, wedges and ground spike. Provide fine aggregate and hardwood wedges tamped in place after pole has been set plumb.

3.1 CONSTRUCTION METHODS

A. Locate and install flagpoles as shown on the Drawings and in accordance with approved Shop Drawings. The Trade Contractor shall be responsible for timing the delivery of flagpole so as to minimize on-site storage time prior to installation. All stored materials and items must be protected from weather, careless handling or vandalism.

B. Protect materials, fabrications and assemblies with metal coatings from damage during construction using methods approved by fabricator and coating manufacturer. Trade Contractor shall touch up any scratches or abrasions that occur during installation with material provided by manufacturer to match factory anodized finish. At factory-finished surfaces the Trade Contractor shall touch up finish in conformance with coating manufacturer's recommendations. Provide touch-up such that repair is not visible from a distance of six (6') feet.

C. Trade Contractor shall backfill the excavation for construction of foundation with Compacted Granular Fill which meets requirements of Section 31 23 23 Fill specifications.

D. The Trade Contractor shall provide a foundation for the flagpole designed per manufacturer requirements for the pole height specified above.

END OF SECTION 10 75 00

SECTION 11 06 00 - EQUIPMENT SCHEDULE

PART 1 - GENERAL

PART 1 - GENERAL

The following Equipment Schedule provides information on equipment shown on the Industrial drawings. Equipment is listed numerically by mark number with the following information:

1. Mark # - All identical equipment items are assigned the same number. The Equipment Mark Number coordinates this schedule with EQ drawings and the specifications.

2. Item Description.

3. Spec Section - Identifies division or section where technical specifications for the equipment item can be found. NIC means "Not in Trade Contract".

4. Procurement Method

    a. CF/CI = Trade Contractor Furnished/Trade Contractor Installed.

    b. OF/OI = Owner Furnished/Owner Installed.

    c. OF/CI = Owner Furnished/Trade Contractor Installed.

5. Submittals - Identifies type(s) of submittals required:

    a. PD = Product Data

    b. SD = Shop Drawings

    c. OM = Operation and Maintenance Manuals

    d. T = Training of Owner's personnel on specific equipment items

    e. TR = Test Reports

PART 2 - PRODUCTS

INDUSTRIAL EQUIPMENT SCHEDULE

Mark	Description	Specification Section	Procurement	Submittals
1140	Cabinet, flammable materials, large	10 56 00	CF/CI	PD
1185	Cabinet, storage, shop, 18"	10 56 00	CF/CI	PD
1456	Rack, bulk storage, w/ deck	10 56 00	CF/CI	PD
1491	Rack, gas cylinder storage	10 56 00	CF/CI	PD
1531	Rack, pallet, 42" deep, 12' high, 108" beams, 6000lb, w/ deck	10 56 00	CF/CI	PD
1680	Shelving unit, 18"	10 56 00	CF/CI	PD
1750	Stool, electronic station, anti-static	11 96 00	CF/CI	PD, OM
1793	Table, welding, heavy duty	11 96 00	CF/CI	PD
1800	Workbench, electronics, anti-static top, 2 cabinet	11 96 00	CF/CI	PD
1802	Workbench, electronics, anti-static top, 6 ft.	11 96 00	CF/CI	PD
1862	Workbench, severe use, w/ cabinets	11 96 00	CF/CI	PD
1864	Workbench, severe use, wood top	11 96 00	CF/CI	PD
2080	Buffer/grinder, 8", w/ dust collector	11 96 00	CF/CI	PD, OM
2215	Drill press, variable speed, 20"	11 96 00	CF/CI	PD, OM
2422	Machine, pipe threading, w/ stand	11 96 00	CF/CI	PD, OM
2539	Press, hydraulic, 20 ton	11 96 00	CF/CI	PD, OM
2725	Saw, table, tilting arbor, 14"	11 96 00	CF/CI	PD, OM
2832	Vise, combination, swivel base, 5"	11 96 00	CF/CI	PD, OM
2880	Vise, swivel base, electronics	11 96 00	CF/CI	PD, OM
3200	Extractor, fume, w/ extension arm	44 11 37	CF/CI	PD, OM
3202	Extractor, fume, mini	44 11 37	CF/CI	PD, OM
3305	Reel, vehicle exhaust, motor operated, w/ 8" hose	44 11 37	CF/CI	PD, OM, SD
5350	Forklift, electric, sit-down, 4000 lb	41 63 00	OF/OI	PD, OM, SD, T
5362	Hoist, chain, elect., 1 ton	41 22 00	CF/CI	PD, OM, SD, T
5960	Truck, platform, wood deck	11 96 00	CF/CI	PD, OM
7421	Lamp, workbench, w/ magnifier	11 96 00	CF/CI	PD, OM
9100	Building, storage, hazardous materials, prefabricated	13 34 23.10	CF/CI	PD, OM, SD, T

Mark	Description	Specification Section	Procurement	Submittals
11421	Storage, cabinet, hazardous materials, vented	none	OF/OI	NA
11422	Storage, cabinet, flamable materials, vented	none	OF/OI	NA
18901	Workbench, w ood top, w / sheet metal storage	none	OF/OI	NA
18902	Layout table, w ood top , fabricated	none	OF/OI	NA
18903	Workbench, w ood top , fabricated	none	OF/OI	NA
20811	Buffer, grinder, stand mounted	none	OF/OI	NA
23211	Jointer, w ith fabricated infeed table	none	OF/OI	NA
27011	Saw , band, 14"	none	OF/OI	NA
27141	Wall mounted panel saw	none	OF/OI	NA
27151	Saw , radial arm	none	OF/OI	NA
29001	Spot Welder	none	OF/OI	NA
29211	Oxygen / Acetylene cart, portable	none	OF/OI	NA
29301	Welder, multi-process	none	OF/OI	NA
50351	Cart, portable	none	OF/OI	NA
50352	Cart, panel, portable	none	OF/OI	NA
62561	Sheet metal brake, 8'	none	OF/OI	NA
62562	Sheet metal brake, 9', folding, portable	none	OF/OI	NA
62563	Sheet metal hand brake, 4', on stand	none	OF/OI	NA
62571	Roll former w / flanger attachment, portable	none	OF/OI	NA
62581	Sheet metail slitter, mounted to fab w ood top w orkbench	none	OF/OI	NA
67021	Shear, 16 GA	none	OF/OI	NA
99013	Storage, vertical,w ood panel, fabricated	none	OF/OI	NA
99014	Storage, cut w ood, fabricated	none	OF/OI	NA
99015	Storage, bins, fastener, fabricated	none	OF/OI	NA

PART 3 - EXECUTION

Not Used

END OF SECTION 11 06 00

SECTION 11 11 36 – VEHICLE CHARGING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnishing and installation of electric vehicle chargers of the size and type called for at the location shown on the plans.

1.2 SUBMITTALS

A. See Section 01 33 00 Submittal Procedures and Section 01 33 00.13 – Document Control, for submittal requirements for this work.

1.3 RELATED REQUIREMENTS

A. Section 31 23 16, for excavation.

B. Section 32 11 23 Aggregate Base Courses.

C. Shop Drawing: Trade Contractor is to submit shop drawing of electric vehicle charger for review and approval prior to ordering.

PART 2 PRODUCTS

2.1 MATERIALS

A. The materials for this work shall conform to the following requirements:

The materials for electric vehicle charger shall be a level 2 Watt Point Dual Curbside model#3722-IG-1000-C/D by Control Module Inc., EVSE LLC, Enfield Connecticut, www.evsellc.com with precast concrete base to charge two vehicles with the specifications noted on the plans or approved equal. The materials also include all required building mounted communication equipment, communication cabling and connectors, electrical hardware, mounting hardware, and conductors for a complete installation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that construction area indicated on the plans is ready for the Work as indicated.

3.2 PREPARATION

A. Layout the location indicated on the plans prior to construction.

3.3 CONSTRUCTION METHODS

A. The electric vehicle chargers shall be installed at the location indicated on the Drawings. The electric vehicle charger shall be plumb, level, true, neat, rigid, and installed in accordance with manufacturer's instructions, the approved shop drawings, and these specifications.

B. Field repairs shall not be allowed without prior approval. All exposed edges shall be smooth, free from burrs, slivers and other projections and neatly finished. All clamps used to install the electric vehicle charger shall be adequately padded to prevent scarring to the material surfaces. The electric vehicle charger materials shall be adequately protected to prevent scarring or damaging of the various surfaces during shipment.

C. If the Trade Contractor's work results in any damage, it will be his responsibility to replace the damaged items or properties to the CTDOT PM's satisfaction. Any costs involved will be borne solely by the Trade Contractor.

D. The Trade Contractor shall remove all excess and packaging materials, dispose of excess and packaging materials, and restore the work area to its original condition.

E. The Trade Contractor shall test the electric vehicle chargers according to the manufacturer's recommendations prior to acceptance.

END OF SECTION 11 11 36

SECTION 11 13 13 - LOADING DOCK BUMPERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Dock bumpers of reinforced rubber with attachment frame.

1.2 RELATED REQUIREMENTS

A. Section 03 10 00 - Concrete Forming and Accessories: Placement of bumper anchors into concrete.

1.3 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Indicate unit dimensions, method of anchorage, and details of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Dock Bumpers:

1. Blue Giant Equipment Corporation: www.bluegiant.com.

2. Chalfant Sewing Fabricators, Inc.: www.chalfantusa.com.

3. Durable Corp: www.durablecorp.com.

4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 COMPONENTS

A. Bumpers: Fabric reinforced rubber pads, ozone resistant, laminated and compressed in position with two galvanized steel rods with threaded ends, washers and nuts; between 3 x 2-1/2 x 1/4 inch galvanized steel angle end plates:

1. Projection From Wall: 4-1/2 inches.

2. Vertical Height: 10 inches.

3. Length: 15 inches.

B. Attachment Hardware: 3/4 inch diameter galvanized bolts and expansion shields.

C. Touch-up Primer: Zinc rich type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install dock bumpers in accordance with manufacturer's instructions.

B. Set plumb and level.

END OF SECTION 11 13 13

SECTION 11 40 00 - FOODSERVICE EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This item shall consist of furnishing and installation of an ice making and dispensing system of the size and type called for and at the location shown on the Drawings. Furnish and install equipment identified as ICE MACHINE on the Drawings including an ice storage bin/dispenser and fully compatible top-mounted icemaker.

B. Provide connections to utilities, including domestic water and electrical power.

1.2 RELATED REQUIREMENTS

A. Section 01 60 00 – PRODUCT REQUIREMENTS

B. Section 22 08 00 – PLUMBING SYSTEMS

C. Section 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

1.3 REFERENCE STANDARDS

A. ASTM A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.
B. ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
C. ASTM C1048	Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2012.
D. NEMA LD 3	High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.
E. NEMA MG 1	Motors and Generators; National Electrical Manufacturers Association; 2011.
F. NFPA 70	National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. UL (EAUED)	Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.
H. NSF/ANSI 12	Automatic Ice Making Equipment

1.4 SUBMITTALS

A. See Section 01 33 00 - SUBMITTAL PROCEDURES and Section 01 33 00.13 – DOCUMENT CONTROL for submittal requirements for this work.

B. Product Data: Provide data on appliances; indicate configuration, sizes, materials, finishes, locations, and utility service connection locations, service characteristics, and wiring diagrams.

C. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.

D. Certificates: Certify that products of this section meet or exceed specified requirements.

E. Operation Data: Provide operating data for the specified equipment.

F. Maintenance Data: Provide lubrication and periodic maintenance requirement schedules.

G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of standard products of the type specified.

1.6 REGULATORY REQUIREMENTS

A. Conform to NSF and UL requirements.

B. Products Requiring Electrical Connection: Listed and classified by UL (EAUED) as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products clear of floor in a manner to prevent damage.

B. Coordinate size of access and route to place of installation.

1.8 WARRANTY

A. See Section 01 77 00 - Closeout Procedures, for additional warranty requirements.

B. Provide five year manufacturer’s warranty for replacement or repair of scheduled equipment, refrigerant and compressors, including disconnection and removal of defective unit, and connection of replacement unit.

PART 2 PRODUCTS

2.1 ICE MAKER

A. NSF and UL agency approved commercial icemaker

B. Equipment Requirements:

1. Top mounted, air cooled condenser

2. Capable of producing compressed nugget ice using an efficient, sanitary horizontal evaporator/auger system and delivering ice by a flexible wire reinforced, transport tube to ice dispenser

3. Stainless steel frame and exterior, slide-out compressor/condenser with utility docking station, front-mounted unit status display, automatic self-flush, and semi automatic cleaning and sanitizing system, alumi.num-bronze evaporator

4. Provide wall mounting bracket to support ice maker.

5. Ice maker shall produce 1000 pounds in 24 hours

C. Basis of Design shall be Follett Horizon Icemaker HCC 1000, or equivalent product manufactured by other companies.

2.2 AUTOMATIC ICE STORAGE AND DISPENSING SYSTEM

A. Provide ice storage bin with automatic agitation, including both push button and foot pedal activation; 100 lbs per minute supply rate; removable front access panel; removable and lockable clear window; nominal dimensions 72” high by 54” long by 46” deep.

B. Equipment Requirements:

1. Bin to hold up to 1000 lbs of ice

2. Dispense rate shall be approximately 100 lbs per minute

3. Two-position ice discharge chute with sector lever allows filling of bags or other containers.

4. Lockable clear inspection window shall have interlock switch to prevent operation if window is removed.

5. Hopper to be constructed of double wall rotationally molded polyethylene insulated with non-CFC polyurethane foam.

6. Storage hopper shall be supported by stainless steel frame.

7. Heavy-duty agitation system includes two stainless steel agitators and ½ HP motor.

8. Dispense auger to be rotationally molded plastic auger driven by ¼ HP motor.

9. Front assembly removes for installation through narrow doors.

10. Activation of the dispensing function shall be controlled by foot pedal.

11. Accessory: Jug and Cooler Kit to dispense ice into 5 liter and 10 liter jugs and large coolers while minimizing spills. Provide main support, jug guide, chute assembly, jug cradle assembly, support assembly, drain pan, legs with leveling, drain fitting, required screws and nuts, stainless steel construction.

C. Basis of Design shall be Follett DB 1000 or equivalent product manufactured by other companies.

2.3 EQUIPMENT

A. Installation Accessories: Provide all rough-in hardware, supports and connections, attachment devices, closure trim, and accessories required for complete installation.

2.4 INSTALLATION

A. Install rubber button feet on bearing surface of any item positioned on a finished surface.

B. Mount icemaker on top of ice storage and dispensing machine.

C. Do not position bin drain lines to block bin cart.

D. Install floor drain with grate with all ice storage bins. Drains should be hard piped and insulated. Maintain at least ¼” per foot slope away from ice maker.

2.5 FINISHES

A. Stainless Steel: No. 4 finish.

END OF SECTION 11 40 00

SECTION 11 96 00 - SHOP EQUIPMENT

PART 1 - GENERAL

The General Provisions of the Trade Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.1 WORK INCLUDED

A. Equipment items as listed below by Equipment Mark Number:

1. STOOL, ELECTRONIC STATION, ANTI-STATIC
   Equipment Mark Number: 1750

2. TABLE, WELDING, HEAVY DUTY
   Equipment Mark Number: 1793

3. WORKBENCH, ELECTRONICS, ANTI-STATIC TOP, 2 CABINET
   Equipment Mark Number: 1800

4. WORKBENCH, ELECTRONICS, ANTI-STATIC TOP, 6 FOOT
   Equipment Mark Number: 1802

5. WORKBENCH, SEVERE USE, WITH CABINETS
   Equipment Mark Number: 1862

6. WORKBENCH, SEVERE USE, WOOD TOP
   Equipment Mark Number: 1864

7. BUFFER/GRINDER, 8 INCH, WITH DUST COLLECTOR
   Equipment Mark Number: 2080

8. DRILL PRESS, VARIABLE SPEED, 20 INCH
   Equipment Mark Number: 2215

9. MACHINE, PIPE THREADING
   Equipment Mark Number: 2422

10. PRESS, HYDRAULIC, 20 TON
    Equipment Mark Number: 2539

11. SAW, TABLE, TILTING ARBOR, 14 INCH
    Equipment Mark Number: 2725

12. VISE, COMBINATION, SWIVEL BASE, 5 INCH
    Equipment Mark Number: 2832

13. VISE, SWIVEL BASE, ELECTRONICS
Equipment Mark Number: 2880

14. TRUCK, PLATFORM, WOOD DECK
Equipment Mark Number: 5960

15. LAMP, WORKBENCH WITH MAGNIFIER
Equipment Mark Number: 7421

B. Roughing-in, installation of equipment, and final connection of utilities, with labor, services, and incidentals necessary for complete and operational equipment installation.

C. Piping, wiring, and switching between equipment and utilities.

1.2 ALTERNATIVE BIDS

A. Refer to Division 1 - General Requirements for possible effect on Work of this Section.

1.3 QUALITY ASSURANCE

A. Experience: Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.

B. Manufacturer's Representative:

1. Installation: Provide a qualified manufacturer's representative at site to supervise work related to equipment installation, check out and start up.

2. Training: Provide technical representative to train Owner's maintenance personnel in operation and maintenance of specified equipment.

1.4 STANDARD AND REGULATORY REQUIREMENTS

A. Equipment indicated within this specification section shall comply with all applicable national, state and local codes and regulations, including seismic, fire, and racking codes and regulations. Additional, more specific compliance requirements may be listed under individual equipment headings.

1.5 SUBMITTALS

A. Refer to Section 11 06 00 Equipment Schedule for submittal requirements listed in the “Submittals” column of the equipment list. In the event of conflict between Section 11 06 00 Equipment Schedule and the following expanded submittal descriptions, Section 11 06 00 Equipment Schedule is to govern.

B. Product Data:

1. Submit Product Data in accordance with Division 1 - General Requirements of these specifications.

2. All Product Data submittals shall identify proposed project specific items marked by arrow, circle, underline, reproducible highlight, or other markings clearly discernable by the reviewer, to show which specific items, parts and accessories are being submitted for the project product data review. Non-marked or generic product data submittals with no marks indicating specific items, parts and accessories will be a cause for rejection.

3. Restrict submitted material to pertinent data. For instance, do not include manufacturer's complete catalog when pertinent information is contained on a single page.

C. Operation and Maintenance Manual:

1. Provide a Complete parts list, operating instructions, and maintenance manual covering equipment at time of installation including, but not limited to:

a. Description of system and components.

b. Schematic diagrams of electrical, plumbing and compressed air systems.

c. Manufacturer's printed operating instructions.

d. Printed listing of periodic preventive maintenance items and recommended frequency required to validate warranties. Failure to provide maintenance information will indicate that preventive maintenance is not a condition for validation of warranties.

e. List of original manufacturer's parts, including suppliers' part numbers and cuts, recommended spare parts stockage quantity and local parts and service source.

2. Assemble and provide copies of manual in 8-1/2 by 11 inch format. Foldout diagrams and illustrations are acceptable. Manual to be reproducible by dry copy method. Provide copies per provisions of Division 1 - General Requirements.

D. Shop Drawings: Submit Shop Drawings in accordance with Division 1 -General Requirements of these specifications. Refer to Section 11 06 00 Equipment Schedule for the equipment mark numbers requiring shop drawings.

1. Submitted shop drawings shall be project specific and shall include a minimum 1/8 inch to 1 foot scaled (or larger standard architectural imperial scale), dimensioned, graphical representation of the size, orientation, and location for the submitted equipment. The drawings shall further include dimensions from structural elements or architectural grid lines, operational clearances, locations of any utility

service connection points, mounting requirements, and structural supports required for the submitted equipment.

1.6 PRODUCT SUBSTITUTIONS

A. Follow requirements specified in Division 1 - General Requirements.

B. Additional costs resulting from substitution of products other than those specified, including drawing changes and construction, will be at the expense of the Trade Contractor.

C. Substitution Approval: Manufacturers listed for each equipment item may bid without submittal for that item. Manufacturers not listed shall submit for approval in accordance with "Instructions to Bidders". Prior to procurement, submittals for each equipment item by Mark Number shall be provided in accordance with Division 1 - General Requirements.

1.7 WARRANTY

A. Warrant work specified herein for eighteen months from substantial completion against defects in materials, function and workmanship.

B. Warranty shall include materials and labor necessary to correct defects.

C. Defects shall include, but not be limited to noisy, rough, or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish.

D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.

E. All parts shall be readily available locally in the United States.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during shipment and storage in humid, dusty conditions.

B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Mark Number of this specification.

C. Provide equipment and materials specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.9 LABELING

A. Manufacturer shall securely attach in a prominent location on each major item of equipment a non-corrosive nameplate showing manufacturer's name, address, model number, serial number, and pertinent utility or operating data.

B. All electrical equipment and materials shall be new and shall be listed by Underwriter's Laboratories, Inc. (U.L.), or other National Recognized Testing Laboratory (NRTL), in categories for which standards have been set by that agency and labeled as such in the manufacturer's plant.

PART 2 – PRODUCTS

2.1 STOOL, ELECTRONIC STATION, ANTI-STATIC
Equipment Mark Number: 1750

A. General: A portable, adjustable personnel stool designed to dissipate static electricity by means of a grounding cable.

B. Capacities and Dimensions:

1. Seat:

a. Width: 20 inches.

b. Depth: 18 inches.

c. Thickness: 3 inches.

d. Tilt adjustment: 8 degrees.

e. Height adjustment: 19 to 27 inches with automatic 8-inch adjustment while seated.

2. Back rest:

a. Width: 16 inches.

b. Height: 15 inches.

c. Tilt angle adjustment: 20 degrees.

d. Height adjustment: 5 inches.

3. Base:

a. Diameter: 20 inches.

b. Number of legs: 5.

C. Features and Construction:

1. Electrostatic dissipation: Stool shall be designed with all components integrated into one complete circuit that enables static electricity to be discharged through a grounding cable in the base of the stool.

2. Ergonomic design: The stool shall be ergonomically designed for maximum comfort and efficiency and shall be built to withstand heavy continuous use in industrial applications.

3. Single control: Stool shall have a single control for adjustment of seat tilt and backrest angle.

4. Base: Base of stool shall have aluminum legs and footrest ring in one-piece construction.

5. Upholstery: Seat and back of stool shall be upholstered with electro-static dissipative coated, stain resistant, heavy weight cotton fabric.

6. Spindle dust cover: Stool shall have a telescoping dust cover to conceal the lift mechanism and spindle.

7. Legs of stool base shall have hard floor conductive casters, Part No. 2071CR.

D. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Lyon Workspace Products
420 North Main
Montgomery, IL 60538
Phone: (630) 892-8941, (800) 433-8488
Fax: (630) 892-8966 , (800) 367-6681
Website: www.lyonworkspace.com

b. Model: 2056N with accessories

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers may be considered as equal.

a. BioFit Engineered Products
P.O. Box 109
Waterville, OH 43566
Phone: (419) 823-1089, (800) 597-0246
Fax: (419) 823-1342
Website: www.biofit.com

b. Safco Products Company
9300 Research Center Rd W
Minneapolis, MN 55428
Phone: (763) 536-6700
Website: www.safcoproducts.com

2.2 TABLE, WELDING, HEAVY DUTY
Equipment Mark Number: 1793

A. General:

1. Description: Steel platen and stand with accessories, all specifically designed for use in welding applications.

2. Compliance: The equipment shall comply with the most recent editions of all applicable local, state, and federal codes and regulations.

B. Capacities and Dimensions:

1. Dimensions, nominal:

a. Width: 60 inches.

b. Depth: 60 inches.

c. Height: 32 inches (with stand).

2. Weight, nominal:

a. Platen: 2,000 pounds.

b. Stand: 300 pounds.

3. Loading capacity on stand: 10,000 pounds, nominal.

C. Features and Construction:

1. Platen: Weldsale No. WS55B, one each.

a. Construction: Platen shall be constructed of semi-steel casting.

b. Surface: Top surface and side ledges shall be machined to within .005 inches of flatness per linear foot.

c. Holes: 1-3/4 inch square holes shall be spaced 3-1/2 inches center to center.

2. Stand: Platen stand shall be constructed of structural steel with flanges for anchoring to floor. Weldsale No. WS55BNS, one each.

D. Accessories:

1. Table shall be supplied with the following: Horizontal clamps, two each; Tapered drift pin, 10 inch, ten each; Vise with connecting plate, one each; Gooseneck hold-down, two each; Bending post, five each; Burning pyramid, four each; Arm clamp, two each.

E. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Weldsale Company
Division of J. A. Cunningham Equipment, Inc.
2151 Dreer Street
Philadelphia, PA 19125
Phone: (215) 739-7474
Fax: (215)-426-1260
Website: www.weldsale.com

b. Model: WS55B and WS55BNS with Accessories

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Acorn Iron & Supply Company, Inc.
915 North Delaware Avenue
Philadelphia, PA 19123
Phone: (610) 287-3788
Fax: (610) 287-3396
Website: www.acorniron.com

b. Brodhead-Garrett
100 Paragon Parkway
Mansfield, OH 43903
Phone: (419) 589-8222
Fax: (877) 256-3739
Website: www.brodheadgarret.com

2.3 WORKBENCH, ELECTRONICS, ANTI-STATIC TOP, 2 CABINET
Equipment Mark Number: 1800

A. Capacities and Dimensions:

1. Overall dimensions:

a. Length: 72 inches.

b. Depth: 30 inches.

c. Height: 49 inches.

2. Workstation top:

a. Length: 72 inches.

b. Depth: 30 inches.

c. Height (above finished floor): 33-1/2 inches.

3. Aerial shelf:

a. Depth: 12 inches.

b. Length: 72 inches.

c. Height (above top workstation): 14 inches.

4. Lower recessed shelf:

a. Depth: 12 inches.

b. Length: 42 inches.

c. Height (above finished floor): 14 inches.

5. Left-hand cabinet (one each):

a. Depth: 27-3/4 inches.

b. Length: 15 inches.

c. Height: 32 inches.

d. Drawer quantity: four each.

e. Drawer heights:

1) 4-1/2 inches, one each.

2) 6 inches, two each.

3) 12 inches, one each.

6. Right-hand cabinet (one each):

a. Depth: 28 1/2 inches.

b. Length: 13-1/2 inches.

c. Height: 28-3/8 inches.

d. Door quantity: one each.

B. Features and Construction:

1. Workstation top: Industrial quality static dissipative top shall have 10^6 to 10^9 OHMS per square inch resistivity and be constructed of 1-1/2 inch static dissipative plastic laminate with grounding kit. The top shall be supported by steel cabinets on each end, with 13 gauge steel legs.

2. Aerial shelf: Shelf shall be constructed of the same material as the workstation top and supported by steel supports on each end. Each shelf support shall have factory installed UL recognized fused electric outlets.

3. Lower recessed shelf: Shelf shall be constructed of 14 gauge steel and supported by steel cabinets on each end.

4. Cabinets: Cabinets shall be constructed of 16 gauge steel with locks and 100 percent extendable and 100 pound capacity drawers.

C. Utilities Available: 120 VAC, 20 A.

D. Finish: Durable enamel in manufacturer's standard color.

E. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Equipto
225 Main Street
Tatamy, PA 18085
Phone: (800) 323-0801
Fax: (888) 859-2121
Website: www.equipto.com

b. Model: 389R6C

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Lyon Workspace Products
420 North Main
Montgomery, IL 60538
Phone: (630) 892-8941, (800) 433-8488
Fax: (800) 367-6681
Website: www.lyonworkspace.com

b. Stanley Vidmar
Queen City Airport Park
11 Grammes Road
Allentown, PA 18103
Phone: (610) 797-6600, (800) 523-9462
Fax: (610) 776-3895
Website: www.stanleyvidmar.com

2.4 WORKBENCH, ELECTRONICS, ANTI-STATIC TOP, 6 FOOT
Equipment Mark Number: 1802

A. Capacities and Dimensions:

1. Overall dimensions:

a. Length: 72 inches.

b. Depth: 30 inches.

c. Height: 33-1/2 inches.

2. Workstation top:

a. Length: 72 inches.

b. Depth: 30 inches.

c. Height (above finished floor): 33-1/2 inches.

3. Lower recessed shelf:

a. Depth: 12 inches.

b. Length: 66 inches.

c. Height (above finished floor): 14 inches.

4. Pedestal legs (two each):

a. Depth: 27-3/4 inches.

b. Length: 3 inches.

c. Height: 32 inches.

B. Features and Construction:

1. Workstation top: Industrial quality static dissipative top shall have 10^6 to 10^9 OHMS per square inch resistivity and be constructed of 1-3/4 inch static dissipative plastic laminate with grounding kit. The top shall be supported by steel pedestals on each end.

2. Lower recessed shelf: Shelf shall be constructed of 14 gauge steel and supported by steel pedestals on each end. Provide full height modesty panel behind shelf extending from finished floor to workstation top.

3. Pedestals: Pedestals shall be constructed of 16 gauge steel and include factory installed UL recognized fused electric outlets

C. Utilities Available: 120 VAC, 20 A.

D. Finish: Durable enamel in manufacturer's standard color.

E. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Equipto
225 Main Street
Tatamy, PA 18085
Phone: (800) 323-0801

Fax: (888) 859-2121
Website: www.equipto.com

b. Model: 388-6C

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Lyon Workspace Products
420 North Main
Montgomery, IL 60538
Phone: (630) 892-8941, (800) 433-8488
Fax: (800) 367-6681
Website: www.lyonworkspace.com

b. Stanley Vidmar
Queen City Airport Park
11 Grammes Road
Allentown, PA 18103
Phone: (610) 797-6600, (800) 523-9462
Fax: (610) 776-3895
Website: www.stanleyvidmar.com

2.5 WORKBENCH, SEVERE USE, WITH CABINETS
Equipment Mark Number: 1862

A. Capacities and Dimensions:

1. Bench top:

a. Capacity: 10,000 pounds.

b. Bench height: 31 inches.

c. Lip height: 3 inches.

2. Drawer:

a. Quantity: 1.

b. Capacity: 400 pounds.

c. Dimensions, nominal: 26 inches wide by 6 inches high by 26 inches deep.

3. Cabinets:

a. Quantity: 3.

b. Width: 26 inches.

c. Depth: 26 inches.

d. Height:

1) 17 inches, 1 cabinet each.

2) 26 inches, 2 cabinets each.

e. Shelves: 1 shelf per cabinet, 1800 pound capacity per shelf.

4. Overall dimensions, nominal:

a. Width: 84 inches.

b. Depth: 30 inches.

c. Height: 34 inches.

5. Weight, nominal: 675 pounds.

B. Features and Construction: Cabinets shall include three-point locking systems. Drawer shall be lockable and include ball bearing pull-out system. Workbench unit shall be of all welded construction and conform to American Welding Society standards. Bench top and legs shall be 7-gauge steel, cabinet shelves shall be 14-gauge steel, and all other surfaces shall be of 12-gauge steel construction.

C. Finish: Durable enamel in manufacturer's standard color.

D. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Strong Hold
P. O. Box 9043
Louisville, KY 40209
Phone: (800) 880-2625
Fax: (502) 363-3827
Website: www.strong-hold.com

b. Model: 73-WB-303-1DB

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Penn Equipment & Tool Corporation
207 Washington Avenue
Dravosburg, PA 15034
Phone: (412) 466-8900,
Fax: (412) 466-4345
Website: www.pennequipment.com

b. Global Equipment Company
2505 Mill Center Pkwy

Buford, GA 30518
Phone: (770) 822-5600, (800) 645-1232
Fax: (800) 336-3818
Website: www.globalindustrial.com

2.6 WORKBENCH, SEVERE USE, WOOD TOP
Equipment Mark Number: 1864

A. Capacities and Dimensions:

1. Bench top:

a. Capacity: 10,000 pounds.

b. Wood top thickness: 1-3/4 inches.

c. Bench height: 37 inches.

2. Cabinet:

a. Quantity: 1.

b. Width: 66 inches.

c. Depth: 32 inches.

d. Height: 30 inches.

e. Shelves: 1 shelf, 2300 pound capacity.

3. Overall dimensions, nominal:

a. Width: 72 inches.

b. Depth: 36 inches.

c. Height: 37 inches.

4. Weight, nominal: 650 pounds.

B. Features and Construction: Workbench shall include full-length solid maple work surface. Lower cabinet shall be lockable and have a full-width adjustable shelf. Workbench unit shall be of all welded construction and conform to American Welding Society standards. Bench top shall be 7-gauge steel, cabinet shelf shall be 14-gauge steel, and all other surfaces shall be of 12-gauge steel construction.

C. Finish: Durable enamel in manufacturer's standard color.

D. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Strong Hold
P. O. Box 9043

Louisville, KY 40209
Phone: (800) 880-2625
Fax: (502) 363-3827
Website: www.strong-hold.com

b. Model: 63-361-MT

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Penn Equipment & Tool Corporation
207 Washington Avenue
Dravosburg, PA 15034
Phone: (412) 466-8900,
Fax: (412) 466-4345
Website: www.pennequipment.com

b. Global Equipment Company
2505 Mill Center Pkwy
Buford, GA 30518
Phone: (770) 822-5600, (800) 645-1232
Fax: (800) 336-3818
Website: www.globalindustrial.com

2.7 BUFFER/GRINDER, 8 INCH, WITH DUST COLLECTOR
Equipment Mark Number: 2080

A. Capacities and Dimensions:

1. Buffer/grinder:

a. Motor: 3/4 horsepower (HP), 3600 revolutions per minute (RPM).

b. Wheel:

1) Diameter: 8 inches.

2) Thickness: 1 inch.

3) Bore: 3/4 inch.

c. Wheel spacing: 16-5/8 inches.

d. Height to center of spindle: 43-7/8 inches.

2. Dust collector:

a. Motor: 1/2 HP, 3,600 RPM.

b. Base dimensions:

1) Width: 22 inches.

2) Depth: 16 inches.

3. Overall dimensions, nominal:

a. Width: 26 inches.

b. Depth: 20 inches.

c. Height: 50 inches.

4. Weight: 235 pounds.

B. Features and Construction:

1. Buffer / Grinder motor: Motor shall be totally enclosed, non-vented (TENV), direct drive, and rated for continuous service, with permanently lubricated ball bearings.

2. Grinding wheels: Unit shall be provided standard, with two grinding wheels; one coarse and one medium grit.

3. Wheel guards: Guards shall be adjustable for wheel wear, and provided with exhaust outlets, adjustable work rests, and spark breakers.

4. Dust collector: The body of the dust collector shall be the cabinet base for the buffer grinder, and fully support it. The dust collector shall have front-opening doors for access to motor and filters, and removable dust drawer. The dust collector shall meet OSHA ventilation standards, and shall include a spark trap. The dust collector motor shall be a totally enclosed, fan cooled (TEFC) type.

5. Conduits: Flexible dust collection conduits shall permit guard adjustment without disturbing connections.

6. Quenching pot: Pot shall be mounted on grinder base between wheels.

7. Power cord: Unit shall be provided with connections for hookup to fused disconnect. Connections shall be as follows:

a. Grinder Connection: 3 pole, 4 wire grounding – J-box connection with shared Electrical Disconnect

b. Dust Collector Connection: 3 pole, 4 wire grounding – J-box connection with shared Electrical Disconnect.

C. Controls: Pushbutton safety starter shall have ON/OFF pushbutton switch; motor thermal overload and under voltage protection. Switching and other electrical controls shall meet applicable National Electrical Code requirements.

D. Accessories:

1. Illuminated eyeshields installed with transformer, Cincinnati No. 000-131, one set of two each per grinder.

2. Push button magnetic starter with overload and under voltage protection, Cincinnati No. 000-532.

E. Utilities Available: 460 VAC, 3 phase, 1-1/4 HP (total).

F. Finish: Durable enamel in manufacturer's standard color.

G. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Cincinnati Electrical Tool, Inc.
5928 State Route 128
Cleves, Ohio 45002
Phone: (513) 941-5000
Fax: (513) 353-4040
Website: www.cincinnatielectrical.com

b. Model: 602-134 with Accessories

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Delta Power Equipment Corp.
246 Alpha Drive
Pittsburgh, PA 15238
Phone: (412) 963-2400, (800) 223-7278
Website: www.deltamachinery.com

b. Baldor Electric Company
5711 R.S. Boreham, Jr. Street
Fort Smith, AK 72908
Telephone: (501) 646-4711
Fax: (501) 648-5785
Website: www.baldor.com

2.8 DRILL PRESS, VARIABLE SPEED, 20 INCH
Equipment Mark Number: 2215

A. General:

1. Description: An upright, free standing and floor mounted, electrically powered variable speed drill press with manually adjustable work table and with manually adjustable feed handle. The drill press shall be designed specifically for the drilling of holes into various metals, including various types of steel and iron.

2. Compliance: The equipment shall comply with the latest edition of all applicable local, state, and federal codes and regulations. The equipment shall also comply with the following:

   a. National Fire Protection Administration (NFPA) 70: National Electric Code (NEC), most recent edition.

B. Capacities and Dimensions:

1. Motor: 1-1/2 horsepower (HP), 1,725 revolutions per minute (RPM).

2. Spindle:

   a. Speeds: Infinitely variable, 300 to 2,000 RPM.

3. Drilling capacities:

   a. Steel: 7/8 inch diameter hole, minimum.

   b. Cast iron: 1-1/8 inch diameter hole, minimum.

4. Drill to center of circle: 20 inches diameter.

5. Quill diameter: 2.5 inches diameter, nominal.

6. Spindle nose: #3 Morse Taper; 1.74 inches outside diameter (OD), nominal.

7. Spindle travel: 6.5 inches, nominal.

8. Spindle to table: 33.125 inches, maximum.

9. Spindle to base: 43.375 inches, maximum.

10. Column diameter: 4 inch, 3/8 inch thick wall, nominal.

11. Table working surface:

   a. Width: 22 inches, nominal.

   b. Depth: 19.5 inches, nominal.

   c. Table vertical travel range: 20 inches, nominal.

   d. T-slots: two, each 15.5 inches long, at 9 inch centers, nominal, for 0.5 inch t-bolts.

12. Base:

   a. Width: 13 inches, nominal.

   b. Depth: 15.5 inches, nominal.

   c. Base T-slots: two, each 13 inches long, at 9 inch centers, nominal, for 0.5 inch t-bolts.

13. Overall dimensions, nominal:

    a. Width: 22 inches.

    b. Depth: 36 inches.

    c. Height: 69 inches.

14. Weight, nominal: 630 pounds.

C. Features and Construction:

1. Speed control: Speed control shall be operable while machine is running and shall hold speed setting constant under all rated load conditions.

2. Belt drive: Alignment and tension of belt shall be automatically maintained.

3. Bearings: Spindle assembly shall be supported by not fewer than eight permanently lubricated ball bearings.

4. Work table: Two T-slots shall be provided for worktable.

5. Table lock: Expanding bushing table lock shall be provided for positioning of table at various angles.

6. Floor base: Two full-length T-slots shall permit insertion of T-bolts from front and rear.

7. Safety features:

    a. Chuck key: Unit shall include self-ejecting chuck key.

    b. Guard: Steel clip on guard shall completely enclose spindle.

8. Spindle: No. 3 Morse Taper shall accept accessory Jacobs type chuck for use with standard bits.

9. Motor: Motor shall be totally enclosed, fan cooled (TEFC).

10. Depth control: Self-locking adjustment depth stop shall be provided for feed.

11. Table adjustment: Hand gear crank shall permit table elevation.

12. Function controls: Knobbed spoke wheels shall be provided for manual speed selection and feed.

13. Power cord: Unit shall be provided with a minimum 6-foot power cord and plug compatible with facility's receptacles.

D. Controls: 24 volt pushbutton control station with shrouded START button and protruding STOP button, magnetic starter with transformer and no-voltage/low-voltage and three leg overload protection. Switches and other electrical controls shall meet applicable National Electrical Code requirements.

E. Accessories:

1. Magnetic Starter and Reversing Drum Switch, Clausing No. 2377MT, one each, installed.

2. Drill Chuck, key type, Clausing No. 1897, one each.

F. Utilities Available:

1. Electrical: 440 VAC, 3 phase, 3 Amps (1-1/2 HP).

G. Finish: Durable enamel in manufacturer's standard color.

H. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Clausing Industrial
1819 North Pitcher Street
Kalamazoo, MI 49007
Phone: (800) 323-0972; (269) 345-5945
Fax: (269) 345-5945
Website: www.clausing-industrial.com

b. Model: 2274 with Accessories

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers may be considered as equal.

2.9 MACHINE, PIPE THREADING
Equipment Mark Number: 2422

A. General:

1. Description: Machine for threading, reaming, and cutting of metal pipe of various diameters.

B. Capacities and Dimensions:

1. Motor: 1/2 HP, electric.

2. Nominal dimensions:

a. Length: 33-3/4 inches.

b. Width: 20 inches.

c. Height: 19 inches.

3. Threading capacity:

a. Pipe: 1/8 inch through 2 inches.

b. Bolt: 1/4 inch through 1 inches.

4. Cutting capacity: 1/8 inch through 2 inches.

5. Reamer capacity: 1/8 inch through 2 inches.

6. Spindle speeds: 45 and 16 RPM.

7. Shipping weight, nominal: 240 pounds.

C. Features and Construction:

1. Chuck: Automatic chucking system shall center and grip material.

2. Oiling: Through-head oiling shall insure constant and proper lubrication of dies and workpiece.

3. Filtration: Unit shall have triple filtration.

4. Cutter: Cutter shall be full-floating and self-centering.

5. Pump: Pump shall be self-priming.

6. Transmission: Unit shall have a two speed transmission with a shift-able cone type clutch.

7. Standard equipment:

a. Power cord: 15 foot oil resistant cord, one each.

b. Oil: One gallon can of cutting oil, one each.

c. Cutter, one each.

d. Cutter wheel: 1/8 to 2 inch roll type cutoff, one each.

e. Reamer: 1/8 inch through 2 inches, one set each.

f. Die head, one each.

g. Dies:

1) Alloy, NPT: 1/2 to 3/4 inch, one set each.

2) High-speed, NPT: 1 to 2 inch, one each.

D. Controls: OPEN-OFF-CLOSE, toggle type, recessed power switch, reversing toggle switch, integral foot switch, and other electrical controls shall meet applicable National Electrical Code requirements.

E. Utilities Available:

1. Electrical: 120 VAC, 1 Phase,1/2 HP.

F. Finish: Durable enamel in manufacturer's standard color.

G. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Reed Manufacturing Company
1425 West 8th Street
Erie, PA 16502
Phone: (814) 452-3691, (800) 666-3691
Fax: (814) 455-1697, (800) 456-1697
Website: www.reedmfgco.com

b. Model: 5401TMSO with Accessories

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, may be considered as equal.

2.10 PRESS, HYDRAULIC, 20 TON
Equipment Mark Number: 2539

A. Capacities and Dimensions:

1. Overall dimensions:

a. Width: 31 inches.

b. Depth: 30 inches.

c. Height: 74 inches.

2. Capacity: 20 tons.

3. Inside width: 24 inches.

4. Width between table rails: 5 inches.

5. Maximum vertical clearance: 37-1/2 inches.

6. Ram travel: 6 inches.

7. Ram diameter: 2-1/4 inches.

8. Cylinder bore: 2-1/4 inches.

9. Left to right cylinder movement: None, cylinder fixed at center.

10. Shipping weight, nominal: 265 pounds.

B. Features and Construction:

1. Head and bed rails: Constructed of 6 inch channel steel with channel ends and corners cut and ground.

2. Pump: Single speed hand operated hydraulic pump with spring loaded chevron packing and hardened and ground pump plungers with bronze guides in honed cylinders.

3. Table: Vertically adjustable with self-locking table winch.

4. Gauge: Large dial-type pressure gauge mounted with pump controls on outside of frame isolating gauge from mechanical shock.

5. Equipment protection: Ram travel limit valve to prevent overextension of ram and maximum capacity relief valve to prevent loading more than 110 percent of press capacity.

6. Standard equipment: Two flat parallels and two V-blocks.

C. Finish: Durable enamel in manufacturer's standard color.

D. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Nugier Press Company, Inc.
18031 La Salle Avenue
Gardena, CA 90248
Phone: (310) 515-6025
Fax: (310) 527-7362
Website: www.nugier.com

b. Model: H20-6

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Dake, Division of JSJ Corporation
724 Robbins Road
Grand Haven, MI 49417
Phone: (616) 842-7110, (800) 937-3253
Fax: (800) 846-3253
Website: dake-div-jsjcorp.com

b. OTC Division of SPX
655 Eisenhower Drive
Owatonna, MN 55060
Phone: (507) 455-7000, (800) 533-6127
Fax: (507) 455-8354
Website: www.otctools.com

2.11 SAW, TABLE, TILTING ARBOR, 14 INCH
Equipment Mark Number: 2725

A. Capacities and Dimensions:

1. Motor: 3450 RPM.

2. Diameter of arbor: 1 inch.

3. Diameter of saw blade: Up to 14 inches.

4. Maximum depth of cut: 5-1/8 inches

a. At 45 degrees: 3-1/2 inches

5. Maximum rip to right of blade: 50 inches.

6. Maximum rip to left of blade: 14 inches.

7. Maximum width of dado: 13/16 inch.

8. Table height: 35 inches.

9. Table size (L x W): 38 by 26 inches.

a. With standard extension: 38 by 48 inches

10. Chip exhaust opening: 4 inch.

11. Overall dimensions:

a. Width: 84 inches.

b. Depth: 53 inches.

c. Height: 42 inches.

12. Weight: 750 pounds, nominal.

B. Features and Construction:

1. Blade stops: Adjustable from the top of the table.

2. Blade guard: Capable of being stowed without detaching from machine.

3. Magnetic starter and automatic reset overload shall be included as standard.

4. Drive system: Shall be enclosed in steel cabinet, fan cooled, and the Poly-V drive belt system results in quieter, more efficient power transfer with virtually no vibration and less heat build-up. A wide-stance trunnion and concave teeth on the trunnion gears promote smooth blade raising/tilting. The riving knife rises and lowers with the blade, substantially reducing kickback risk; and both riving knife and blade guard each have a quick-release, so mounting and removing them is fast and tool-free.

5. Table: Extra large for handling large stock, shall be a fully machined working surface with heavily ribbed underside to prevent distortion. Shall have polished cast iron finish.

6. Arbor locking mechanism: Push button arbor lock (patent pending) for rapid blade change. Locking button shall emerge close to table surface when blade is in full upright position. Button shall be depressed in order to lock arbor for blade changing and shall retract when button is released.

7. Adjustable miter gage: Shall have heavy-duty micro adjustable miter gauge with aluminum extruded fence, for good work-piece guidance and fine angle adjustments. This allows for cuts to be made at angle or straight. Locking lever shall secure miter at desired angle of cut, angle of cut shall be determined by adjustable angle indicators (patent pending) on the blade bevel scale for repeatable bevel cuts

8. Chip Exhaust: Shall exhaust wood chips and sawdust efficiently due to self-adjusting exhaust chute and large diameter waste outlet.

9. Rip fence: The rip fence system shall operate in vertical or horizontal position, with forward operating capability for ripping solid stock safely. Fence must travel effortlessly along guide bar, and must be capable of being positioned precisely due to calibrated scale. Fence adjustments shall be securely held in place by locking levers and knobs.

C. Controls: ON switch shall be a green concaved button and the off button shall red and exposed. Large diameter hand wheel shall operate blade raising and tilting and must lock in place with hand knob to ensure desired blade height or angle. Unit controls must be located to the front of the machine for easy access.

D. Accessories:

a. Dado insert for PM3000, Model No. 1791081, one each.

E. Utilities Available: 230 VAC, 3 phase, 7 1/2 HP.

F. Finish: Durable enamel in manufacturer's standard color. Polished cast iron table.

G. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Powermatic
427 Sanford Road
LaVergne, TN 37086
Phone: (931) 473-5551, (888) 804-7129
Fax: (800) 274-6840
Website: www.powermatic.com

b. Model: PM3000 w/ accessories.

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. DoAll Company
254 North Laurel Avenue
Des Plaines, IL 60016
Phone: (847) 824-8191, (800) 923-6255
Fax: (847) 699-1946
Website: www.doall.com

b. Grizzly Industrial, Inc.
1815 W. Battlefield
Springfield, MO 65807
Phone: (1-800)-523-4777
Fax: (1-800)-438-5901
Website: www.grizzly.com

2.12 VISE, COMBINATION, SWIVEL BASE, 5 INCH
Equipment Mark Number: 2832

A. Capacities and Dimensions:

1. Jaw width: 5 inches.

2. Jaw opening: 6 inches.

3. Throat depth: 6-1/4 inches.

4. Pipe capacity: 1/8 to 4-1/2 inches.

5. Overall dimensions, nominal:

   a. Length: 14 inches.

   b. Width: 8 inches.

   c. Height: 10 inches.

6. Weight, nominal: 95 pounds.

B. Features and Construction:

1. Slide bar: Machined steel slide bar with oil port shall operate in machined channel.

2. Base: 360 degree swivel base shall include locking device.

3. Construction: Semi-steel cast body shall include hardened tool steel nut and screw.

4. Jaws: Main and pipe jaw facings shall be replaceable.

5. Wear compensation: Adjustable collar shall eliminate handle slack.

C. Finish: Durable enamel in manufacturer's standard color.

D. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

   a. Reed Manufacturing Company
      1425 West 8th Street
      Erie, PA 16502
      Phone: (814) 452-3691, (800) 666-3691
      Fax: (814) 455-1697, (800) 456-1697
      Website: www.reedmfgco.com

   b. Model: 3CA

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

   a. Ridge Tool Company
      400 Clark Street
      Elyria, OH 44036
      Phone: (440) 323-5581, (888) 743-4333
      Fax: (800) 873-2160
      Website: www.ridgid.com

   b. Wilton - WMH Tool Group, Inc.
      2420 Vantage Drive

Elgin, Illinois 60123
Phone: 847-851-1000, 1-800-274-6848
Fax: 847-851-1045
Website: www.wmhtoolgroup.com

2.13 VISE, SWIVEL BASE, ELECTRONICS
Equipment Mark Number: 2880

A. Capacities and Dimensions:

1. Maximum jaw opening: 12 inches.

2. Jaw length: 6 inches.

B. Features and Construction:

1. Mounting: Cast metal, 8-1/2 inch diameter mounting shall include integrally cast tray compartments and slip-resistant neoprene pads.

2. Base: Cast metal base shall include machined split-ball and control knob for full 360 degrees positioning of head in any plane.

3. Jaws: Aluminum, "V"-grip groove jaws shall be adjustable on cross-bar from 0 inches to 12 inches and shall hold printed circuit boards up to 5/32 inch in thickness.

4. Solder station: Combination soldering iron holder and controlled feed solder spool holder shall attach to mounting base.

C. Accessories:

1. Standard head: Standard vise head, interchangeable with printed circuit board holder with 2-1/2 inch wide nylon lined jaws and maximum opening of 2-1/4 inches, Panavise No. 303, one each.

2. Vacuum base: For mounting vise base on smooth surfaces, Panavise No. 380, one each.

3. Wide opening head: Interchangeable with printed circuit board holder and standard head to provide full 6 inch opening, Panavise No. 366, one each.

D. Finish: Durable surface treatment per manufacturer's standard.

E. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. PanaVise Products, Inc.
7540 Colbert Drive
Reno, NV 89511-1225
Phone: (775) 850-2900, (800) 759-7535
Fax: (775) 850-2929, (800) 395-8002
Website: www.panavise.com

b. Model: 324 with Accessories

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Ridge Tool Company
400 Clark Street
Elyria, OH 44036
Phone: (440) 323-5581, (888) 743-4333
Fax: (800) 873-2160
Website: www.ridgeid.com

b. Wilton Corporation
300 South Hicks Road
Palatine, IL 60067
Phone: (847) 934-6000, (800) 543-3224
Fax: (847) 934-6730
Website: www.wiltoncorp.corp

2.14 TRUCK, PLATFORM, WOOD DECK
Equipment Mark Number: 5960

A. Capacities and Dimensions:

1. Capacity: 1400 pounds.

2. Caster size: 6 by 2 inches.

3. Overall dimensions:

a. Width: 24 inches.

b. Length: 48 inches.

c. Height (deck): 9-3/4 inches.

d. Height (handle): 26 inches from deck.

B. Features and Construction:

1. Frame: Shall be constructed of a 2 x 2 x 3/16 inch angled steel frame.

2. Deck: Shall consist of Oak broads varying in size between 4 and 8 inches, which shall be flush with top of steel frame.

3. Casters: Two swivel and two rigid casters.

4. Wheels: Equipped with self-lubricating bearing soft rubber wheels.

5. Handle: Removable push handle included as standard.

C. Finish: Durable enamel in manufacturer's standard color.

D. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Hamilton Castor & Manufacturing Co.
1637 Dixie Highway
Hamilton, OH 45011
Phone: (513) 863-3300, (800) 733-7655
Fax: (513) 863-5508, (800) 232-3733
Website: www.hamiltoncaster.com

b. Model: PB1106-A-R2448

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. Hodge Manufacturing Company, Inc.
55 Fisk Avenue
Springfield, MA 01107
Phone: (413) 781-6800, (800) 262-4634
Fax: (413) 733-6573, (888) 262-4634
Website: www.hodgemfg.com

b. Global Industrial Equipment
120B Satellite Blvd.
Suwanee, GA 30024
Phone: (770) 995-0007, (800) 645-1232
Fax: (800) 336-3818
Website: www.globalindustrial.com

2.15 LAMP, WORKBENCH WITH MAGNIFIER
Equipment Mark Number: 7421

A. Capacity and Dimensions

1. Overall dimensions:

a. Length: 45 inches.

b. Width: 5 inches.

c. Height: 45 inches.

2. Weight: 3 pounds.

B. Features and Construction :

1. Electrical Connection: 9 foot - three prone conductor cord

2. Lens: 3-diopter distortion free glass lens

3. Clamp: Fully adjustable zinc cast clamp

4. Arm: 45 inch spring balanced arm

5. Lamp: 5 inch diameter with an 22w bulb

C. Utilities: 120 VAC, 1 ph, 10 A.

D. Manufacturers Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

a. Grainger, Incorporated
5959 West Howard Street
Niles, Illinois 60714
Telephone: (847) 965-7600

b. Model: 6VT78

2. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

a. DoAll Company
254 North Laurel Avenue
Des Plaines, Illinois 60016
Telephone: (847) 824-8191, (800) 923-6255

PART 3 - EXECUTION

3.1 INSPECTION

A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.

B. Inspect delivered equipment for damage from shipping and exposure to weather.

C. Compare delivered equipment with packing lists and specifications to assure receipt of all items.

3.2 INSTALLATION

A. Perform work under direct supervision of Foreman or Construction Superintendent with authority to coordinate installation of scheduled equipment with CTDOT PM.

B. Install equipment in accordance with plans, shop drawings and manufacturer's instructions:

1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level, plumb and at right angles to adjacent work.

2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.

3. Anchorage: Attach equipment securely to floor, as directed by CTDOT PM, to prevent damage resulting from inadequate fastening. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.

4. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.

3.3 TESTING

A. After final connections are made and prior to authorizing payment, specified equipment shall be tested for compliance with all specified features in the presence of the CTDOT PM using acceptance procedures provided by the manufacturer.

3.4 CLEANUP

A. Touch-up damage to painted finishes.

B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.

C. Clean area around equipment installation and remove packing or installation debris from job site.

D. Notify CTDOT PM for acceptance inspection.

E. Provide a Windows compatible movie file format recording on DVD disk of the training session. The DVD training movie can be of a live session or a produced training video.

END OF SECTION 11 96 00

SECTION 12 24 00 - WINDOW SHADES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Clutch Operated Manual Roller Window Shades and Accessories.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Concealed wood blocking for attachment of headrail brackets.

B. Section 09 21 16 - Gypsum Board Assemblies: Substrate for window shade systems.

1.3 REFERENCE STANDARDS

A. NFPA 701 Standard Methods of Fire Tests for Flame Propagation of Textiles and Films; 2010.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Do not fabricate shades until field dimensions for each opening have been taken.
   2. Do not install shades until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.

C. Shop Drawings: Include shade schedule indicating size, location and key details.

D. Certificates: Manufacturer's documentation that line voltage components are UL listed or UL recognized.

E. Selection Samples: Include fabric samples as indicated on drawings.

F. Verification Samples: Minimum size 6 inches square, representing actual materials, color and pattern.

G. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with no less than five years of experience.

B. Installer Qualifications: Company specializing in performing work of this type with minimum 5 years of experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.

B. Handle and store shades in accordance with manufacturer's recommendations.

1.8 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 WARRANTY

A. See Section 01 78 30 –Warranties and Bonds, for additional warranty requirements.

B. Provide manufacturer's warranty from the Date of Substantial Completion, covering the following:
   1. Shade Hardware: eighteen months.
   2. Fabric: eighteen months.
   3. Aluminum and Steel Coatings: eighteen months.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Clutch Operated Manual Roller Window Shades: Draper, Clutch Operated FlexShade with 5% Opacity, Sheerweave #2390, Charcoal/Alpaca: www.draperinc.com, or equal.

B. Other Acceptable Manufacturers::
   1. Lutron Electronics Co., Inc; www.lutron.com.
   2. Hunter Douglas; www.hunterdouglas.com.
   3 Substitutions: See Section 01 60 00 - Product Requirements.

2.2 WINDOW SHADE APPLICATIONS

A. Shades throughout.
   1. Type: Roller shades.
   2. Mounting: Inside

2.3 ROLLER SHADES

A. Roller Shades: Fabric roller shades complete with mounting brackets, roller tubes, hembars, hardware and accessories; fully factory-assembled.
   1. Drop: Regular roll - steel or extruded aluminum. Roller assembly easily removable.
   2. Spring-assist Bead chain clutch, stainless steel, right mounted.
   3. Mounting brackets.
   4. Roller idler assembly: Fiberglass reinforced polyester thermopolymer with spring-loaded pin to interlock with mounting bracket.
   5. Endcaps.
   7. Endcap covers.
   8. Fascia: L-shaped, extruded aluminum, clear anodized finish.
   9. Headbox: consists of Fascia, L-shaped cover, clear anodized finish.
   10. Size: As indicated on drawings.

B. Fabric: PVC coated fiberglass, woven into a full basket weave designed expressly for those applications which require a more opaque and nondirectional fabric. 35 percent fiberglass 65 percent vinyl on fiberglass.
   1. Flammability: Pass NFPA 701 large and small tests.
   2. Openness factor: 5 percent.
   3. Average fabric thickness: 0.017 inch.
   4. Average Face weight: 11.90 ounces per square yard.
   5. Bacterial and fungal resistance: ASTM 2180.
   6. UV blockage: 95 percent.

C. Hembars and Hembar Pockets: Wall thickness designed for weight requirements and adaptation to uneven surfaces, to maintain bottom of shade straight and flat.

2.4 ACCESSORIES

A. Brackets and Mounting Hardware: As recommended by manufacturer for mounting configuration and span indicated.

B. Fasteners: Non-corrosive, and as recommended by shade manufacturer.

2.5 FABRICATION

A. Fabricate shades to fit openings within specified tolerances.

1. Vertical Dimensions: Fill openings from head to sill with 1/2 inch space between bottom bar and window sill.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.

B. Installation Tolerances:

1. Maximum Offset From Level: 1/16 inch.

C. Adjust level, projection and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth operation.

3.2 CLEANING

A. Clean soiled shades and exposed components as recommended by manufacturer.

B. Replace shades that cannot be cleaned to "like new" condition.

3.3 PROTECTION

A. Protect installed products from subsequent construction operations.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 12 24 00

SECTION 13 34 23.10 - PRE-FABRICATED HAZARDOUS MATERIALS STORAGE STRUCTURES

PART 1 - GENERAL

The General Provisions of the Trade Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.1 WORK INCLUDED

A. Equipment items as listed below by Equipment Mark Number:

1. BUILDING, STORAGE, HAZARDOUS MATERIALS, PREFABRICATED Equipment Mark Number: 9100

B. Roughing-in, installation of equipment, and final connection of utilities, with labor, services, and incidentals necessary for complete and operational equipment installation.

C. Piping, wiring, and switching between equipment and utilities.

1.2 QUALITY ASSURANCE

A. Experience: Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.

B. Manufacturer's Representative:

1. Installation: Provide a qualified manufacturer's representative at site to supervise work related to equipment installation, check out and start up.

2. Training: Provide technical representative to train Owner's maintenance personnel in operation and maintenance of specified equipment.

1.3 STANDARD AND REGULATORY REQUIREMENTS

A. Equipment indicated within this specification section shall comply with all applicable national, state and local codes and regulations, including seismic, fire, and racking codes and regulations. Additional, more specific compliance requirements may be listed under individual equipment headings.

1.4 SUBMITTALS

A. Refer to Section 11 06 00 Equipment Schedule for submittal requirements listed in the “Submittals” column of the equipment list. In the event of conflict between Section 11 06 00 Equipment Schedule and the following expanded submittal descriptions, Section 11 06 00 Equipment Schedule is to govern.

B. Shop Drawings: Submit Shop Drawings in accordance with Division 01 - General Requirements of these specifications. Refer to Section 11 06 00 Equipment Schedule for the equipment mark numbers requiring shop drawings.

1. Submitted shop drawings shall be project specific and shall include a minimum 1/8 inch to 1 foot scaled (or larger standard architectural imperial scale), dimensioned, graphical representation of the size, orientation, and location for the submitted equipment. The drawings shall further include dimensions from structural elements or architectural grid lines, operational clearances, locations of any utility service connection points, mounting requirements, and structural supports required for the submitted equipment.

1.5 WARRANTY

A. Warrant work specified herein for eighteen months from substantial completion against defects in materials, function and workmanship.

B. Warranty shall include materials and labor necessary to correct defects.

C. Defects shall include, but not be limited to noisy, rough, or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish.

D. Warranty: Submit warranties in accordance with Division 01 - General Requirements of these specifications.

E. All parts shall be readily available locally in the United States.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment is to be shipped on flatbed trailers.

B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Mark Number of this specification.

C. Provide equipment and materials specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.7 LABELING

A. Manufacturer shall securely attach in a prominent location on each major item of equipment a non-corrosive nameplate showing manufacturer's name, address, model number, serial number, and pertinent utility or operating data.

B. All electrical equipment and materials shall be new and shall be listed by Underwriter's Laboratories, Inc. (U.L.), or other National Recognized Testing Laboratory (NRTL), in categories for which standards have been set by that agency and labeled as such in the manufacturer's plant.

PART 2 – PRODUCTS

2.1 BUILDING, STORAGE, HAZARDOUS MATERIALS, PREFABRICATED
Equipment Mark Number: 9100

A. General Description:

1. Storage Unit shall be FM Approved 2 hour fire rated DENIOS Model L82-2413, as manufactured by DENIOS of Kentucky. The unit shall be provided from one manufacturer and not pieced together. Units should allow for additional room for personnel inspection around Totes/Drum pallets. Units must be designed to allow easy addition or removal of Totes/Drum pallets by fork truck.

B. Capacity and Dimensions:

1. Containment sump capacity: 202 gallons.

2. Design loads:

a. Roof snow load: 40 psf.

b. Wind load: 110 mph, Units must be anchored

c. Seismic condition: Zone 4 or Performance Category E.

3. Nominal Dimensions:

a. Each:

1) Length: 194 inches.

2) Depth: 75.5 inches.

3) Height: 138 inches.

4. Two storage tiers; two storage bays

5. Weight, nominal: 6,500 pounds. Clearance provided beneath the sump for forklift or crane strap access.

6. Storage capacity: Number of Storage Tiers – 2; Number of Bays – 2; Capacity per Bay (with 55 gal drums) - 12; Load Capacity per Bay to be 9,600 lbs. (grating); Total Capacity per Cabinet (with 55 gal drums) 24.

C. Features and Construction:

1. General description: Building shall be a free-standing, re-locatable storage and containment structure for the storage of flammable or combustible liquids and other hazardous materials.

2. Roll-up Doors – Provide UL classified, 3 hour rated steel roll-up doors

3. Construction:

a. Fully welded 11 gauge tubular and angle frame construction. Exterior walls of 16 gauge galvannealed steel sheet.

b. UL U425/505 two hour fire rated walls with corrosion-protection galvanized steel siding on the interior and exterior.

c. UL fire rated roof and ceiling assemblies have a Class A spread-of-flame rated roof covering of corrosion-protected heavy gauge steel.

d. Firewalls to be constructed using UL U505 listed and approved 2-hour fire rated designs. All doors and roof/ceiling are provided with compatible fire rated construction.

e. Provide flame resistant insulation with providing R-11 protection. Insulation is incorporated into the wall and roof/ceiling design. Insulation is to be layered between interior and exterior steel skin providing uniform temperature control.

4. Interior lighting: UL listed electric light designed for hazardous and corrosive environments. Light is rated for NEMA 4 and NEMA 7 class I, Division 1, Group C and D environments. Light is furnished with aluminum guard and 300 W incandescent bulbs. A weather tight switch will be placed on the outside of the unit.

5. Exterior lighting: 175-watt mercury vapor light designed for outdoor locations. Light includes photoelectric cell for automatic activation. Light has die-cast aluminum housing and acrylic refractor. (Light is detached for shipment and requires mounting on site). Light is designed to shine back into cabinet for interior illumination. Light will be 4-feet above roof to allow for fork truck mast clearance.

6. Door: Provide per unit, One (1) Lockable UL Classified, 3-hr Fire Rated Steel Roll Up Door UL Classified fire door with Key Lock. Door opening to provide full access. Provide heavy duty hold open mechanisms for each door. Unit to be one sided access.

7. Static grounding system: Unit will be supplied with a 10 foot copper clad grounding rod, six feet of #6 copper wire, and a grounding connector located on exterior corner of building.

8. Signage: D.O.T. hazard classification placard with rust-proof aluminum holder and stainless steel clips and pressure sensitive NFPA 704 Hazard Rating Signs shall be furnished and installed.

9. Electrical Components: All interior electrical fittings will be NEMA 7 rated for Class I, Div. 1, Group C and D environments unless otherwise specified. Exterior electrical boxes, housings, and controls will be NEMA 4 rated. Exterior conduit and fitting will be weather tight.

10. Sump Liner: Provide one unit with a corrosion resistant epoxy coating. Provide one unit with an Epoxy Liner. Liner to be divided evenly side to side.

11. Storage Platform: Sumps to be provided with removable non-slip heavy duty rated non-corrosive fiberglass grating (to support required loading plus safety

factor). Tier to be provided with heavy duty removable heavy duty rated non-corrosive fiberglass grating (to support required loading plus safety factor)

12. Ventilation: Passive ventilation system manually operated to be located on the exterior of the storage unit. To be weather resistant.

13. Placarding: Provide 2 (two) NFPA 704 placard kits per storage unit. Provide a numbering kit along with a Storage Unit operation, maintenance & installation manual.

D. Accessories:

1. Fire suppression system: Shall meet the Requirements of NFPA-17, FM approved, UL listed Dry Chemical Fire Suppression System. Nozzles with fusible link rated at 212°F. Fire Suppression system is to be a pre-engineered, stored pressure dry chemical type with a fixed nozzle distribution network. The system is to be capable of automatic detection and actuation as well as remote manual action. Audible electric (110V) alarm bell and manual pull station to be included. Manual pull station, dry chemical tank, and bell mounted on the outside of the cabinet. Controls are protected in a weather tight control box. Alarm System shall have the capability of being tied into and monitored by the facility alarm system.

   Note: Clearance immediately beneath the dry chemical nozzles is to be approximately 4 inches less than the inside clearances listed above.

2. Heating System: UL listed electric convection type heating system designed for hazardous locations. Heating system rated for NEMA 7, Class I, Groups B, C, & D / Division 1 & 2 environments. Heating system is rated at 3.6 KW (12,000 BTU) output, Single Phase, 240 Volt, 15 Amps. Heater is rated T-2A and is appropriate for use in areas where vapors or gases present do not possess ignition temperatures below 280°C (536°F). Other heat ratings and voltages available. System is designed to maintain 45 degrees F at –5 degrees F outside temperature.

3. Explosion relief: Explosion relief panels shall be provided.

E. Exterior/Interior Finish:

1. Interior walls (and sump) will be treated with a corrosion resistant epoxy coating.

2. Exterior walls will be coated with a UV resistant acrylic enamel.

3. Supply a can of exterior UV resistant acrylic enamel for touch up purposes.

4. Color: RAL 5100 (DENIOS Blue)

PART 3 - EXECUTION

3.1 INSPECTION

A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.

B. Inspect delivered equipment for damage from shipping and exposure to weather.

C. Compare delivered equipment with packing lists and specifications to assure receipt of all items.

3.2 INSTALLATION

A. To determine the recommended method of off-loading the building refer to MFR information. If a crane is required it is recommended that a qualified rigger be contacted to-off load the unit. After off-loading and anchoring the building, removal and discard of wooden blocks from door. The door will be locked and key located behind the D.O.T. placard.

B. Forklift Off-loading Instruction:

1. Off loading: Building is unstable when off-loading. Forks on lift must be 8”-0” and reach completely under the building.

C. Crane Off-loading:

1. All necessary spreader bars, chains and straps to be provided by others.

2. Full with spreader bars must be used in lifting building.

3. Lifting by us of straps only will result in damage to the exterior skin.

4. See building weights for recommended crane capacities.

5. Do not lift building using hold down angles.

6. Check overhead clearance for electrical hazards.

D. Foundation and Anchoring:

1. The unit shall be placed on a hard level surface. A one degree change in elevation of the slab is not acceptable. Please allow room for off-loading, daily usage and visual inspection under the building. A level concrete pad with fork lift access from the front is recommended.

E. Electrical Requirements and Installation:

1. A competent licensed electrician should conduct all wiring. The wiring shall conform to the latest edition of NFPA 70 National Electric Code and all state codes.

    a. Units shall be equipped with standard load center requiring 110V /208V, single phase power.

    b. All electrical shall be pre-wired to a load center located on the right end wall on the exterior of the building (unless location is otherwise specified) Please refer to submittal information prior to rough-in of electrical, and prior to making any electrical connections.

    c. Provide 70 Amp, 120/240 Volt, Single Phase service

F. Static Ground Kit:

1. Each Unit is shall be provided with a static electricity grounding kit. The kit consists:

    a. Building ground lug (attached to the base)

    b. Grounding Electrode Conductor (20 feet)

    c. Grounding Electrode with Lug (8 feet)

    d. Exterior Light: Install as per data sheet in installation manual

3.3 TESTING

A. After final connections are made and prior to authorizing payment, specified equipment shall be tested for compliance with all specified features in the presence of the CTDOT PM using acceptance procedures provided by the manufacturer.

3.4 CLEANUP

A. Touch-up damage to painted finishes.

B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.

C. Clean area around equipment installation and remove packing or installation debris from job site.

D. Notify CTDOT PM for acceptance inspection.

END OF SECTION 13 34 23.10

SECTION 14 20 10 - PASSENGER ELEVATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Complete elevator systems.

B. Elevator maintenance.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Elevator machine foundation.

B. Section 04 27 31 – Reinforced Unit Masonry: Masonry hoistway enclosure; building-in and grouting hoistway door frames.

C. Section 05 50 00 - Metal Fabrications: Pit ladder, Sill supports, divider beams, and overhead hoist beams.

D. Section 07 14 00 – Fluid Applied Waterproofing: Waterproofing of Elevator pit walls and floor.

1.3 REFERENCE STANDARDS

A. ASME A17.1 Safety Code for Elevators and Escalators; The American Society of Mechanical Engineers, 2010.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a meeting one week prior to starting work.

1. Review schedule of installation, installation procedures and conditions, and coordination with related work.

B. Construction Use of Elevator: Not permitted.

1.5 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures and Section 01 33 00.13 – Document Control.

B. Shop Drawings: Indicate the following information:

1. Locations of machine room equipment: driving machines, controllers, governors and other component.

2. Hoistway components: Car, counterweight, sheaves, machine and sheave beams, guide rails, buffers, ropes, and other components.

3. Rail bracket spacing; maximum loads imposed on guide rails requiring load transfer to building structural framing.
4. Electrical characteristics and connection requirements.

C. Product Data: Provide data on the following items:
1. Signal and operating fixtures, operating panels, indicators.
2. Cab design, dimensions, layout, and components.
3. Cab and hoistway door and frame details.
4. Electrical characteristics and connection requirements.

D. Maintenance Contract.

E. Maintenance Data: Include:
1. Parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
2. Technical information for servicing operating equipment.
3. Legible schematic of hydraulic piping and wiring diagrams of installed electrical equipment and changes made in the Work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with applicable code and as supplemented in this section.

B. Installer Qualifications: Employees and supervisor on payroll of elevator equipment manufacturer.

1.7 WARRANTY

A. See Section 01 78 30 – Warranties and Bonds, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Schindler; Product 330A Holeless Hydraulic Elevator.

B. Other Acceptable Manufacturers:
1. ThyssenKrupp Elevator; www.thyssenkruppelevator.com.
2. Otis Elevator Co; www.otis.com.
3. Substitutions: See Section 01 60 00 - Product Requirements.

C. All components to be manufactured by same entity, unless otherwise indicated.

2.2 ELEVATORS

A. Elevator No.1: Passenger, holeless hydraulic type with cylinder in hoistway.

1. Operation and Controls: Two-stop automatic.
2. Hoistway Doors and Frames: Stainless steel.
3. Door Operation: Side opening.
4. Rated Net Capacity: 3500 lbs.
5. Rated Net Speed: 125 fpm.
6. Travel Distance: As indicated on drawings.
7. Interior Finishes: As indicated on drawings.

2.3 CONTROLS

A. Elevator Controls: Provide landing buttons and hall lanterns.

B. Door Controls:

1. Program door control to open doors automatically when car arrives at floor.
2. Render "Door Close" button inoperative when car is standing at dispatching terminal with doors open.
3. If doors are prevented from closing for approximately ten seconds because of an obstruction, automatically disconnect door reopening devices, close doors more slowly until obstruction is cleared. Sound buzzer.
4. Door Safety Devices: Moveable, retractable safety edges, quiet in operation; equip with photo-electric light rays.

C. Landing Buttons: Stainless steel type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows.

D. Provide "Firefighter's Operation" in accordance with applicable code. Designated Landing: First Floor.

E. Landing Position Indicators: Illuminating White

F. Cab Direction Indicators: Illuminating White.

2.4 EMERGENCY POWER

A. Arrange elevator operation to operate under emergency power when normal power supply fails.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that hoistway, pit, and machine room are ready for work of this section.

C. Verify hoistway shaft and openings are of correct size and within tolerance.

D. Verify location and size of machine foundation and position of machine foundation bolts.

E. Verify that electrical power is available and of the correct characteristics.

3.2 PREPARATION

A. Arrange for temporary electrical power for installation work and testing of elevator components.

3.3 INSTALLATION

A. Install system components. Connect equipment to building utilities.

B. Provide conduit, boxes, wiring, and accessories.

C. Mount machines on vibration and acoustic isolators, on bed plate and concrete pad. Place on structural supports and bearing plates. Securely fasten to building supports. Prevent lateral displacement.

D. Accommodate equipment in space indicated.

E. Install guide rails using threaded bolts with metal shims and lock washers under nuts. Compensate for expansion and contraction movement of guide rails.

F. Accurately machine and align guide rails. Form smooth joints with machined splice plates.

G. Coordinate installation of hoistway wall construction.

H. Install hoistway door sills, frames, and headers in hoistway walls. Grout sills in place. Set entrances in vertical alignment with car openings and aligned with plumb hoistway lines.

I. Structural Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime two coats.

J. Machine Room Components: Clean and degrease; prime one coat, finish with one coat of enamel.

K. Adjust equipment for smooth and quiet operation.

3.4 ERECTION TOLERANCES

A. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1.

B. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

3.5 FIELD QUALITY CONTROL

A. Testing and inspection by regulatory agencies will be performed at their discretion.

1. Schedule tests with agencies and notify Owner.
2. Obtain permits required to perform tests.
4. Perform tests required by regulatory agencies.
5. Furnish test and approval certificates issued by authorities having jurisdiction.

3.6 ADJUSTING

A. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.

B. Adjust automatic floor leveling feature at each floor to achieve 1/4 inch from flush.

3.7 CLEANING

A. Remove protective coverings from finished surfaces.

B. Clean surfaces and components ready for inspection.

3.8 PROTECTION

A. Do not permit construction traffic within cab after installation of finished floor or after cleaning.

B. Protect installed products until project completion.

C. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

3.9 MAINTENANCE

A. See Section 01 78 23 – Operations and Maintenance Data, for additional requirements relating to maintenance service.

B. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer or original installer.

C. Provide service and maintenance of elevator system and components for eighteen months from Date of Substantial Completion.

D. Examine system components monthly. Clean, adjust, and lubricate equipment.

E. Include systematic examination, adjustment, and lubrication of elevator equipment. Maintain hydraulic fluid levels. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment. Replace wire ropes when necessary to maintain the required factor of safety.

F. Perform work without removing cars during peak traffic periods.

END OF SECTION 14 20 10

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 STIPULATIONS

A. The Specification Section "Division 01 General Requirements" form a of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The Specification Sections in Division 01 and 21 forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 WORK INCLUDED

A. This specification applies to the installation of the automatic sprinkler systems as described herein and in the Fire Protection Systems Construction Documents. This specification provides general items related to the fire protection work.

B. Within the scope of work for this project, the Sprinkler Trade Contractor shall:

1. Provide a complete and fully operational, hydraulically designed automatic sprinkler system in each building. Refer to Division 21 Specifications, and the Construction Drawings.

2. Provide Additional Connections as required under Section 44 11 10.

C. The Sprinkler Trade Contractor shall provide all work as required for a complete and operable system, including but not limited to the items listed below.

1. Motors, starters, disconnect switches, and variable frequency drives.
2. Fire protection piping, fittings, valves, gauges, hangers, supports, and appurtenances for complete fire suppression systems.
3. Sleeves, seals, and firestopping for all piping and ductwork penetrations.
4. Vibration controls.
5. Piping and equipment identification.
6. Plumbing fixtures, trim, traps, and appurtenances.
7. Concrete housekeeping pads.
8. Equipment supports, curbs, and rails.
9. Installation of equipment defined below.

D. The Sprinkler Trade Contractor shall furnish the equipment listed below. The Sprinkler Trade Contractor shall install the equipment listed below. The Sprinkler Trade Contractor shall assume full responsibility for the equipment including operation, warranties, etc.

E. Electrical Requirements for Fire Suppression Equipment

1. General Requirements

a. The Sprinkler Trade Contractor shall provide mechanical equipment with voltages and other electrical characteristics as indicated on the drawings and specifications.

b. All controllers (starters), enclosed switches (disconnect switches), motor control centers (MCCS), and variable frequency motor controllers (VFCs), except factory mounted controllers and VFCs, for equipment provided by Sprinkler Trade Contractor, shall be furnished by the Sprinkler Trade Contractor and installed by the Electrical Trade Contractor. Factory mounted controllers and VFCs are furnished and installed by the Sprinkler Trade Contractor. Provide controllers, enclosed switches, MCCs, and VFCs in accordance with Electrical Trade Contractor.

c. The Sprinkler Trade Contractor shall submit wiring diagrams to the CTDOT PM for approval and provide approved diagrams to the Electrical Trade Contractor so that the electrical work may be properly accomplished.

d. The Sprinkler Trade Contractor shall fully cooperate with the other Divisions and trades on the job and their manufacturers in promptly providing the information required for proper coordination of motor protection and control equipment and wiring and the characteristics of the equipment.

e. It shall be the responsibility of the Sprinkler Trade Contractor and the Electrical Trade Contractor to check for adequacy of supply wiring, overcurrent protection, proper voltage, phase rotation and final location of equipment provided prior to the running of any conduit or wiring. Coordinate with the Electrical Trade Contractor to assure proper electrical service is provided to equipment provided by the Trade Sprinkler Contractor.

f. Equipment connections shall be made through conduit or raceways in accordance with the Electrical Trade Contractor, except that connections to motors shall be made through liquid tight flexible metal conduit with equipment grounding conductor.

2. Power Requirements

a. All power wiring, for mechanical equipment provided by the Sprinkler Trade Contractor, shall be furnished and installed by the Electrical Trade Contractor to the point of final connection (from source to controllers, enclosed switches, MCCs, or VFCs, and to equipment, motor, or other connection point). Except where specifically indicated otherwise, all power wiring to the point of final connection, for equipment provided by the Sprinkler Trade Contractor, shall be accomplished by the Electrical Trade Contractor.

b. Final electrical power connections to all equipment shall be furnished and installed by the Electrical Trade Contractor. In general, the point of final connection shall be the terminal housing on the equipment, motor, or an integral junction box on the equipment item. If no junction box is furnished, a junction box shall be furnished and installed by the Electrical Trade Contractor. Wire leads of adequate length to ensure a proper connection at the final location shall be furnished and installed by the Electrical Trade Contractor.

c. Wiring, overcurrent protection devices, voltage, phase, rotation and final location of all equipment provided by the Sprinkler Trade Contractor shall be coordinated with all similar devices and power wiring furnished and installed by the Electrical Trade Contractor. Coordination shall be accomplished prior to the running of any conduit or wiring.

3. Control Requirements

a. All control wiring (line voltage and/or low voltage), for mechanical equipment provided by the Sprinkler Trade Contractor, shall be furnished and installed by the Electrical Trade Contractor. All control wire and conduit shall comply with the National Electric Code and the Electrical Trade Contractor of the specification. All control wiring shall be in conduit.

b. All motors, mounts, remote mounted push-button controls and all speed control switches for multi-speed motors for all mechanical equipment provided by the Sprinkler Trade Contractor shall be furnished and installed by the Sprinkler Trade Contractor.

1.3 DEFINITIONS

A. The Authority Having Jurisdiction (AHJ) and other project supervisors are defined as:

1. Fire Marshal: Connecticut Office of the State Building Inspector

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

F. 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.

G. The following definitions apply to all Division 21 Fire Protection Specifications and are defined as:

1. The Sprinkler Trade Contractor shall refer to the Sprinkler Trade Contractor or the Sprinkler Trade Contractor’s designated Trade Sub-Contractor or representative.

2. Provide: Includes the furnishing and installation of a device or system.

1.4 APPROVALS

A. The Sprinkler Trade Contractor must comply with all laws, ordinances, and regulations of all Authorities Having Jurisdiction (AHJ), including State, Federal, Insurer (FM Global) and Public Utility.

B. Hydraulic calculations, product data sheets, shop drawings and all other associated submittals must bear the stamp of approval of the AHJ. Provide NFPA 13 working plans to the AHJ. Any and all comments received from the AHJ and resolution thereof shall be submitted to the Engineer-of-Record.

C. The Sprinkler Trade Contractor is responsible for all fees associated with the required approvals.

1.5 SUBMITTALS

A. Requirements: Refer to any front end specifications for additional detailed requirements regarding shop drawings, product data, and samples.

B. Review: The Sprinkler Trade Contractor shall be responsible for all fees associated with the AHJ's reviews.

C. Submittal: The submittal shall be made as a complete package consisting of fire protection equipment ONLY. The submittal shall NOT include other plumbing equipment or components not directly related to the fire protection system installation for approval. Where other equipment or components are an integral part of the fire protection system, they shall be indicated as such, but not included with the submittal and only show required interface details. Failure to submit all required materials as a complete, separate single package shall be cause for rejection of entire package. Copies of the Sprinkler Trade Contractor's notes thereon will be rejected. Simply redlining the Design Documents is not acceptable.

D. Additional Requirements: Refer to the individual sections for additional submittal requirements, including identified equipment and materials for which submittals are required.

E. Qualifications: Submit the Sprinkler Trade Contractor Qualifications to the Engineer-of-Record.

1. Fire Protection Engineer Credentials

2. Installation Experience

3. Designer Certification

F. Data: The Sprinkler Trade Contractor shall submit, for review by the Engineer-of-Record, identification and data of specific materials and equipment to be incorporated in the project. Shop drawings, hydraulic calculations, catalog cuts, and associated materials shall be submitted as a complete, single package. This package shall include:

1. Water flow test results. This Sprinkler Trade Contractor shall coordinate NFPA 291 water flow tests required by this Trade Contract. The Water Authority shall be notified at

least 5 working days prior to said water flow test. The results of the water flow test shall be submitted within 10 working days following the water flow test and prior to or in conjunction with the submission of shop drawings. If a water flow test is not possible due to the incomplete construction of the civil site fire protection loop, the Sprinkler Trade Contractor may hydraulically model the complete fire protection loop including the water tower, pipe to the fire pump with backflow preventer, the characteristic of the approved fire pump, and piping information and elevations from the approved civil site plans or use approved water flow and pressure estimates from the Engineer-of-Record. The Sprinkler Trade Contractor will be required by the commissioning period to run the said water flow test and submit the results with the as-builts. It is the responsibility of the Sprinkler Trade Contractor to make any adjustments to his installed systems if his hydraulically calculated design is inadequate for the actual water flow results. See Specification Section 21 30 00 for additional information on the new site fire pump. See the approved civil site utility drawings for additional information on the site fire loop.

2. Product data. Identification of specific product data and equipment shall be submitted prior to or in conjunction with the submission of shop drawings. Should more than one item or a specific item with multiple options appear on a single cut sheet, the item or items shall be specifically indicated.

3. Complete shop drawings. Failure of the Sprinkler Trade Contractor to submit complete shop drawing packages may result in delay in processing time or rejection of the submittal. All such delays to the job resulting from the Sprinkler Trade Contractor's failure to submit complete shop drawings at one time will be the responsibility of the Sprinkler Trade Contractor. The Shop drawing submittal shall be subdivided by drawing and clearly identify the Trade Contract Specification Section or drawing referenced, identifying and highlighting each item to be reviewed.

4. Submit materials and information described in NFPA 13, NFPA 24, NFPA 25, NFPA 70 and NFPA 72.

5. Hydraulic calculations and piping drawings. All calculations and CAD drawings shall:

    a. Be prepared under the direct supervision of an individual having NICET Level III or IV certification or an individual having registration as a Professional Engineer. Preparation of hydraulic calculations and/or piping drawings by individuals who do not have said certification or who are not directly supervised by an individual with said certification is prohibited.

    b. Be prepared using a commercially available computer models such as HASS, HydraCALC, Sprinkler-CALC, Sigma or "THE".

    c. Be prepared using the same computer model. Hydraulic calculations and the model used shall be consistent throughout the project. Hydraulic calculations shall be neat and orderly (e.g. columns and rows line up accordingly on printouts).

    d. Have hydraulic reference points, provided in a systematic and consistent manner, clearly indicated on both the shop drawings and the hydraulic calculations.

6. Where sprinkler systems are submitted separately, a schematic drawing indicating locations of all nodes used in the hydraulic calculations shall be included with the submission. Common piping and nodes shall utilize that same nomenclature.

7. Where phasing of construction requires submission of portions of the system, all piping and equipment associated with any calculations must be provided with the submittal. Additionally, the phasing plan as it relates to the fire protection system installation shall be provided either diagrammatically or by narrative.

G. Revisions: Where the Sprinkler Trade Contractor must revise and resubmit, the revised submittal shall be accompanied by the written response to all previous submittal comments. Failure to provide written response to previous comments shall be cause for rejection of the submittal.

H. CAD Drawings: CAD layout drawings shall be submitted for the automatic sprinkler system. The layout drawings shall be prepared at a scale of not less than 1/8 inch = 1 foot, and drawings sheet size shall be either 24x36 or 30x42 inches. All drawing sizes shall be approved by the General Trade Contractor prior to submitting and shall be of one size only. The layout drawings shall include all information identified in NFPA 13 to be indicated and:

1. All Room numbers shall be provided on the drawings.

2. Plan and Elevation views of the mechanical room showing the sprinkler riser, proposed piping, equipment pads, dimensions of openings in floors, roofs, and walls, and equipment to establish that all proposed equipment will fit within the allotted spaces with clearances for installation and maintenance.

3. Plan views, with elevation views where necessary for clarity, of all piping and distribution systems indicating locations of proposed piping, hangers, sprinklers, water flow switches, hose outlets, and penetrations to fire-rated or smoke enclosure walls.

4. Where trapeze hangers are to be used, provide all pertinent information for determining size of trapeze member.

5. The drawings shall show proposed details for attachment, anchoring, and hanging to structural framing of the building; vibration isolation units; foundation and support; location and size of sleeves and prepared openings for passage of pipes. If the Sprinkler Trade Contractor deems departures from the Trade Contract Drawings necessary, details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the drawings for review by the Engineer-of-Record. Allowed departures shall be made at no additional cost to the Owner.

6. The available water supply data for the sprinkler system design shall be provided on the drawing that indicates the location of the fire protection water service entrance. The data shall include: date and time of test, location (relative to building) of static pressure reading and location of residual pressure reading, along with the pressures and flows during the test. Further, the data for adjustments to the water supply data, including elevation changes and friction loss components, between the street and the building shall be noted. Provide a “schematic” for clarity if necessary.

7. Items on or projecting through the ceiling shall be coordinated with other items and shall be shown on the reflected ceiling plan shop drawings submitted for the Engineer-of-Record's review. Such items shall follow the intent as shown on the contract documents reflected ceiling plan drawings and shall not be installed until reviewed by the Engineer-of-Record.

I. Shop Drawings: The Sprinkler Trade Contractor shall forward to all AHJ's, for their review and comment, a minimum of 3 sets of the shop drawings indicating the final sprinkler head layout with associated hydraulic calculations.

J. Electrical Data: Fire Protection Equipment Electrical Data shall be submitted for review:

1. Prior to submitting data for equipment requiring electrical service, the Sprinkler Trade Contractor shall verify that electrical characteristics of equipment submittals comply with electrical service provided for the specified items of equipment.

2. Upon receipt of reviewed submittals for equipment provided under this Division of this specification, the Sprinkler Trade Contractor shall coordinate the electrical service requirements such as, motor horsepower and full load amps; electrical service characteristics such as voltage and phase; and number of services for each item of equipment requiring electrical connections with the electrical drawings and specifications. The Sprinkler Trade Contractor shall furnish to the Engineer-of-Record and the General Trade Contractor's representative responsible for electrical systems a complete typewritten list of electrical requirements for each item of equipment to be installed.

K. Operation and Maintenance Manuals: Operation and Maintenance Manuals shall be provided and include system components, water flow test information, CAD as-built drawings, as-built hydraulic calculations, and test certifications as a minimum. See Operations and Maintenance section of this Specification.

L. Approval: All firestopping material and installation methods must be approved by the Engineer-of-Record.

M. Provide a Valve Chart. Provide 3 copies in metal frame with clear window. Mount on wall at locations directed by the CTDOT PM.

N. Provide documentation of grooved coupling training.

O. Drawings: The Sprinkler Trade Contractor shall submit for review and approval to the Engineer-of Record three (3) sets of shop drawings and hydraulic calculations indicating the sprinkler system layout including head locations. Submit drawings with the required application and fee.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 QUALITY ASSURANCE

A. Fire Protection Engineer

1. The Sprinkler Trade Contractor shall have on staff or under trade contract a qualified and experienced Fire Protection Engineer (FPE). It is the FPE's responsibility to develop the specific requirements of the fire protection design and to seal that portion of the design. This person shall be responsible for performing and overseeing all engineering aspects of the fire protection system construction, including but not limited to, calculations, layout, shop drawings, equipment selection and inspections. In addition, this person shall be responsible for the testing plan and for final commissioning and testing of the system. For the purpose of meeting qualification requirements, a qualified FPE is defined as an individual meeting one of the following conditions:

   a. Bachelor of Science or Master of Science degree in Fire Protection Engineering from an accredited university, plus a minimum of 5 years' work experience in Fire Protection Engineering. Plus, Professional Engineer (PE) registration obtained by passing the Fire Protection Engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES).

   b. Bachelor of Science in a related engineering discipline with a minimum of 5 years of direct work experience in Fire Protection Engineering. Plus, Professional Engineer (PE) registration obtained by passing the Fire Protection Engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES).

B. The fire protection equipment and installation shall conform to the full meaning and intent of the following codes and regulations:

1. The International Code Council (ICC) – International Codes, 2003, Edition.

2. Local Water Authority Rules and Regulations

3. FM Global Data Sheets

C. The fire protection and installation shall conform to the full meaning and intent of the following National Fire Protection Association (NFPA) codes and standards (International Building Code - 2003/International Fire Code -2003 Referenced Edition if so designated, otherwise the latest edition):

1. NFPA 13 - 2007, Standard for the Installation of Sprinkler Systems

2. NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection

3. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances

4. NFPA 25, Inspection, Testing, and Maintenance of Water-Based Fire Protection System

5. NFPA 70, National Electrical Code (NEC)

6. NFPA 72, National Fire Alarm Code

7. NFPA 101, Life Safety Code

8. NFPA 291, Recommended Practice for Fire Flow Testing and Marking of Hydrants

D. The fire protection equipment and installation shall conform to the full meaning and intent of the latest edition of the following agency standards:

1. UL Fire Protection Equipment Directory

2. FM Global Approval Guide

E. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Department all certificates of said inspection issued by the AHJ.

F. Workmanship and Materials

1. The workmanship and materials covered by these specifications shall conform to all ordinances and regulations of the State and/or other AHJ.

2. All products and materials utilized in the fire protection systems shall be listed for fire protection service by Underwriter's Laboratories (UL) and/or approved for fire protection service by FM Global.

G. Qualifications of the Sprinkler Trade Contractor

1. The Sprinkler Trade Contractor for the fire protection systems shall be qualified for the work specified herein and be regularly engaged in the installation of automatic sprinkler systems and equipment.

2. The Sprinkler Trade Contractor shall have a minimum of five years experience in the installation of sprinkler systems. Documentation shall be submitted to show that the Sprinkler Trade Contractor has provided similar systems to those specified herein. Documentation on at least 3 similar systems shall be provided including the system size and the name of a contact person at the facility.

3. Documentation shall be provided to show that all fire protection systems are designed by a regular full-time employee with a Level III or Level IV NICET (National Institute for Certification in Engineering Technologies) certification in automatic sprinkler system layout or a Registered Professional Engineer. If such a certified individual is not employed, adequate documentation shall be provided to show comparable training and experience of the designer. Additionally, the section 1.6 A registered Fire Protection PE will review and certify the design.

4. Welding:

a. All welders employed for the work shall be qualified under the requirements of ANSI B31.1.0 Section 127.5.

b. Evidence of welders' qualifications shall be submitted to the Professional before any welds are made.

c. All welding shall be performed at the shop to greatest extent possible. Field welding only permitted where assemblies too large for transport.

5. The proposed Sprinkler Trade Contractor shall submit evidence of the above qualifications items to the Professional prior to proceeding with any work on this project. Sprinkler Trade Contractors not meeting these requirements will not be permitted to perform work specified under this section, unless specifically authorized in writing by the Department.

H. Qualifications of Manufacturer and Products

1. Pipe, valves, fittings, and appurtenances shall be manufactured in the United States.

2. Firms whose equipment and product name appear within the Underwriter Laboratory's "Fire Protection Equipment Directory" list of specialties and/or accessories and Factory Mutual's "Fire Protection Approval Guide".

3. All products/parts installed or furnished under this Trade Contract shall be listed and approved for use by the Authorities and Agencies listed herein.

1.8 AS-BUILTS, OPERATION AND MAINTENANCE INSTRUCTIONS, TRAINING

A. Refer to any front end specifications for additional information and detail requirements.

B. Operation and Maintenance Manuals, with a Table of Contents, shall include:

1. Printed material relating to all the fire protection equipment.

2. All flow test information including date, time, location and pressure readings.

3. Trade Contractor's Materials and Test Certificates as required by NFPA 13, completed and signed.

4. Completed and signed Trade Contractor's Material and Test Certificate for Private Fire Service Mains, as required by NFPA 24, where outside underground water supply is installed under this project, either by the Trade Contractor or by others.

5. Completed and approved as-built hydraulic calculations.

6. Provide a copy of the valve schedule.

7. As-built drawings. Provide drawings updated in CAD.

8. A synopsis of the requirements of NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

C. Provide a minimum of 4 properly labeled copies of Operations and Maintenance Manuals with a table-of-content in 3-ring binders.

D. A minimum of 2 hours of instruction/training shall be provided to Department designated personnel.

1. Before final inspection at a time designated by the Sprinkler Trade Contractor or Department, provide a competent representative to instruct Department's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems under this Division of the specifications. For equipment requiring seasonal operation, perform instruction for other seasons within six months unless requested otherwise.

2. The information provided for the Operation and Maintenance Manuals shall be used as basis of instruction. Review contents of said manual with personnel in detail to explain all aspects of operation and maintenance.

3. Prepare and insert additional data in the Operation and Maintenance Manual when the need for such data becomes apparent during instruction.

1.9 RECORD DOCUMENTS

A. Refer to the front end specifications for additional information related to record documents and related submittals.

B. As-Built Documents - Upon completion of approvals, installation, testing, and acceptance thereof of each phase of construction, the Sprinkler Trade Contractor shall provide to the Department one complete set of reproducible drawings, one set of CAD/Electronic Drawings, and one set of corresponding hydraulic as-built calculations.

1.10 CONSTRUCTION DOCUMENTS

A. The drawings are diagrammatic and are indicative of the work to be performed and unless explicitly dimensioned show general locations of main piping, apparatus, and equipment. It is not intended that they show every pipe, fitting, or apparatus required for a complete installation.

B. When sprinkler head locations are shown on the fire protection trade contract drawings or the Architectural reflected ceiling plans, they are also diagrammatic and are indicative of the work to be performed. The Sprinkler Trade Contractor is responsible for determining final locations in accordance with NFPA 13 and the reflected ceiling plans.

C. Where a specific pipe routing, equipment arrangement or pipe size is indicated, the Fire Protection trade contract drawings shall be followed as closely as circumstances will permit unless prior approval is granted by the Engineer-of-Record. The Sprinkler Trade Contractor may improve upon equipment locations and pipe routings as required to facilitate the proper installation of the system.

D. The Sprinkler Trade Contractor is responsible for the proper installation of all materials and equipment required for a complete installation within the intent and meaning of the Fire Protection Contract documents and NFPA 13.

E. The Sprinkler Trade Contractor shall follow drawings and specifications in laying out work and check drawings of other disciplines relating to work to verify space conditions. The Sprinkler

Trade Contractor is responsible for field verification of all fire protection equipment and water service connections. Scaling drawings without field verification is not sufficient.

F. Equipment layout is based on one typical manufacturer's product. Where equipment selected by the Sprinkler Trade Contractor for use on the job differs from the layout indicated in the Fire Protection Systems Construction Documents and Fire Protection Specifications, the Sprinkler Trade Contractor shall be responsible for coordinating space requirements and connection arrangements.

1.11 GUARANTY

A. The components of the fire protection systems shall be guaranteed for a period of eighteen months from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier, against defective materials, design, and workmanship. Upon receipt of notice from the Bridging Team or Department of failure of any part of the equipment during the guaranty period, the affected part or parts shall be replaced promptly. This includes all parts and labor for removing the defective part or parts and subsequently replacing and installing the new part or parts at the expense of the Sprinkler Trade Contractor.

1.12 FIELD MEASUREMENTS

A. It is the Sprinkler Trade Contractor's responsibility to verify the location of any and all underground utilities in the vicinity of the work contained herein including the location of the fire water service. When it has been indicated that these utilities are to remain in place, the Sprinkler Trade Contractor shall provide adequate means of support and protection during excavation operations.

B. Before ordering any equipment and material, or performing any work, the Sprinkler Trade Contractor shall verify all measurements and dimensions at the job site and shall be held responsible for the correctness of same.

C. No extra compensation will be allowed on account of difference between actual dimensions and measurements and those indicated on the drawings.

D. Any difference which may be found shall be submitted to the Engineer-of-Record for consideration before proceeding with the work.

1.13 LINES AND GRADES

A. The Sprinkler Trade Contractor shall lay out his work, establishing heights and grades for all exterior and interior piping included in these specifications in strict accordance with the intent of the drawings, the physical conditions of the building and the finished site grades. The Sprinkler Trade Contractor shall be responsible for the accuracy of such heights and grades and make sure that they meet all physical conditions of the building and the requirements of these specifications.

1.14 PROTECTION OF SERVICES AND EQUIPMENT

A. The Sprinkler Trade Contractor, at his own expenses, shall repair, replace and maintain in service any utilities, facilities or services (underground, aboveground, interior or exterior) damaged, broken, or otherwise rendered inoperative during the course of construction. The method used by the Sprinkler Trade Contractor in repairing, replacing, or maintaining the services shall be approved by the Engineer-of-Record and the Department.

B. The Sprinkler Trade Contractor shall protect, at his own expense, all materials or equipment related to his work that is liable to damage during the construction period. All openings into any piping, ducts, equipment, or building components, must be securely covered, or otherwise protected, to prevent injury, due to accidental encroachment of, or carelessly or maliciously dropped tools, materials, dirt, or any foreign matter. The Sprinkler Trade Contractor shall be held responsible for all damage so done until his work is fully and finally accepted.

C. It shall be the responsibility of the Sprinkler Trade Contractor to protect motors, pumps, electrical equipment, and all similar items of equipment from dirt, grime, plaster, water, etc. during all phases of construction. This protection shall be provided by covering equipment with transparent plastic sheeting to the satisfaction of the Bridging Team or the Department.

1.15 INTERRUPTION OF SERVICES

A. The Sprinkler Trade Contractor shall schedule his work to avoid any major interruption of any utility services.

B. The Sprinkler Trade Contractor shall not interrupt existing utilities serving facilities occupied and used by Department or others during occupied hours except when such interruptions have been authorized in writing by the Department or Bridging Team and then interruptions shall occur only after acceptable temporary utility services have been provided. The Sprinkler Trade Contractor shall provide a minimum of 10 working days notice to the Department and Using Agency and receive written notice to proceed before interrupting any utility.

1.16 EQUIPMENT STORAGE AND EQUIPMENT HANDLING

A. Deliver and store equipment in the original manufacturer’s shipping containers.

B. Piping and other supplies that are not provided in original manufacturer’s shipping containers shall be stored in a neat and orderly manner that minimizes the potential for damage.

C. Protect pipe, fittings, and other fire protection equipment from the weather so as to avoid undo rust. Any component exhibiting rust shall be replaced at the discretion of the Bridging Team or the Department at no additional cost.

1.17 COORDINATION

A. The Sprinkler Trade Contractor shall prepare inter-trade coordination drawings.

B. The Sprinkler Trade Contractor must coordinate his work with that of the other trades so that the work of all trades will be performed in an orderly manner and with the least possible interference. In the case where interference with the work of the other Trade Sub-Contractors should occur, the decision of the General Trade Contractor or Engineer-of-Record as to changes to be made in the work shall be final.

C. The Sprinkler Trade Contractor must thoroughly familiarize himself with all specifications and drawings for the project so that he clearly understands his responsibility in relationship to the work to be performed under this Trade Contract. The Trade Contractor must plan and perform his work so as to permit the use of the building at the earliest possible date.

D. The Sprinkler Trade Contractor shall be responsible for coordinating all fire protection equipment locations with the locations of all lighting fixtures, HVAC diffusers, ceiling architectural features, and structural members. The Sprinkler Trade Contractor is responsible for coordinating the locations of all fire protection piping and equipment with all other trades to prevent obstructions to the required sprinkler discharge pattern.

E. The Sprinkler Trade Contractor is responsible for coordinating locations of all fire protection piping with respect to electrical equipment and the NEC. Routing of piping directly above electrical equipment shall be prohibited.

F. The Sprinkler Trade Contractor shall coordinate locations of fire protection system piping with respect to fresh air intake louvers. Routing of piping directly in front of such louvers shall be avoided due to potential freezing conditions. Refer to mechanical drawings for exact locations for all louvers. All louvers shall be shown on the shop drawing submittals.

1.18 CUTTING, PATCHING, AND FINISHING

A. Unless otherwise noted, the Sprinkler Trade Contractor shall cut, patch and finish all penetrations and openings in walls, and floor/ceiling assemblies required for the installation of work to be performed under this Trade Contract in accordance with this section of the specification and any additional front end specification requirements. All patching and finishing shall match existing adjacent undisturbed surfaces.

B. Penetrations made in existing or new fire rated chases, partitions, floors, etc. shall be sealed with an approved material and method as required to maintain the integrity of the fire separation in accordance with a UL method as well as any additional requirements herein.

C. Cutting of the construction excessively or carelessly done shall be repaired to match the original work by the Sprinkler Trade Contractor and to the satisfaction of the Department, and Bridging Team who will make the final decision with respect to excessive or careless cutting work. The Sprinkler Trade Contractor shall seal all openings made in plenum spaces, fire rated floors, ceilings or partitions after all work has been installed. The material used for sealing the openings shall have a fire rating equal to or greater than the rating of the floor, ceiling or partition material.

D. Where present equipment is removed and unused opening remain in walls, floors, partitions, etc., the Sprinkler Trade Contractor shall properly patch all such openings except as hereinafter specified under “Work by Others”. All patching and repairing shall be done by workmen skilled in this type of work and shall match present or new finishes.

E. No cutting shall be done which may affect the building structurally or architecturally without first securing the approval of the Engineer-of-Record. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces that cannot be concealed by plates, escutcheons or other construction. Cutting shall not cause damage to the building or leave unsightly surfaces. Where such unsightly conditions are caused, the Sprinkler Trade Contractor shall be required, at his own expense, to repair the damaged areas.

F. No structural member shall be cut.

G. The Sprinkler Trade Contractor shall contact the holder of the guarantee and obtain written approval before cutting the roofing membrane so as not to void said guarantee.

H. The Sprinkler Trade Contractor shall set all sleeves, hangers, and anchors required for the work under this Trade Contract and shall be responsible for their proper and permanent location.

1.19 PAINTING AND INDICATON

A. Painting

1. Steel equipment hangars, supports, and pipe shall be prepared as indicated below.

2. The Sprinkler Trade Contractor shall paint all exposed piping. The color shall be red.

3. Apply at least 1 coat of approved primer and 1 coat of machinery enamel on all piping.

4. All painting shall conform to the manufacturer's requirements.

5. All painting shall be done in a careful, neat and workmanlike manner, with particular care being exercised to protect building equipment and finishes.

6. Provisions shall be made to protect sprinklers from being painted. All sprinklers having "non-factory-applied paint" on them shall be replaced.

7. The manufacturer shall paint all items of equipment. All equipment manufacturers shall supply sufficient paint to completely paint each unit one coat in the field to cover all scratches, etc., due to installation. The Engineer-of-Record will carefully inspect all equipment for acceptance. If paintwork does not meet the Engineer-of-Record's approval, the Sprinkler Trade Contractor shall repaint all equipment found to be defective as directed by the Engineer-of-Record.

8. All exposed hangers and supports shall be primed and finished with rust inhibitor paint.

9. All nameplates and data plates that indicate or identify data on equipment shall not be painted, but shall be carefully marked and left unpainted.

10. Where pipe support members are welded to the structural building framing, scrape and/or brush clean and apply one coat of zinc primer to welding.

11. All colors to be used shall be submitted to the Engineer-of-Record for approval.

B. Identification

1. The Sprinkler Trade Contractor shall provide permanently affixed identification of fire protection piping. This may include stenciled painting or labels.

2. Identify all sprinkler piping (except branch lines), concealed or exposed, with permanently affixed identification. Install in clear view and align with axis of piping. Locate identification not to exceed 15-feet on straight runs including risers and drops, adjacent to each valves and "T", at each side of penetration of structure or enclosure, and at each obstruction.

3. Identify service as "FIRE PROTECTION". Letters shall be of height equal to the diameter of the pipe on piping up to and including 1½ inches, and 2 inches high on pipes 2 inches in diameter and over. Flow arrows shall be approximately 4 inches long having a 1 inch wide head and base with a ½ inch wide shaft.

4. The band color shall be red and letter color shall be white.

5. Background color coding and stenciling for piping, equipment, and related appurtenances provided under this Trade Contract shall meet the minimum standards for identification as set forth by the latest edition of the ANSI A13.1.

C. Sprinkler Trade Contractor Indications

1. Clearly marked permanent labels which are securely fastened to the ceiling shall be provided to identify access points for concealed control valves in accordance with NFPA 13.

2. Place tags on all valves indicating function.

3. The following schedules shall be used for manufacture and application of indication:

a. Plastic Nameplates: Laminated 3 layer plastic with engraved white letters on red background color.

b. Metal Tags: Brass with stamped letters; tag size minimum 1 1/2 inch diameter with smooth edges.

1.20 EXCAVATION, BACKFILLING, AND COMPACTION

A. General

1. This section is applicable to all underground fire protection lines.

2. The Sprinkler Trade Contractor shall notify the CTDOT PM prior to commencing any excavation.

3. The Sprinkler Trade Contractor shall perform all excavation, backfilling, compaction, and necessary finishing for all lines, equipment, and accessories installed under this Trade Contract. Piping installation and testing shall be in accordance with NFPA 24 and applicable State and Local codes.

4. The Sprinkler Trade Contractor shall provide all bracing, sheathing, and shoring necessary to perform and protect the excavations. Safety rails, lights, signs, etc. shall be provided as necessary or required for safety, as directed by the CTDOT PM or as required to conform to governing laws.

5. The Sprinkler Trade Contractor shall furnish, maintain, and operate pumping equipment of sufficient capacity to insure that all excavations and trenches required herein are kept free of water at all times.

6. All surfaces of streets, walkways, seeded areas, or finished grade areas disturbed by the excavation shall be restored to their original condition and/or as shown on the Civil site plans and specifications.

7. Existing structures, utilities, sidewalks, pavements, and other facilities not indicated for removal shall be protected from damage caused by settlement, lateral movement, undermining, washout, and/or hazards resulting from the excavation operations specified herein.

8. If it becomes necessary to install any lines or equipment in locations other than those shown, the Engineer-of-Record acceptance shall be obtained before starting said excavation.

9. The presence of explosives on the project site or the use of explosives in the execution of the work under this Trade Contract is not permitted.

B. Excavation

1. Trenches shall be dug to uniform width not less than 12 inches or more than 16 inches wider than the bell diameter. Trench sides shall be vertical. Excavate trenches to depth indicated or required. Carry depth of trenches for piping as required to establish desired flow line and invert elevations. Beyond building perimeter, keep bottom of trenches sufficiently below finished grade to protect against frost and allow for the minimum required depth of cover. The bottom of trenches shall be accurately graded to provide uniform and smooth flow throughout. Any over-excavation shall be backfilled with No. 2A modified aggregate and thoroughly tamped.

2. If trench excavation operations are performed when the atmospheric temperature is less than 35 degrees Fahrenheit, the Sprinkler Trade Contractor shall provide, at his own expense, cold weather protection to protect excavated trench bottoms from freezing. Under no circumstances will any pipe be permitted to be laid in a trench containing water or on a subgrade containing frost.

3. All material excavated shall be deposited on the side of the trenches and beyond the reach of sides. Excavated material shall not be piled where it will interfere with traffic.

4. Surplus excavated material not required for backfill shall be removed from the building site or distributed on the premises as directed by the CTDOT PM.

5. Take up and re-lay pipe that is not laid true to required alignment or grade. Pipe that has had the joints disturbed after being laid shall be taken up and laid again. Deviation from the required lines and grades will not be permitted unless approved by the Engineer-of-Record.

6. Pipe Embedding Material – All pipe shall be laid on a First Class granular bedding. The bedding shall be a minimum depth of 6 inches or 1/4 the pipe diameter, whichever is greater. The bedding shall provide uniform longitudinal support to the pipe and shall be laid to provide the grade and line as shown on the drawing or as directed by the Engineer-of-Record. Compaction of bedding materials under the hunches and around the springline of the pipe shall be by hand tamping. Final bedding material for ferrous pipe materials shall extend from the springline of the pipe to a depth of 6 inches (minimum) above the top of the pipe.

C. Backfilling

1. Backfilling shall not be undertaken until all test and inspections have been completed.

2. Backfilling operations shall avoid damaging or displacing installed piping systems.

3. The Sprinkler Trade Contractor shall restore the surface of all excavations to their original conditions, including paved or unpaved streets, gutters, shrubbery, fences, walls, sidewalks, and sod. The Sprinkler Trade Contractor shall furnish all labor and material required.

4. All backfill material shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks or stones, frozen soil, or other material that is unsuitable. When the type of backfill material is not indicated on the plans or is not specified, the excavated material may be used, provided that such material consists of loam, clay, sand, gravel, or other material that is suitable for backfilling. Above the top of the pipe to the subgrade of the pavement, material containing stones greater than 6 inches in their greatest dimension may not be used.

5. All trench backfill shall be brought to subgrade ready for base material or topsoil. After the initial aggregate backfill layer has been placed, refill remainder of the trench using backfill materials specified below.

6. Walks and Parking Areas – Clean earth backfill compacted in 6 inch layers to a point 8 inches below the adjacent existing surfaces. Refill the remaining 8 inches with compacted 2A modified stone and replace walk or paving as required.

7. Paved Areas - When working within the right-of-way limits of all Connecticut highways, a city street, avenue or alleys constructed of concrete or macadam surfaces, school driveways, backfilling must be in conformance with the requirements of the Connecticut Department of Transportation.

D. Compaction

1. Thoroughly compact subgrade prior to the installation of 6 inches of First Class pipe bedding. Following satisfactory pipe laying and in-line structure installation, backfill

trenches to a height of at least 12 inches above the top of the outside barrel of the pipe with No. 1B Crushed Stone.

2. All fill shall be compacted to 95 percent. Each layer shall be compacted to the specified percent of maximum density obtained at optimum moisture content, in accordance with ASTM D1557, method D and ASTM D1556 sand cone method.

3. Compaction shall be accomplished by approved equipment suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

4. Thoroughly compact successive layers of backfill material with a vibrating compactor of a type and size satisfactory to the Engineer-of-Record. Compacting of this backfill by pudding or jetting will not be permitted. Use mechanical tampers to compact backfill materials in trench refill operations to produce a density of backfill at the bottom of each layer of not less than 95 percent of the maximum density obtained at optimum moisture content as determined by AASHTO T99. Perform field determinations of backfill density in accordance with AASHTO T 191.

5. The use of special equipment such as the "HYDRA-HAMMER" for compaction of backfill is prohibited.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Pipe and fitting shall be as specified herein and used on the services indicated. Pipe shall be clear and free of dirt, debris, or any other obstruction.

B. "Plain-end" pipe/fittings and threadable light-wall pipe are NOT permitted. All pipe must have a Corrosion Resistance Ratio ≥ 1.00 for the joint specified.

C. All sprinkler piping shall be steel. CPVC piping is not permitted. Additionally, all pipe and fittings shall be in accordance with the requirements of NFPA 13. All piping and fittings for dry pipe and pre-action systems shall be galvanized. All piping and fittings for the wet pipe system shall be black. All piping which utilizes threaded fittings shall be Schedule 40.

D. Sprinkler piping 1-1/4 inches in diameter or larger, connected by welded flanged fittings, welded socket fittings or roll grooved fittings, shall be Schedule 40, Schedule 30, or Schedule 10 as permitted by NFPA 13. Cut grooves are not permitted. All sprinkler piping 2 inches in diameter and smaller (that is not roll grooved or welded) shall be Schedule 40 utilizing screwed fittings (plain end fittings shall not be accepted).

E. All miscellaneous drain and test piping and fittings shall be Schedule 40 internally and externally galvanized.

F. All above ground piping on the supply side of the backflow prevention device shall be listed for potable service and in accordance with the local water department requirements and internally and externally galvanized steel pipe.

G. Outside underground piping shall be Class 52, cement-lined ductile-iron pipe listed for potable service and shall be in accordance with NFPA 24. HDPE piping, listed for fire water service applications, may be utilized.

H. Provide a seismic bracing analysis to confirm if seismic bracing is required.

2.2 VALVES – GENERAL

A. All valves in each system, except for special types, shall be the product of a single manufacturer. Valves shall have the name or trademark of the manufacturer and the working pressure stamped or cast on the valve body.

B. All valves requiring packing shall be designed and constructed such that they can be repacked under pressure.

C. Hand wheels for valves 2 inches and smaller shall be malleable iron or aluminum except where specified otherwise. Hand wheels for valves 2 ½ inches and larger shall be malleable or cast iron except where specified otherwise.

D. Valves shall have listing or approval agency identification mark stamped or cast on valve body. All valves shall be listed for fire protection service use.

E. All Fire Protection service valves shall be UL listed and FM approved, with minimum 175 psig (1200-kPa) non-shock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type ends specified.

2.3 GATE VALVES

A. All gate valves shall be in accordance with UL 262.

B. Gate valves (2 ½ inches in size and larger) shall be OS&Y type with iron body, bronze trim, solid wedge, and flanged ends.

C. Gate valves (2 inches in size and smaller) shall be OS&Y type with bronze body, solid wedge, and threaded end.

D. Indicator-Post, Gate Valves shall be iron body, bronze mounted, solid-wedge disc, and non-rising stem with operating nut and flanged ends.

2.4 BUTTERFLY VALVES

A. Butterfly valves shall be lug type with ductile iron body, stainless steel stem, Buna N or EPDM seat, nickel or aluminum plated brass disc, and gear operator. Valve shall be listed for fire service and rated for the anticipated operating pressure.

B. Indicating Valves: NPS 2-1/2 and Smaller shall be in accordance with UL 1091 and be butterfly or ball-type utilizing a bronze body with threaded ends and integral indicating devices.

2.5 CHECK VALVES

A. All check valves shall be in accordance with UL 312.

B. Check valves (2 1/2 inches in size and larger) shall be Class 150, horizontal swing type with iron body, bronze trim, and flanged or grooved ends.

C. Check valves (2 inches in size and smaller) shall be Class 150, horizontal swing type with bronze body, composition disc, and threaded ends.

2.6 GLOBE AND ANGLE VALVES

A. Globe valves shall have bronze body, rising stem, composition disc, and be threaded.

B. Globe valves having cast iron handwheels shall be permitted.

C. Angle valves shall have bronze body, rising stem, composition disc, and threaded ends.

2.7 FLUSH WALL MOUNTED FIRE TEST CONNECTION

A. Ductile iron body with powder-coated with an electrostatically-applied, thermally-fused red polyester Finish. Male 2 1/2" hose thread snoots with cap and chain. Brass plate lettered "TEST CONNECTION". The inlet size, location and number of outlets shall be determined by full flow capacity of backflow preventer.

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

1. Potter Roemer

2. Guardian Fire Equipment, Inc.

3. National Fire Equipment Ltd.

2.8 FLOW SWITCHES

A. Vane type waterflow switch/detectors shall be installed on the sprinkler system piping. Waterflow switches shall be furnished and installed by the Sprinkler Trade Contractor. The Sprinkler Trade Contractor shall connect the flow switches to the Fire Alarm Control Panel.

1. Said switch/detectors shall be designed for mounting on either vertical or horizontal piping, but shall not be mounted in a fitting or within 12 inches of any fitting that changes the direction of water flow.

2. Said switch/detector shall have a sensitivity setting to signal any flow of water that equals or exceed the discharge from one sprinkler head for the specified retard period.

3. The waterflow switches shall have a minimum rated capacity of 15 amps at 125V AC and 2 amp at 0-30V DC resistive, two (2) normally open contacts, and shall be actuated by a polyethylene vane extending into the waterway of the piping.

4. The waterflow switch/detectors shall be of weatherproof, dust tight construction, shall provide a ½ inch conduit entrance, and shall be finished in red baked enamel.

5. The waterflow switch mechanisms shall incorporate an instantly recycling pneumatic retard element in the adjustable range of 0 to 70 seconds.

B. A pressure switch shall be provided on Preaction and Dry systems. Pressure type flow alarm switches shall contain one single pole, double throw contact (nominally rated at 2.5 amp at 30V DC). The unit shall be factory adjusted to operate on a pressure increase between 4 and 8 psi. They may be adjusted to operate on pressure between 4 and 20 psi.

2.9 SUPERVISORY SWITCHES/EQUIPMENT

A. Supervisory switches shall be installed on the system control valves per NFPA 13. Supervisory switches shall be furnished and installed by the Sprinkler Trade Contractor. The Electrical Trade Contractor shall connect the supervisory switches to the Fire Alarm Control Panel.

B. The mechanism shall be contained in a weatherproof, die cast aluminum housing, which shall provide a ¾ inch tapped conduit entrance and incorporate the necessary facilities for attachment to the valve.

C. Post Indicator Valve, Wall Mounted Indicator Valve, and Outside Screw and Yoke type switches shall contain one single pole, double throw contact (Form C nominally rated for 2.5 Amp at 0-30V DC resistive.) Switches shall be mounted so as not to interfere with the normal operation of the valve. The switch shall activate when the valve is closed during the first two revolutions of the hand wheel or during one-fifth of the travel distance of the valve control apparatus from its normal position. The switch shall provide for a restoration signal when the valve is returned to the normal position. The switch cover shall be tamper resistant and cause the switch to activate if the cover is removed or if the unit is removed from its mounting.

D. Valve supervisory switches shall be designated for valve mounting either vertically or horizontally.

E. The Sprinkler Trade Contractor shall provide a supervisory switch on the Post Indicator Valve and the Wall Mounted Indicator Valve. Wiring extended to the Fire Alarm Panel location and connection to the Fire Alarm Panel will be provided by the Electrical Trade Contractor.

F. Dry pipe and pre-action high/low air pressure supervisory switches. Switches shall be provided with 1/2-inch NPT male pressure connection to be connected into the air supply line on the system side of any shutoff valve. Provide a bleeder valve in line with the switch as a means of testing the operation of the switch. The switch shall contain SPDT (Form C) switches. One switch shall operate at a pressure decrease of 10 psi from normal. The second switch shall operate at a pressure increase of 10 psi from normal. Switches shall be rated at 15.0 amps as 125/250 VAC and 2.5 amps at 30 VDC. The units shall have a maximum pressure rating of 250 psi and shall be adjustable from 10 to 175 psi. The switch housing shall be weatherproof and oil resistant. The cover shall incorporate tamper resistant screws. The unit shall be UL listed and FM approved.

2.10 WALL TYPE INDICATOR POST

A. Provide a wall type indicator post that is mounted directly to an exterior wall, and it is designed to work with 4 through 14 inch PIVs employing 2 inch operating nuts. The wall type indicator post shall have 3/4 inch clearance holes or the mounting bolts. It shall have has a 14 pitch Threaded Sleeve which can readily accommodate field positioning of the "OPEN" and "SHUT" Targets for 4 through 14 inch PIVs requiring 14 to 48 turns to open. The wall type indicator post shall be provided at all fire water entrances to buildings as noted on the fire protection drawings and the civil site utility drawings. Coordinate the wall type indicator post with the double detector check valve back flow preventer at each fire riser. The backflow preventer shall be ordered to accommodate the wall type indicator post on the inlet OS&Y valve.

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

1. Mueller
2. Guardian
3. United Water Products

2.11 IDENTIFICATION SIGNS

A. Identification signs shall be provided on all valves in accordance with NFPA 13.

B. Provide riser placards for each remote area of each system per NFPA requirements.

C. In addition to the required identification signs above, a means for identifying the locations of concealed control valves shall be provided with signage in the vicinity of each valve in a conspicuous location. The information provided on the identifying plate shall be as required by NFPA 13, including the location of the control valve, the area isolated by the valve, and the "normal" position of the valve, and shall be approved by the Engineer-of-Record prior to installation.

D. Signs shall be manufactured of metal or plastic, and shall be securely fastened.

E. A valve chart shall be provided to indicate the location of all valves with the function and areas served by said valves. The valve chart shall be accompanied by legible scaled plan views of the building indicating the relative location of all remotely located isolation valves and the bulk feed supply piping to said valves.

2.12 FLANGES

A. Flanges in threaded pipelines shall be cast iron screwed flanges.

B. Flanges in welded pipelines shall be steel weld neck or slip-on type welding flanges.

C. Flanges shall have either raised or flat faces. All flanges mating with adjacent flanges, valve fittings, and equipment shall be of the same type.

D. Flange gasket shall be 1/16 inch non-metallic, non-asbestos, ring type.

E. Flange bolts shall be carbon steel, all threaded type. Nuts shall be carbon steel hexagon type. Steel for bolt and nuts shall conform to NFPA 24 requirements.

2.13 GROOVED COUPLINGS

A. Grooved couplings shall be two-piece malleable iron or ductile iron, ASTM A536, with gasket and two bolts. Gasket shall be Buna N. Coupling shall be rated for 300 psig working pressure.

B. All mechanical fittings shall be manufactured by the same company.

C. Only full flow fittings shall be permitted.

D. Mechanical tees may be used to connect to 2 inch or larger pipe only. Mechanical tees, which incorporate a "U" bolt of hinged strap arrangement, shall not be used.

E. Fittings shall be roll grooved. Cut grooves are not permitted.

F. Flanged connection transitions shall be made via approved adapters.

G. The grooved coupling Manufacturer's Representative shall provide an on-site training session with the Sprinkler Trade Contractor's sprinkler fitters to ensure that the products are being properly installed and utilized. The Sprinkler Trade Contractor shall provide documentation of such training to the CTDOT PM.

2.14 HANGERS

A. All hanging methods shall be in accordance with the requirements contained in NFPA 13. The portion of the hanger that directly attaches to the piping or the building structure shall be listed for that purpose.

B. Fire Protection System piping shall not be supported from the bottom chord of bar joists.

C. Hangers used on sloped or angled structures shall be of the articulating beam clamp style. Do not bend or angle threaded rod.

D. All thread rod used for hanger assemblies shall be galvanized. Black all thread rod is not acceptable.

E. The use of powder driven anchors for hanging of fire protection equipment is generally prohibited. The use of powder driven anchors may be permitted for certain applications where no other reasonable alternative exists. Specific approval by the Design Build Trade Contactor's Retained Professional or the CTDOT PM is required prior to use.

PART 3 - EXECUTION – NOT USED

END OF SECTION 21 05 00

SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The Specification Section “Division 01 General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).

4. Pipeline Seal and Insulator, Inc.

5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Carbon steel.

3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.

b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 21 05 17

SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The Specification Section “Division 01 General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.

g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 21 05 18

SECTION 21 05 48 - VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

A. The Specification Section “Division 01 General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Restraining braces.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: E.
2. Seismic Design Category as Defined in the IBC: C.
   a. Importance Factor: 1.00.
   b. Response Modification Factor: 3.0.
   c. Amplification Factor: 3.0
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.403.
4. Design Spectral Response Acceleration at 1-Second Period: 0.145.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.

   b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.

2. Seismic-Restraint Details:

   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

   c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer and testing agency.

B. Welding certificates.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC and NFPA 13 unless requirements in this Section are more stringent.

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

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval by ICC-ES showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

2.2 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti, Inc.
5. Kinetics Noise Control.
6. Loos & Co.; Cableware Division.
7. Mason Industries.
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

H. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

I. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127 and NFPA 13.

2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.

3. Brace a change of direction longer than 12 feet (3.7 m).

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 21 13 13 for piping flexible connections.

END OF SECTION 21 05 48

SECTION 21 13 13 - AUTOMATIC SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The Specification Section "Division 01 General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. All Specification Sections in Division 21 form a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 WORK INCLUDED

A. This Specification applies to the installation of the automatic sprinkler systems including wet pipe, dry pipe, and pre-action sprinkler systems as described herein and by the Fire Protection Systems Construction Documents and Drawings.

B. The Sprinkler Trade Contractor shall provide a new minimum 8-inch Class 52, cement lined, ductile iron fire protection underground service line from 5-feet outside each building as shown on the drawings to each of the buildings on the site. The Sprinkler Trade Contractor shall flush the outside underground and complete the Flushing and Testing Certificate, as required by NFPA 24.

C. The Sprinkler Trade Contractor shall provide and coordinate a confirming water flow test for the site in accordance with NFPA 291, prior to submitting all hydraulic calculations/shop drawings. Include test results with the submittal. See Specification Section 21 05 00, § 1.5.F. for additional information.

D. The Sprinkler Trade Contractor shall design and install a hydraulically designed automatic sprinkler system in accordance with NFPA 13, all referenced codes, FM Global requirements, and the requirements specified under "Sprinkler System Design" below. See Specification 21 05 00 – Common Work Results for Fire Suppression for all applicable codes.

E. The Sprinkler Trade Contractor shall provide a dry type sprinkler system for use in areas subject to cold and freezing as indicated on the design drawings.

F. The Sprinkler Trade Contractor shall provide a pre-packaged, single interlocked, pre-action type sprinkler system for use in IT/Communications areas as indicated on the design drawings.

G. The Fire Alarm Trade Contractor shall provide and install all alarm and supervisory sprinkler system equipment (e.g., flow and tamper switches) for interface with the building fire alarm system. The Sprinkler Trade Contractor shall coordinate these equipment locations with all other trades as applicable.

H. The Sprinkler Trade Contractor shall provide one wall mounted fire department connections as indicated on the fire protection plans. The fire department connection shall be readily accessible to the fire department and shall not be obstructed by fences or other equipment.

I. The Sprinkler Trade Contractor shall provide flush wall mounted fire hose outlets as indicated on the fire protection plans for the full flow testing of the backflow preventers at any so equipped fire water entrance. The fire hose outlet(s) shall be connected to the outlet side of the double check detector backflow preventer with a normally closed valve.

J. The area of a sprinkler zone for each control valve shall not exceed the requirements of NFPA 13.

K. Coordinate all equipment installations with the building architectural and structural features and with the other trades to ensure a complete, supervised, and operational system. Review architectural plans to understand any varying, sloped, and open ceilings, soffits, or bulkheads throughout the building.

L. The Sprinkler Trade Contractor shall provide a wall mounted electric alarm bell as indicted on the fire protection plans. It shall be located on the rear face of the building and be at least 10 feet above grade.

1.3 SUBMITTALS

A. All submittals shall comply with any front end specification requirements as well as Section 21 05 00.

B. Product Data shall be submitted on the following items. Where more than one item, or a specific item with multiple options appear on a single cut sheet, the items shall be specifically indicated:

1. Waterflow Switches
2. Supervisory Switches
3. Sprinkler Heads, Cabinet, Escutcheons, and Guards
4. Fire Department Connection
5. Hose Valves
6. Piping, Fittings, and Mechanical Couplings
7. Hangers and Supports
8. Test/Drain Assemblies
9. Control Valves
10. Alarm Check Valves

11. Dry Pipe Valve and Appurtenances

12. Packaged Pre-action system

13. Backflow Prevention Device

14. Electric Alarm Valve

15. Means of Identification of Piping and Valves

16. Means of Identification of Concealed Control Valve Locations

17. Seismic Separation Assemblies

18. Soffit System, including product sample, color samples, and means and methods of installing

C. Operation and Maintenance

1. Data shall be submitted on the following items:

   a. Waterflow Switches
   b. Supervisory Switches
   c. Sprinkler Heads
   d. Fire Department Connection
   e. Fire Hose Valves
   f. Test/Drain Assemblies
   g. Control Valves
   h. Alarm Check Valves
   i. Dry Pipe Valve and Appurtenances
   j. Pre-action Valves and Appurtenances
   k. Backflow Prevention Device

2. Completed Final Certificates for All System Tests

D. Hydraulic Calculations

1. Data and all relevant drawings shall be submitted indicating hydraulic design calculations, flows, pressures, pipe sizes, and layout of all piping; including the outside underground to the effective point of available water supply data. Calculations and pipe layout shall also be submitted and must be approved by the AHJ and FM Global. Provide responses to any and all comments received from the AHJ and FM Global and resolution thereof to the Engineer-of-Record.

2. Include the allowance for outside hose streams and domestic usage.

3. Hydraulic calculations shall be provided for the remote area of each specific hazard class (e.g., Light, Ordinary Group 1, and Ordinary Group 2 and FM Global HC-1, HC-2 and HC-3).

4. Common piping throughout different sets of calculations shall utilize the same nomenclature.

E. Shop Drawings

1. CAD drawings shall be provided in accordance with the requirements of Section 21 05 00 and NFPA 13. Provide CAD working plan drawings and data as required by NFPA 13. The shop drawings, scaled at a minimum of 1/8 inch = 1 foot shall:

a. Provide Room Names and/or Numbers along with the reflected ceiling layout, including light fixture locations, HVAC diffuser locations, and other ceiling mounted fixtures and devices to verify that the sprinkler system layout has been coordinated with the other trades.

b. Provide the "noded" and dimensioned portion of the sprinkler system drawing independently of the reflected ceiling plan drawings (for clarity in submittal reviews).

c. Provide ceiling elevations and pipe elevations.

d. Indicate make, type, and orifice size of sprinkler heads.

e. Identify all locations where piping and/or fittings will be exposed to sight along with identification of all trapped segments of pipe and auxiliary/low-point drains.

f. Provide piping volume calculations for the Dry Pipe System.

g. Identify all walls and/or floors which are fire-rated, smoke barriers, or smoke partitions that are penetrated by the fire protection piping or equipment. Identification of the wall/floor and penetration thereto shall include the required rating, type of construction, and reference to type of penetration seal that is to be used (including UL System Number). Refer to Architectural Drawings for locations.

h. Include a diagram of all control valves, checks, drain pipes, and test pipes.

i. Include a diagram of the underground water supply to the building. Include all piping between the building and the location of the confirming water flow test data. Identify source of water supply, pressure, and elevation.

j. Provide a copy of the hydraulic design information sign that will be installed on the riser.

F. As-Builts

1. Prior to final acceptance, complete CAD as-built drawings and hydraulic calculations shall be submitted to the Engineer-of-Record for review. As-builts shall reflect all piping and head location deviations from the approved shop drawings including additional fittings.

2. Provide one half-sized, laminated set of approved as-built drawings. Install a complete set of these drawings at each sprinkler riser location.

3. Provide a copy of the revised hydraulic design information sign. Upon approval, install on each sprinkler riser.

4. Coordinate as-built submission with Section 21 05 00.

1.4 SPRINKLER SYSTEM DESIGN

A. The Sprinkler Trade Contractor is responsible for a confirming water flow test in accordance with NFPA 291. The results shall be submitted in accordance with Specification 21 05 00 - Basic Fire Suppression Materials and Methods. The pressure hydrant location utilized in the calculations shall be the effective point of the flow test. The hydraulic calculations shall utilize the confirming water flow test data at the sprinkler system demand flow rate. See Specification 21 05 00, §1.5.F. for additional information.

B. De-rate the water supply by 10% of the static pressure reading for both the static and residual pressure values.

C. Hydraulic calculations shall be done utilizing the Density/Area method outlined in NFPA 13 and shall entail all pertinent piping including all outside underground extending to the point of the aforementioned confirming water flow test data.

D. Hydraulic calculations shall not be done utilizing the Room Design Method provided in NFPA 13.

E. Dry Pipe Systems shall be designed so as to limit the volume to less than 750 gallons per system. If this volume limit cannot be met, The Sprinkler Trade Contractor must design the system to trip within the 60 second limit in accordance with NFPA 13 and calculations shall be provided to validate the maximum trip time.

F. The design area for the hydraulic calculations shall be in accordance with FM Global Data Sheet 3-26.

1. Where sprinkler head locations are not specifically shown, they shall be provided in accordance with NFPA 13 and these specifications to form a complete system.

G. The hose stream demand shall be in accordance with FM Global Data Sheet 3-26. The hose stream demand shall be added to the hydraulic calculations in accordance with NFPA 13.

H. Hydraulic calculations shall be revised and resubmitted to include all system design modifications, at no additional cost to the owner, until a satisfactory design in accordance with these specifications is provided.

I. All piping shall be concealed above finished ceilings, in chases, or in pre-engineered soffits unless otherwise indicated. Where piping cannot be run concealed (e.g., areas without ceilings), the exposed piping shall be routed in a neat and orderly fashion.

J. The Sprinkler Trade Contractor is responsible for the routing of sprinkler piping such that only piping serving the Electrical Rooms, Wiring Closets, and Telecommunication or data rooms shall be permitted to enter these rooms. Route piping so that it enters the room over the door. Routing of any piping above electrical equipment or panels shall be avoided throughout the building.

K. All sprinkler heads in areas throughout the building that are below 7 foot clearance, or subject to mechanical damage, or indicated on the Fire Protection Schedule Drawings shall be equipped with head guards.

L. Sprinklers shall be installed under all ducts or obstructions, greater than 48 inches in width, including overhead retractable doors, in accordance with NFPA 13.

M. Sprinklers near heat sources shall be provided in accordance with NFPA 13, with respect to temperature rating and location.

N. Provide an inspectors test connection for each sprinkler system zone. Test connections may be located off the system riser permitting that the initial system test can be conducted off the hydraulically most remote head. The most remote head should be an outlet with hose bib and cap. Inspector's test connections shall discharge to an accessible location on the exterior of the building.

O. All control, drain, and test connection valves shall be provided with permanently marked weatherproof metal or rigid plastic identification signs. The sign shall be secured with corrosion-resistant wire, chain, or other approved means.

P. Where zone control valves are concealed above ceilings, identification signs shall be provided in the vicinity of the control valve to indicate location of said valve, the area isolated by said valve, and normal position of said valve.

Q. All drains and inspectors test connections shall be piped to the exterior or suitably sized drain risers as indicated on the drawings.

R. Auxiliary and low-point drains shall be kept to a minimum. Auxiliary drains shall be provided in accordance with NFPA 13 except that all trapped sections shall be provided with an auxiliary drain consisting of a valve 3/4" or larger and a plug or nipple and cap. Auxiliary and low-point drains that are required to be piped to an accessible location are permitted to discharge to the building exterior, drain risers, mop receptors/sinks, or floor drains.

S. All piping and fittings on the discharge side of all drain valves shall be internally and externally galvanized.

T. Piping Restrictions: Piping is prohibited in the following areas, except when solely supplying sprinklers in such areas:

1. Electrical rooms and electrical closets.

2. Telephone rooms and telephone closets.

3. Computer rooms, MDF rooms, IDF rooms and electronic rooms.

U. Clearance from Electrical Equipment: Piping and automatic sprinklers are prohibited directly over:

1. Transformers.

2. Substations.

3. Switchboards.

4. Motor control centers.

5. Emergency generators.

6. Bus ducts.

7. Electrical panels: If installing pipe over electrical equipment is unavoidable, provide galvanized drip pans under piping or secondary contentment piping to protect electrical equipment. Provide ½ inch drain pipe from pan or secondary containment piping and terminate 6 inches above floor.

1.5 EXTRA STOCK

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets in accordance with NFPA 13, shall be finished, wall-mounted steel cabinets with a hinged cover and space for the minimum required spare sprinklers plus sprinkler wrench. Include a separate wrench for each type of sprinkler on Project.

2. Provide 3 spare sprinkler head guards for every 12 installed or portion thereof.

3. Locate code required extra stock for each system near the associated sprinkler riser.

PART 2 - PRODUCTS

2.1 ALARM VALVES

A. A minimum 4-inch alarm check valve shall be provided for each system.

B. Provide a full trim package including retard chamber.

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

1. The Viking Corporation

2. Tyco Fire Products, LP

3. Reliable

2.2 DRY PIPE VALVE

A. A minimum 6-inch Dry Pipe Sprinkler valve shall be provided where dry pipe is required. Valve shall be UL Listed.

B. Provide a full trim package including retard chamber and electric alarm bell. Provide an accelerator or other listed quick opening device on the dry or pre-action system when required to meet the time requirements of NFPA 13-2007. Provide all pressure switches, supervisory switches and low/high air pressure switches in accordance with NFPA and the manufacturer's recommendations. The trim package may be a wall-mounted, self-contained, factory assembled package with braided stainless steel connectors equal to the Viking TrimPac.

C. Provision shall be made to prevent excessive water accumulation. The dry pipe valve shall be fitted with an alarm bypass test connection so the waterflow device may be tested without opening the dry pipe valve.

D. Provide an air compressor rated for the capacity of the system. The automatic air compressor shall be capable of maintaining the required operating pressure on the dry system and capable of full recovery within 30 minutes. Compressor may be mounted on the riser if so prescribed by the manufacturer. The Sprinkler Trade Contractor shall provide the starter. Riser mounted air compressors are indicated on the Construction Drawings. Tank mounted air compressors may be used where space is available for installation. The Sprinkler Trade Contractor must coordinate the electrical requirements with the Electrical Trade Contractor.

E. The main fire alarm panel shall be used as the releasing panel for the pre-action system. Coordinate with the Electrical Trade Contractor as required for integration with the fire alarm system.

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

1. The Viking Corporation

2. Tyco Fire Products, LP

3. Reliable

2.3 PRE-ACTION SYSTEM

A. Deluge Valve (Pre-action System):

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

   a. Globe Fire Sprinkler Corporation.

   b. Reliable Automatic Sprinkler Co., Inc.

   c. Tyco Fire & Building Products LP.

d. Victaulic Company.

e. Viking Corporation.

2. Standard: UL 260.

3. Design: Hydraulically operated, differential-pressure type.

4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.

5. Air-Pressure Maintenance Device:

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

1) Globe Fire Sprinkler Corporation.

2) Reliable Automatic Sprinkler Co., Inc.

3) Tyco Fire & Building Products LP.

4) Victaulic Company.

5) Viking Corporation.

b. Standard: UL 260.

c. Type: Automatic device to maintain minimum air pressure in piping.

d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig outlet pressure.

6. Air Compressor:

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

1) Gast Manufacturing Inc.

2) General Air Products, Inc,

3) Viking Corporation.

b. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

c. Motor Horsepower: Fractional.

d. Power: 120-V ac, 60 Hz, single phase.

7. Control Panels

a. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1) Panels: UL listed and FM Global approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.

2) Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

7. Fire/Smoke detection devices – coordinate fire and smoke detection devices with Fire Alarm Contractor

2.4 ELECTRIC ALARM BELL

A. Electric alarm bells shall be a nominal 8-inch diameter with a red powder coating finish. Bell shall have a typical decibel rating of 92 dB. The bell shall be rated for use at 24VDC and approved for outdoor use (-40°F to 150°F). The bell shall be UL Listed and FM Approved and equal to model is Potter Electric Signal Company model PBD248.

B. Provide a weatherproof backbox approved for outdoor use equal to Potter Electric Signal Company model BBK-1.

2.5 SPRINKLER HEADS

A. All sprinkler heads shall be the product of a single manufacturer, UL listed, and FM approved. All heads shall be the same model year and style throughout. The Professional must approve any deviations.

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

1. The Viking Corporation

2. Tyco Fire Products, LP

3. Reliable

C. Automatic sprinklers shall have a heat responsive element complying with UL 199.

D. Sprinklers shall have an ordinary temperature rating (165°F Nominal) unless otherwise required by NFPA 13 or indicated on the Construction Documents.

E. All areas shall be provided with quick response sprinkler heads unless otherwise indicated on the Fire Protection Schedule sheets.

F. Upright or pendent type sprinkler heads having a brass finish shall be utilized in all areas without finished ceilings.

G. Semi-recessed sprinklers with chrome finish shall be utilized in areas with finished ceilings.

H. Spaces subject to corrosive atmosphere shall utilize specially coated sprinklers in accordance with the specific requirements of the manufacturer's listing, FM approval listing and NFPA 13

I. Dry-pendent or dry-horizontal type sprinkler heads shall be provided for areas subject to freezing such as loading docks. Also, utilize listed dry sprinklers where pendent sprinklers are required on Dry Pipe Systems. Do not install wet-type sprinklers in these areas.

J. Adjustable recessed sprinkler heads with escutcheons having a white factory applied finish, shall be utilized in all areas having finished ceilings.

K. Extended coverage heads are permitted in office areas only. If utilized, the specific requirements of the manufacturer's listing, FM approval listing and NFPA 13 shall apply.

L. Sprinkler head guards shall be wire-cage type and include a fastening device for attaching to sprinkler. They shall be oriented to provide the maximum accessibility for operation. Pendent heads with guards or concealed type sprinklers may be utilized in lieu of recessed heads to comply with this requirement.

2.6 SPECIALTY SPRINKLER FITTINGS

A. Specialty Fittings shall be UL listed and FM approved. They shall be made of steel, ductile iron, or other materials compatible with piping.

B. Mechanical T Fittings shall comply with UL 213 and have a ductile iron housing with pressure responsive gaskets, bolts, and threaded or locking-lug outlet.

C. Mechanical-Cross Fittings shall comply with UL 213 and have a ductile iron housing with pressure responsive gaskets, bolts, and threaded or locking-lug outlets.

D. Flexible Sprinkler Hose Fittings shall comply with UL 1474 and shall be stainless steel, braided, flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid/ceiling structure.

E. Sprinkler Drain and Alarm Test Fittings shall be UL listed and utilize a cast or ductile iron body. They shall have a threaded inlet and outlet, a test valve, and orifice and sight glass.

F. Sprinkler Branch-Line Test Fittings shall be UL listed and have a brass body with threaded inlet and capped drain outlet and threaded outlet for sprinkler.

G. Sprinkler Inspector's Test Fittings shall be UL listed utilizing a cast or ductile iron housing. They shall have a threaded inlet, drain outlet, and sight glass.

H. Provide a seismic separation assembly at building expansion joints. The assembly shall be UL listed under VIYY. Acceptable products shall be equivalent to the MetraFlex by FireLoop.

2.7 PREFABRICATED METAL SOFFITS

A. Acceptable vendors are:

1. The Soffi-Steel System by Grice Engineering

2. Superior Systems, Inc.

B. All soffits shall be 0.20 gauge steel with a smooth finish.

C. Provide all materials required by the manufacturer to be suitable for use in a correctional facility.

2.8 ESCUTCHEON PLATES

A. Provide escutcheons for all exposed pipes passing through walls, partitions, or ceiling. Escutcheons shall be steel, primed and finish painted to match adjacent wall finish.

B. Escutcheons used for ceiling sprinklers shall include oversized plate to account for seismic movement (1/4" clearance between escutcheon and ceiling membrane). This shall not apply where flexible sprinkler hose fittings are used.

2.9 BACKFLOW PREVENTION ASSEMBLIES

A. The backflow prevention device shall be a minimum 6-inch Double Check Detector type backflow prevention assembly. Backflow prevention assemblies shall be UL listed for fire protection service, listed for use in the vertical orientation (if so installed), and in accordance with the AHJ requirements.

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

1. Ames Fire and Waterworks

2. Watts Water Technologies

3. Zurn Industries, LLC

2.10 FIRE DEPARTMENT CONNECTION (FDC)

A. The FDC shall be rough brass freestanding siamese type, 2 1/2 inches by 2 1/2 inches by 4 inches, single clapper with female thread connections matching local Fire Department specifications, 2 1/2 inch caps/plugs, finish to match FDC and chains.

B. The FDC shall be equipped with an exterior wall plate labeled “AUTO SPKR” as applicable and check valve with ball drip arranged to maintain the FDC in a dry state. All exposed surfaces shall be finished to match the FDC.

C. The fire department connection shall be located so that it is easily accessible to the responding fire department.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation shall comply with all applicable codes and standards.

B. The drawings show the incoming water service and valve locations. These locations shall be adhered to as closely as possible. The indicated locations for the mains are based on proposed routings of equipment by other trades and structural elements. The Sprinkler Trade Contactor is responsible for providing coordination drawings to the Engineer-of-Record reflecting the other trades works prior to installation.

C. The Sprinkler Trade Contractor shall determine final head locations in accordance with NFPA and in coordination with the reflected ceiling plan. Any dots shown are not intended to show all actual locations or be representative of the total device count. Any heads (dots) shown on the FP drawings or reflected ceiling plans are to show intent only.

1. Sprinkler heads shall be located as required and coordinated with the Reflected Ceiling Plans. Deviations from submitted locations shall be approved by the Engineer-of-Record prior to installation.

2. Sprinkler heads shall be installed in a symmetrical and orderly fashion.

3. Sprinkler heads in suspended acoustical tile ceiling shall not be located closer than 6-inches from center of sprinkler to ceiling features including suspended ceiling grid. Where the ceiling tile is scored, creating multiple surfaces, the location of the sprinkler head shall be with respect to the surface.

4. All recessed sprinkler heads shall be equally recessed. A maximum tolerance of +/- 1/4-inch between any recessed sprinkler heads within a room or common visual area shall be accepted.

5. Positioning of sprinkler heads with respect to obstructions located below or adjacent to the sprinkler heads shall be evaluated in accordance with the requirements of NFPA 13.

6. Sprinkler heads in storage areas, janitor’s closets, and like areas shall not be located within 3 feet of the walls. If this minimum dimension cannot be met due to the room dimension or ceiling coordination features, the head shall be placed in the best alternate location.

7. Sprinkler heads shall be kept free of dirt and debris at the time of installation by covering with plastic bags or covers. Removal of the bags shall be the responsibility of the trade contractor.

8. Remove and replace heads having paint other than factory finish.

D. The Sprinkler Trade Contractor may utilize tree, loop, grid type, or combination thereof piping systems as necessary for the wet pipe system. Dry Pipe Systems shall not be gridded.

E. Concealed combustible construction shall be protected as required by NFPA 13.

F. Coordinate the work of this section with the related work specified under other sections and all Electrical Equipment locations.

G. Piping shall be pitched to permit draining of the sprinkler systems. Drain valves shall be installed at low points in accordance with NFPA 13, except that all drains shall have a 3/4 inch valve and cap or plug and nipple as a minimum.

H. The installation shall not add heads or institute pipe changes in direction or size without submitting revised calculations.

I. All piping in areas with finished ceilings shall be concealed.

J. Locate pipe runs to minimize obstructions of other work and to avoid obvious conflicts.

K. Piping shall be routed in an orderly manner, plumb and parallel to the building structure. Pendent sprinkler "drops" shall be vertical to the ceiling. Piping shall be installed to conserve building space, and in such a manner that it does not interfere with the use of space, other work, or the required headroom.

L. Where trapeze hangers are used, documentation shall be provided to the Engineer-of-Record for each such hanger indicating location, size, length, type, and all pertinent information for reviewing against the requirements of NFPA 13.

M. Changes in direction of piping shall be made with fittings.

N. "Tee" fittings with plugs shall not be used as a substitute for "Elbow" fittings unless approved prior to installation.

O. Pipe size transitions shall be made with reducing fittings. Bushings shall not be used.

P. Any sprinkler pipe, which passes through an exterior wall, shall be internally and externally galvanized.

1. Do not use welded joints with galvanized steel pipe.

2. Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise noted on the drawings.

Q. The Sprinkler Trade Contractor is ultimately responsible for:

1. Maintaining all components of the fire protection system free and clear of all dirt, debris, or other potential obstructions.

2. Not storing materials directly on the ground.

3. Making sure that the open ends of piping are plugged or capped during the construction to prevent dirt or debris from entering the pipe where pipes, fittings, and equipment are located in areas subject to dirt or debris.

4. Using methods that prevent damage, deterioration, and other loss during shipping and on-site storage. These include: using padded or strap slings, etc. as appropriate for materials being handled, lifting equipment by lift points provided or recommended by the manufacturer, and storing equipment away from the effects of rain, wind-driven dust, and other similar phenomena.

5. Coordination of sprinkler work with the fire alarm work performed under the Electrical Trade Contractor.

6. Coordination of sprinkler work with all other trades to avoid obstructions per NFPA 13.

R. Test connections shall not discharge to the interior of the building.

S. All piping on the discharge side of drain valves shall be internally and externally galvanized.

T. Provide a concrete splash block on grade for all exterior sprinkler drains.

3.2 PENETRATIONS

A. All penetrations shall be completed in a neat and orderly fashion.

B. Penetrations of fire-rated wall and/or floor assemblies shall be with a UL listed fire stopping assembly appropriate for the rating and configuration of the penetrated assembly. The number of penetrations shall be kept to a minimum. See the Architectural Drawings to verify floor or wall ratings.

3.3 JOINTS

A. Threaded joints shall be made up with a mixture of graphite and oil applied to male threads only.

B. After cutting, but prior to threading, sprinkler piping shall be reamed and deburred. Additionally, the piping shall be “wiped” out with an absorbent cloth or rag following threading operations (and prior to installation of fittings to the pipe) for the purpose of cleaning and sopping up excess oil.

C. Welded joints for steel pipe shall be fusion welded in accordance with the American Standards Code for pressure pipe, ANSI B31.1, Section 6. All welding shall be performed at the shop.

D. Flanged joints shall be made with ring type non-metallic gaskets, bolts and nuts.

E. Outside Underground Piping:

1. All piping shall be installed per NFPA 24.

2. Tie Rod Anchors:

   a. Rod and clamp type anchors shall be installed on all hub and spigot joints in underground pipe including mechanical joint and push-on joints where change in direction of pipe run occurs unless UL listed or FM approved restrained joints are used. Straight runs of pipe do not require rod and clamps.

   b. After installation, rods and clamps shall be covered with coal tar coating.

3. Thrust Blocks:

   a. Concrete thrust blocks shall be installed at each change in pipe direction on underground piping and at each tee and dead end in accordance with NFPA 24.

   b. Restrained joints that are listed in the Factory Mutual Approval Guide may be used with ductile iron pipe instead of thrust blocks or tie rod anchors.

3.4 WATERFLOW SWITCHES

A. The Sprinkler Trade Contractor shall provide vane type waterflow switches on all wet-pipe systems and pressure switches on all dry-pipe systems under this Trade Contract.

B. The Electrical Trade Contractor shall furnish and install all necessary wire, conduit, and boxes to properly connect flow switches to the fire alarm system.

C. The Sprinkler Trade Contractor shall coordinate with other trades to insure that the flow switches provided are compatible with the fire alarm system and meet the requirements of the NEC.

D. The waterflow switches shall be installed with the retard setting set to between 20 and 30 seconds.

3.5 SUPERVISORY SWITCHES/EQUIPMENT

A. Valve position supervisory switches shall be installed on all control valves.

B. This Sprinkler Trade Contractor shall provide all sprinkler valve supervisory switches under this Trade Contract including the tamper switch on the post indicator valve. The Sprinkler Trade Contractor shall also verify the make and model of all valves to ensure that the switches provided are compatible.

C. The Electrical Trade Contractor shall provide all necessary wire, conduit, and boxes to properly connect supervisory switches to the fire alarm system.

D. The Sprinkler Trade Contractor shall coordinate with the other trades to insure that the supervisory switches provided are compatible with the fire alarm system and meet the requirements of the NEC.

E. The Sprinkler Trade Contractor shall provide the high/low air pressure switch for each dry pipe and preaction sprinkler system under this trade contract.

3.6 SPRINKLER GUARDS AND SHIELDS

A. Provide and install guards on sprinkler heads where heads are 7 feet or less from the finished floor or wherever sprinklers are likely to be subject to mechanical injury.

3.7 FIRE DEPARTMENT CONNECTION (FDC)

A. Locate the FDC such that sufficient clearance from all walls, obstructions, or other equipment is provided to allow full swing of the fire department wrench handle.

B. The FDC shall be mounted at least 18 inches above pavement, sidewalks or grade adjacent to the exterior of the building.

3.8 SPECIALTY SPRINKLER FITTING INSTALLATION

A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.9 VALVE INSTALLATION

A. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and the AHJ.

B. Gate Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

C. Alarm Check Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain-line connection.

D. All valves installed in horizontal lines shall be installed with the stems horizontal or above. Valve hand wheels shall be oriented, when installed, to provide maximum accessibility for operation.

E. Dry and Preaction System Valves: Install as per the manufacturer's instructions and in compliance with NFPA 13.

F. Prepare the air compressor for connection to the system and for wiring by others.

G. Prepare the air compressor for connection to the electrical power system. Verify the low air pressure switch is monitored by the fire alarm system. Air compressors of differing voltages or phase may be available from the manufacturer. The ability to utilize a compressor of differing electrical characteristics to that specified is solely based on coordination and the availability of service. The Sprinkler Trade Contractor shall be responsible for all changes required to properly power the air compressors.

3.10 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and sprinkler mains and risers according to requirements of NFPA 13 and Specification 21 05 00.

3.11 COMMISSIONING

A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

B. Verify that air compressors and their accessories are installed and operate correctly.

C. Verify that specified tests of piping are complete.

D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

F. Verify that interconnected potable-water supplies, where permitted, have correct types of backflow prevention installed.

G. Drain dry-pipe sprinkler piping.

H. Pressurize and check pre-action and dry-pipe sprinkler piping air-pressure maintenance devices and air compressors.

I. Fill wet-pipe sprinkler piping with water.

J. Energize circuits to electrical equipment and devices.

K. Start and run air compressors.

L. Adjust operating controls and pressure settings.

M. Coordinate with fire alarm tests. Operate as required.

3.12 DEMONSTRATION

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. Schedule demonstration with Department. Allow at least 7 days advance notice.

3.13 TESTING

A. The Sprinkler Trade Contractor shall notify the Engineer-of-Record and the AHJ three weeks or more in advance of all tests to be conducted.

B. All underground piping shall be flushed prior to connection to system risers in accordance with NFPA 24 and documented as such.

C. The entire system, including the outside underground, shall be tested in accordance with the requirements of NFPA 13, NFPA 24, and all local requirements. Trade Contractor's Material and Test Certificates shall be completed, signed, and dated and included in the Operations and Maintenance Manuals. The Sprinkler Trade Contractor is responsible for obtaining copies of the Trade Contractor's Material and Test Certificates for the Underground. If such a certificate cannot be obtained, The Sprinkler Trade Contractor shall be responsible for performing the test and preparing the certificate.

D. Any retesting that is required due to failure of any test for any reason shall be conducted at no additional cost to the Department. Any corrections or repairs to the system or building necessary due to such a failure, and retesting of the system shall be performed at no cost to the Department.

E. Report test results promptly and in writing to the Engineer-of-Record and AHJ.

END OF SECTION 21 13 13

SECTION 22 00 00 – PLUMBING

PART 1 - GENERAL

1.1 SCOPE

A. This section of specifications covers plumbing systems complete as shown on the drawings and as specified herein. All systems shall be tested, balanced and made ready for operation. Plumbing systems including manufacturer's products shall be in accordance with the required and advisory provisions of the 2003 International Plumbing Code with 2009 amendments.

1.2 RELATED REQUIREMENTS

A. See Section 22 07 00 for Plumbing Insulation.

B. See Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.

C. Plans are diagrammatic and show generally the location of piping and accessories and are not to be scaled for construction measurements. All dimensions shall be verified at the building site.

D. Both the drawings and specifications shall be considered supplemental to one another so that materials and labor required by one but not by the other shall be supplied and installed as though specifically called for by both.

E. Before submitting a bid to perform the work, the trade contractor shall visit the jobsite to become familiar with the existing site conditions. This includes familiarization with existing plumbing conditions that potentially will be demolished. Any additional work caused by failure to comply with this paragraph shall be performed at no additional cost to the owner.

F. Exact locations of rough-in connections to all equipment shall be determined before any rough-in is started. All work shall be coordinated with the work of other trades to avoid conflicts.

G. The trade whose work is to be cut shall do cutting and patching in connection with the installation. The trade contractor shall lay out and install their work ahead of the work of other trades where possible.

H. All apparatus shall fit into available spaces in the building and shall be introduced into the building so as to not cause damage to the structure. All equipment shall be accessible.

1.3 TRADE CONTRACTOR QUALIFICATIONS

A. Plumbing contractor shall be a State-Certified Master Plumber or Certified Master Plumbing Contractor.

1.4 PERMITS

A. Water Heaters:

1. Make arrangements with the State Department of Labor, Safety Engineering Section, to obtain a permit and have inspected each water heater installed.

2. Trade Contractor shall pay all costs and fees. Trade Contractor shall obtain all permits as required prior to beginning work.

1.5 SUBSTITUTIONS

A. Where equipment is specified herein or on drawings by manufacturer's names or model numbers, this shall denote minimum requirements as to quality, type, capacity, function and performance.

B. Substitutions of specified items will be considered only if written request has been submitted to the CTDOT PM for approval at least ten days prior to the receipt of bid proposals. Each request shall include a description of the proposed substitute, the name of material or equipment for which it is to be substituted, drawings, cuts, performance and test data for an evaluation and a statement from the equipment manufacturer's representative that the items to be substituted meet or exceed the specifications of the item substituted for.

C. If the substitution is allowed, such approval will be set forth in an addendum. No other substitution will be allowed. Verbal approval for substitution shall not be valid.

1.6 SHOP DRAWINGS

A. General:

1. Submittals shall be prepared in pdf format.

2. Submittals shall include, but not be limited to the following:

a. Valves and specialty items.

b. Piping and fittings.

c. Drains.

d. Backflow preventers.

e. Water hammer arrestors.

f. Trap primers

g. Insulation.

h. Cleanouts.

i. Fixtures.

j. Water heating systems.

k. No-hub couplings.

l. Pumps.

m. Compressed air system.

n. Copper pipe supports in chases and plumbing batteries.

3. Submittals shall indicate compliance with specifications and drawings.

4. Include copy of relevant specifications with each submittal. In margins of specification, next to each line item, sentence or paragraph, indicate “complies” or “deviates”. If deviation, note the reasons.

5. Similarly, include copy of equipment schedules and drawing notes relevant to the submitted product. Next to each row in the equipment schedule, note compliance or deviations.

6. Include copy of drawing notes. Next to each note, indicate compliance or deviations.

7. Submittal shall include manufacturers Installation Operation and Maintenance documentation. Indicate exceptions or deviations from installation instructions, note the deviation and reasons.

8. Re-submittals shall include a Re-submittal Summary to address previous review comments shall include an explanation of how each review comment has been addressed.

9. Submittals shall be logically arranged with Acrobat PDF Bookmarks for identification and navigation thru each section. Bookmarks shall be numbered and lettered.

10. Submittals in 3-ring binders shall include an index of contents and divider tabs.

11. Submittals not complying with the format requirements will be returned and will not be reviewed.

B. Only manufacturers listed or approved by addendum will be accepted.

PART 2 - PRODUCTS

2.1 PIPING SYSTEM

A. Provide and install a complete piping system as shown on the drawings and as specified herein.

2.2 PIPING

A. Water Piping; Domestic Hot (Supply and Return) and Cold:

1. Above grade, 4 inches and smaller: Hard drawn type "L" copper tubing.

2. Below grade:

a. 1¼ inches to 3 inches: Hard drawn Type "K" copper tubing.

B. Sanitary Sewer and Vent Piping and Storm: Service weight cast iron soil pipe, hub and spigot pattern, tar coated below grade; no-hub pattern above grade.

C. High-pressure natural gas (above 1 P.S.I.), low-pressure natural gas (below 1 P.S.I.) and compressed air piping (above grade): Schedule 40 black steel. Pipe shall be manufactured per ASTM A-120 for sizes 1-1/2 inch and smaller and ASTM A-53 for sizes 2 inch and larger.

1. Piping 2 inches and smaller shall be screw type; 2½ inches and larger, weld type.

D. Expansion Loops: Expansion loops shall be provided in all plumbing pressure piping where piping crosses expansion joints. Expansion loops shall be “Metraloop” as manufactured by Metraflex, Inc. The material of the Metraloops shall correspond to the material of the distribution piping at the point where the loop will be installed. The Metraloops shall be sized to flex an amount equal to the maximum intended movement of the building at the expansion joints. The trade contractor shall coordinate the locations and amounts of movement of each expansion joint with the structural engineer. Install units per the manufacturer’s recommendations. Provide insulation on Metraloops equal in thickness to the insulation on the adjoining distribution piping.

2.3 FITTINGS

A. Copper Piping: Wrought copper. Provide reducing fittings to reduce pipe size. Bushings are not allowed.

B. Press Fittings (ProPress) as manufactured by Viega or Ridge Tool Co.: Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM.

C. Cast Iron Piping: Fittings shall be cast iron; tar coated and correspond to the pipe (hub and spigot or no-hub).

D. Black Steel Piping 2½ inches and Larger: Standard weight butt weld fittings manufactured per ASTM A 234 standards.

E. Black Steel Piping 2 inches and Smaller: Black malleable iron threaded fittings, Class 150. Fittings shall be manufactured per ANSI B16.3 standards.

2.4 JOINTS AND UNIONS

A. Solder Joints in Type L Copper Tubing and on all Copper Waste Piping: Wire solder, 95/5 lead free, in accordance with manufacturer's recommendations.

B. ProPress Connections: Copper press fittings shall be made in accordance with the manufacturer's installation instructions. The joints shall be installed using the proper tool, actuator, jaws and rings as instructed and approved by the manufacturer. Before starting any work, the trade contractor shall contact the manufacturer's representative to schedule a training session for all personnel who will be installing the press fittings. No work shall begin until the training sessions have been completed.

C. Joints in Cast Iron Pipe:

1. Joints for hub and spigot piping shall be made using one-piece elastomeric compression-type gaskets made of neoprene. Gaskets shall be marked with ASTM C 564 and the "CI" symbol of the Cast Iron Soil Pipe Institute. Gaskets shall completely fill the hub.

2. Joints for no-hub soil pipe shall be made using heavy-duty no-hub couplings conforming to ASTM C 1540. Manufacturers: Clamp-All Corporation-125series, Husky SD 4000 by Anaheim Foundry Company or Tyler Wide Body.

D. Black steel piping joints 2½ inches and larger: Metallic arc weld or gas weld with oxygen and acetylene. Welders shall be qualified per ASA B31-1 code for pressure piping.

E. Black steel piping joints 2 inches and smaller: Threaded.

F. Threaded pipe joints, general: All burrs shall be removed; pipe ends shall be reamed or filed out to size of bore and all chips shall be removed. Pipe joint compound shall be used only on male threads.

2.5 GRADES

A. Interior horizontal drainage piping of less than 3 inches diameter shall be installed with fall of not less than ¼ inch per foot. Drainage piping 3 inches diameter and larger shall be installed with fall of not less than ⅛ inch per foot, unless otherwise shown.

B. Exterior horizontal drainage piping shall be installed with minimum fall as described in foregoing paragraph, unless otherwise noted.

C. Water piping shall be graded for drainage with drain valves at low points.

2.6 FIXTURE CONNECTIONS

A. Urinals: 2 inch PVC waste arm with 2-inch PVC to MIP adapter at stack.

B. Lavatories: 1¼ inch Type "M" copper arm with 1¼-inch C-MIP adapter at stack.

C. Counter Sinks: 1½-inch Type "M" copper arm with 1½-inch C-MIP adapter at stack.

D. Hot and Cold Water Supply Piping to Fixtures: ⅜ inch brass piping, chrome plated when exposed.

2.7 IDENTIFICATION OF PIPING

A. Piping shall be labeled with snap-on pipe markers equal to Seaton "Setmark" pipe markers. Colors and legend shall be:

System	Legend	Background Color	Letter Color
Cold Water	Cold Water	Green	Black
Hot Water	Hot Water	Yellow	Black
Natural Gas	Natural Gas	Yellow	Black
Compressed Air	Compressed Air	Yellow	Black
Hot Water Return	HW Return	Yellow	Black

B. Height of letters shall be:

Outside Pipe Diameter	Letter Height	Background Length
½ inch - 1¼ inches	½ inch	8 inches
1½ inches - 2 inches	¾ inch	8 inches
2½ inches – 6 inches	1¼ inches	12 inches
8 inches – 10 inches	2½ inches	24 inches
Over 10 inches	3½ inches	32 inches

C. Install pipe markers every 15 feet and within 2 feet of each tee branch and valve and at least once in each room including mechanical rooms.

2.8 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

C. Valve-tag schedule shall be framed and mounted on the wall of the water heater room. Include a copy of the schedule in the operation and maintenance data.

2.9 VALVES, COCKS AND SPECIALTY ITEMS

A. Provide and install as shown on the plans and as specified herein.

B. ProPress ball valves may be used where applicable.

C. Gate Valves: 200 psi WOG; non-rising stem, solid wedge; solder ends and screw-in bonnet on sizes 2 inch and smaller, flanged ends and bolted bonnet on sizes 2½ inch and larger.

2 inches and Smaller	**2½ inches and Larger**
Nibco S-113	F-619
Crane 1320	461
Hammond IB647	IR1138
Stockham B-104	G-612
Kitz 41	75
Watts B-3001	406-NRS

D. Globe Valves: 200 psi WOG; 2 inches and smaller; screw-in bonnet, integral seal, renewable discs, solder ends. 2½ inches and larger: bolted bonnet, renewable seat and discs, flanged ends.

2 inches and Smaller	**2½ inches and Larger**
Nibco S-211-Y	F-718-B
Crane 1320	351
Hammond 424	IR116
Stockham B-14-T	G-512
Kitz 12	76
Watts B-4001	F-502

E. Check Valves: 200 psi WOG; horizontal swing; 2 inches and smaller; regrinding type, renewable discs, Y-pattern, solder ends. 2½ inches and larger; bolted, bonnet, renewable seat, and discs flanged ends.

2 inches and Smaller	**2½ inches and Larger**
Nibco S-413-B	F-918-B
Crane 1342	373
Hammond 18912	1R1124
Stockham B-319	G-931
Kitz 23	78
Watts B-5001	F-511

F. Ball Valves: 400 psi WOG; full port, 3-pc. construction, blow-out proof stem, solder ends.

2 inches and Smaller
Nibco 595
Apollo 82
Pittsburgh SP-B
Watts B6800
Kitz 63

G. Ball Valves: 600 psi WOG; full port, 2-pc. construction, threaded ends.

2½ inches and 3 inches
Watts FBV-1 or approved equivalent.

H. Gas Cocks: Lubricated plug valve, 150 pound; threaded ends for valves 2 inches and smaller; flanged ends for valves 2½ inches and larger. Powell 1558, 1559 or approved equivalent.

I. Hose Bibbs: Chrome plated; provide Watts 8AC or Chicago E27 vacuum breaker. Woodford 24P Chrome, Chicago 13LK, Wilkins BFP-8CH or approved equivalent.

J. Wall Hydrant with Wall Box: Woodford B65 Vacuum Breaker, J.R. Smith 5509-QT-NB, Zurn Z-1320-10, Josam 71000, Wade 8600-175, Watts HY-725.

K. Thermometers: 7 inches scale, separable socket, adjustable angle, 3½ inches stem with a scale from 30 degrees F to 240 degrees F in 2 degrees F increments. Duro 7 inch EZ, Weksler AA5a, Weiss 7VU35, Watts TA-9-3.5.

L. Pressure Gauges: 100mm, stainless steel case, glycerin filled. Weksler model 404 or approved equivalent.

M. Backflow Preventer:

1. Horizontal: Watts Series 909S and AG-F or Wilkins 975 S. Other approved manufacturers: Beeco or Febco.

2. Vertical: Watts Series 909S with AG-F and vent ell or Wilkins 975 S. Other approved manufacturers: Beeco or Febco.

N. Pressure Reducing Valve: Watts 223S or approved equivalent set to deliver pressure indicated on the drawings. Other approved manufacturers: Wilkins.

O. Gas Regulator: Provide gas regulators as called for on drawings, locate as shown on floor plans. Approved manufacturers: Rockwell, American Meter or pre-approved equivalent. All interior regulators shall be vented to the exterior of the building.

P. Vacuum Relief Valve: Watts N36. Other approved manufacturers: Wilkins.

Q. Thermal Expansion Valve: Watts #530. Other approved manufacturers: Zurn.

R. Water Hammer Arresters:

Size	**Josam**	**J.R. Smith**	**Wade**	**Zurn**	**Watts**
PDI "A"	75001	5005	W-5	Z-1700-100	SS-A
PDI "B"	75002	5010	W-10	Z-1700-200	SS-B
PDI "C"	75003	5020	W-20	Z-1700-300	SS-C
PDI "D"	75004	5030	W-50	Z-1700-400	SS-D
PDI "E"	75005	5040	W-75	Z-1700-500	SS-E

Units shall be factory charged and sealed, and constructed of stainless steel with heavy-duty balanced expansion bellows to absorb the hydrostatic shock pressure in the water piping. Units shall be extended up from the water piping to a point approximately 6 inches above the line of the finished ceiling (no elbows allowed). No access panel is required.

2.10 HANGERS; SUPPORTS; SLEEVES AND ESCUTCHEON PLATES

A. All piping shall be supported as specified herein and within 3 feet of all changes in direction.

B. All components shall be rated to carry the weight of equipment or piping to be supported.

C. Piping shall not be supported from metal decking. Piping shall be supported from beams and joists.

D. Upper Attachment:

1. Steel: Malleable "C"-clamp with locknut:

a. PHD 270

b. B-Line B-3036L

c. Elcen Fig. 25L

d. Grinnell Fig. 86

e. Michigan Hanger No. 255L

2. Steel: Beam clamp:

a. Grinnell Fig. 292

b. Other approved manufacturers: Elcen, Michigan or Tolco.

3. Channel Steel: When piping runs parallel to steel joists and cannot be hung directly from joists, provide structural steel to span two steel joists and use steel as upper attachment. Size as follows:

a. For piping up to 1¼ inch: 2 inches x 2 inches x ¼ inch.

b. For piping 1½ inch to 8 inches and for multiple runs of smaller piping: 3 inches x 3 inches x ¼ inch.

c. For larger piping, consult structural engineer.

E. Pipe Attachments: Hangers shall be sized for pipe sizes plus insulation where applicable. Insulation shall not be installed to cover hangers. Piping shall be provided with calcium silicate shields at all supports and hangers. Shield shall be standard temperature with standard finish. Refer to specification Section 15050.

1. Cast iron pipe clevis hangers:

a. B-Line B-3100

b. PHD 450

c. Grinnell Fig. 260

d. Michigan Hanger 400

e. Tolco Fig. 1

2. Copper tubing hangers:

a. B-Line B-3172CT

b. PHD 450

c. Grinnell Fig. 97

d. Michigan Hanger 106

e. Tolco Fig. 1

3. Steel pipe clevis hangers:

a. B-Line B-3100

b. PHD 450

c. Grinnell Fig. 260

d. Michigan Hanger 400

e. Tolco Fig. 1

4. Pipe shield:

a. B-Line B3380 series.

F. Trapeze Hangers: Trapeze hangers shall consist of a metal framing system of channel, fittings, and hardware as defined in the Metal Framing Manufacturer's Association Standard Publication MFMA-1:

1. Channel shall be constructed of 12-gauge steel. Nominal width shall be 1⅝ inch x 1⅝ inch with a ⅞ inch slot face opening. Provide a factory-applied coat of rust inhibiting acrylic paint.
2. Length of trapeze shall not exceed 4 feet unless trade contractor submits calculations that indicate the channel is within the manufacturer's recommendations with a safety factory of 30% added to the load.
3. Pipe clamps shall be sized as follows:

a. Non-insulated steel piping: Sized to fit piping.

b. Insulated piping: Sized to fit outside of insulation.

c. Copper piping: Sized to fit outside of piping plus elastomer isolation material.

4. Approved manufacturers: B-Line, Elcen, Michigan Hanger/Erico, Unistrut, Superstrut by Midland-Ross and Tolco.

G. Hanger Rods:

1. Piping:

a. ½ inch to 2 inches: ⅜ inch rod

b. 2½ inches to 4 inches: ½ inch rod

c. 5 inches to 6 inches: ⅝ inch rod

d. 8 inches to 12 inches: ¾ inch rod

e. 15 inches to 18 inches: 1 inch rod

f. 24 inches 1½ inch rod

H. Rod Couplings:

1. B-Line B-655.
2. Michigan Hanger 25.
3. Grinnell Fig. No. 135.
4. Tolco Fig. 70

I. Vertical Supports:

1. Offset pipe clamp:
   a. B-Line B-3148
   b. Elcen Fig. 44
   c. Michigan Hanger 700
   d. Tolco Fig. 7
2. Riser clamp:
   a. B-Line B-3373, B-3373CT
   b. PHD 551, 552
   c. Grinnell Fig. 261, CT121
   d. Michigan Hanger 510, 511
   e. Tolco Fig. 6.82

J. Horizontal Spacing:

1. Cast iron piping: (Locate supports as near as possible to joints.) 10 feet.
2. Copper tubing: (Locate supports a maximum of 1 foot from fitting joints.)
   a. 1½-inches and smaller: 6 feet.
   b. 2 inches and larger: 10 feet.
3. Steel piping: 12 feet.

K. Sleeves: Provide sleeves for all piping through building construction as follows:

1. Above grade, interior.
2. Schedule 40 galvanized steel pipe sections of sufficient size to accommodate piping and insulation (if applicable) with minimum gap of ¼ inch around pipe/insulation.
3. Exterior walls: Cast iron pipe sections.
4. Sleeves shall not be required on cast iron waste piping passing through the floor slab on grade.

5. Sleeves shall be reamed after cutting and shall be of length equal to the width of the wall such that both ends of the sleeve are flush with the wall surface; sleeves through the floor shall extend not less than 1 inch above floor slabs.

6. Annular spaces between sleeves and piping shall be filled and caulked with UL listed fire stopping sealant. Approved manufacturers are: Dow Corning #2000, Flammadur "S-System", or Standard Oil "Fyre Putty".

7. Firestop penetrators:

   a. In lieu of pipe sleeves and sealants described above, the trade contractor shall have the option to use the UL rated Pro-set firestop systems for floor and wall penetrations. Insulation on pipes shall butt against sleeve and sealed.

   b. Exposed insulation and uninsulated pipes through floors, walls, and ceilings shall be fitted with chrome plated escutcheon plates. Each plate shall be large enough to completely hide the hole around the pipe. Plates for exposed insulated pipes shall be sized for the outside diameter of the insulation. Plates shall be securely fastened in place.

L. Plumbing pipe supports within chases or plumbing batteries shall be as manufactured by Holdrite or approved equivalent.

M. Supports for piping installed on the roof shall be Miro or approved equivalent.

2.11 INSULATION

A. See Section 22 07 00 – Plumbing Insulation.

2.12 ROOF FLASHINGS

A. Provide and install waterproof flashing at all roof penetrations. The flashing roof connection shall meet the approval of the roofing material manufacturer and shall meet roof bond requirements.

B. Vent pipes passing through roof shall be flashed with 4 lb. sheet lead. Flashing shall be barrel type, extended up sides of vent pipe and turned down inside of vent pipe. Extend vent to 12 inches above the finished roof.

2.13 FLOOR DRAINS

A. General: Provide and install floor drains as shown on the drawings and as specified herein. Floor drains shall have coated cast iron bodies with cast iron double drainage flanges and bottom outlet, inside caulk connections, with strainers and special items as indicated in Schedule.

B. Schedule:

Type	**J.R. Smith**	**Zurn**	**Josam**	**Wade**	**Notes**
FD"A"	2005-P050	ZN415-5B-P	30000,5A,50	1100-1	1*
FD"B"	2350-MBG-P050	Z520-DG-Y	31120,50	1340TD-IC-DI	2*

Notes:

1. 5-inch satin finished nickel bronze top. Floor drains used in tiled shower stalls shall be flashed with 40-mil thick nonplasticized chlorinated polyethylene as manufactured by the Noble Company.
2. 8-⅛ inch ductile iron top with sediment bucket.
   * Other approved manufacturers: Watts

2.14 TRAP PRIMERS

A. General:

1. Provide trap primers on all trapped floor and hub drains that are connected to the building sanitary system.
2. Where flush valve water closets, lavatories or sinks are close enough to traps that are to be primed, provide the following: VBF-72-A1 by Sloan or Zurn ZTP for flush valve trap primers. J.R. Smith 2698 or Zurn Z1021 for lavatory/sink trap primer.
3. In areas where plumbing fixtures are not close enough to be used for trap priming, provide the following: Precision Plumbing Products, Inc. "Oregon #1, diaphragm operated automatic trap primer. Alternate: In lieu of the diaphragm type, adjustable trap primer valves (Precision Plumbing Products, Inc P1 & P2) can be used.
   a. Install trap primer at least 12-inches above the finished floor for every 20 feet of horizontal make-up water line to the traps to insure proper flow.
   b. Connect to water piping with a line pressure of 35 to 75 psi and provide isolation valve.
   c. Install on cold water piping 1-inch in size or less, which will have the highest probability of showing at least 5-10 psi pressure drop. It will usually be the water piping that will be used the most in the area. Connection to water piping shall be made with a tee pulling water off the top of the water line.
   d. The water system must be flushed before installing the trap primers.
   e. The primers shall be cycled at least six times to assure proper operation.
   f. The trade contractor shall use Teflon tape on threaded connections. Pipe "dope" shall not be used.
   g. Allow a minimum of 18-inches of straight piping below the primer before changing directions.
   h. Trap primer must be accessible. Install the units in unfinished rooms, such as janitor's closets or above ceiling space in areas where lift out tile suspended ceilings are present. Provide 12-inch x 12-inch access panel in areas with non-removable ceiling to insure access to trap primer. Coordinate location with CTDOT PM.
4. Approved manufacturers: PPP, Sloan, J.R. Smith, Zurn or Josam.
5. Provide, as shown on drawings, Precision Plumbing Products Prime-Time electronic trap priming manifold, Model PT-# or approved equivalent, for the floor and hub drains in the mechanical room. Provide with Prime Coat access door with screwdriver lock.

2.15 ROOF DRAINS

A. General: Roof drains shall be coated cast iron, with cast iron clamp ring with integral gravel stop, bottom outlet and no-hub connection.

B. Schedule:

Type	J.R. Smith	Zurn	Josam	Wade	Notes
RD"A"	1010	Z-100	21000,3	3000-52-53	1 &3*
ERD"A"	1080	Z-100-89	20010,3	3000D-52-53	2 &3*

Notes:

1. Provide under deck clamp assembly, sump receiver and plastic dome. Provide modification to standard roof drain as required to meet roofing requirements.
2. Same as note #1 but with external 2-inch water dam.
3. Provide stainless steel mesh (approx. 1/8-inch-1/4-inch openings) on all dome strainers.

2.16 CLEANOUTS

A. Provide cleanouts where shown on the drawings and as follows:

1. At a maximum spacing of 50 feet on 3 inches and smaller lines; at a maximum spacing of 75 feet on larger lines.
2. At all changes in building drain directions greater than 45 degrees.
3. At or near the foot of each vertical roof drain, waste or soil stack.
4. All cleanouts shall be accessible and shall be installed allowing a clearance of not less than 18 inches for the purpose of rodding.

B. Schedule:

Location	Finish	J.R. Smith	Zurn	Josam	Wade
Finished Floor	Nickel Bronze	4025	ZN-1400	56010	6000
Floor (hvy dty)	Ductile Iron	4220-M	Z-1400-DC	56040	6000Z
Wall	Stainless Steel	4710	ZS-1469	58600	8480R
Outside	Cast Iron	4288	Z-1403	58190	6000-CO-75

Notes:

1. Provide carpet markers for cleanouts in carpeted floors. Floor cleanout taps shall be round.
2. Provide heavy-duty cleanouts in area receiving heavy vehicle, forklift or cartloads.
3. Provide wrench with each type cleanout.
4. After installation of cleanouts, remove plug, grease threads and replace.
5. Cleanouts shall be of the same nominal size as the pipe to which they are joined, up to 4 inches. Larger piping shall use 4-inch cleanouts.
6. Provide 18-inch x 18-inch x 6-inch concrete pad around outside cleanouts.

* Other approved manufacturers: Watts

2.17 FIXTURE SCHEDULE

A. Furnish and install all plumbing fixtures complete with all equipment, fittings, trim and accessories as required for a complete installation.

B. All fixtures shall be Grade A. The name and trademark of the manufacturer shall be printed or pressed on all closets and lavatories. All fixtures shall be thoroughly cleaned after installation.

C. Fixture Schedule:

1. F-1

Water Closet, Electronic Flush Valve:
Wall Mounted, Elongated, Stainless Steel, Flush valve operated: Acorn Dura Wear 2105

Flush valve shall be Sloan ECOS Model 111-1.28 HW. Flush valve shall be hard wired, high-efficiency type (1.28 GPF) and have vandal resistant trim and sweat adapter kit.

Water closet carrier shall be Josam 12000 series, Smith 200 or 300, Wade 310 or 330 series, or Zurn ZR 1203 or ZR 1204 series or Watts ISCA-101 or ISCA-131 series.

Water closet seat shall be white, solid plastic with check hinge. Church 9900-C, Olsonite 1050, Beneke 525 CH, Bemis 1655C, Centoco 500.

2. F-2

Water Closet, Electronic Flush Valve, Handicapped Accessible:
Wall Mounted, Elongated, Stainless Steel, Flush valve operated: Acorn Dura Wear 2105

Flush valve shall be Sloan ECOS Model 111-1.28 HW. Flush valve shall be hard wired, high-efficiency type (1.28 GPF) and have vandal resistant trim and sweat adapter kit.

Water closet carrier shall be Josam 12000 series, Smith 200 or 300, Wade 310 or 330 series, or Zurn ZR 1203 or ZR 1204 series or Watts ISCA-101 or ISCA-131 series.

Water closet seat shall be white, solid plastic with check hinge. Church 9900-C, Olsonite 1050, Beneke 525 CH, Bemis 1655C, Centoco 500.

3. F-3

Urinal, Electronic Flush Valve:
Wall Mounted, Elongated rim (17-inches), Stainless Steel, Flush valve operated: Acorn Model 1709HEU, 0.125 GPF, top spud, supplied with wall carriers. Mount with rim 20-inches above finished floor.

Flush valve shall be Sloan ECOS Model 186-0.125. Flush valve shall be hard wired, high-efficiency type (0.125 GPF) and have vandal resistant trim and sweat adapter kit.

4. F-4

Urinal, Electronic Flush Valve, Handicapped Accessible:
Wall Mounted, Elongated rim (17-inch), Stainless Steel, Flush valve operated: Acorn Model 1709HEU, 0.125 GPF, top spud, supplied with wall carriers. Mount with rim 15¼-inches above finished floor.

Flush valve shall be Sloan ECOS Model 186-0.125. Flush valve shall be hard wired, high-efficiency type (0.125 GPF) and have vandal resistant trim and sweat adapter kit.

5. F-5

Lavatory, Electronic Faucet:
Wall mounted, Stainless Steel, 22-inchx20-inch, 4-inch faucet centers: Acorn Dura-Ware Model 1953LC with 4-inch faucet hole centers.

Faucet shall be a hard wired, Sloan Optima Model ETF-600-B-BDT with 0.5 gpm outlet.

Provide 1¼-inch grid drain assembly.

Trap shall be 1¼-inch, 17 gauge adjustable "P" trap with cleanout and wall plate. Exposed surfaces shall be polished chrome. Manufacturers: Brass Craft, McGuire, EBC or Watts.

Stops shall be angle type ½ inch copper sweat extension tube inlet x ⅜ inch O.D. compression risers and loose key, lock shield. Risers shall be flexible copper one-piece with insert. Exposed surfaces shall be chrome plated. Provide bell escutcheon at wall. Brass Craft CS400A-S or McGuire 170 LK, EBC LA26K or Watts B892120CLK.

6. F-6

Lavatory, Electronic Faucet:
Wall mounted, Stainless Steel, 22-inchx20-inch, 4-inch faucet centers: Acorn Dura-Ware Model 1953LC with 4-inch faucet hole centers.

Faucet shall be a hard wired, Sloan Optima Model ETF-600-B-BDT with 0.5 gpm outlet.

Provide 1¼-inch offset grid drain assembly.

Trap shall be 1¼-inch, 17 gauge adjustable "P" trap with cleanout and wall plate. Exposed surfaces shall be polished chrome. Manufacturers: Brass Craft, McGuire, EBC or Watts.

Stops shall be angle type ½ inch copper sweat extension tube inlet x ⅜ inch O.D. compression risers and loose key, lock shield. Risers shall be flexible copper one-piece with insert. Exposed surfaces shall be chrome plated. Provide bell escutcheon at wall. Brass Craft CS400A-S or McGuire 170 LK, EBC LA26K or Watts B892120CLK.

7. F-7

Sink, Stainless Steel, Manual Faucet, Handicapped Accessible:
Single compartment, 18 gauge stainless steel: Elkay LRAD2222, 6½-inch deep with off-centered rear outlet.

Faucet shall be Elkay Model LKE4123 with single lever, gooseneck faucet and hose spray. Provide with 1.5 gpm aerator.

Sink Drain shall be Elkay LK18 stainless steel drain fitting with perforated 3-inch grid strainer. Provide 1½-inch offset tailpiece by Elkay, American Standard, Brass Craft or McGuire.

Trap shall be 1½-inch, 17 gauge adjustable "P" traps with cleanout and wall plate. Exposed surfaces shall be polished chrome. Manufacturers: Brass Craft, McGuire, EBC or Watts.

Stops shall be angle type ½ inch copper sweat extension tube inlet x ⅜ inch O.D. compression risers and loose key, lock shield. Risers shall be flexible copper one-piece with insert. Exposed surfaces shall be chrome plated. Provide bell escutcheon at wall. Brass Craft CS400A-S or McGuire 170 LK, EBC LA26K or Watts B892120CLK.

8. F-8

Shower Head and Valve:
Pressure balanced shower valve with lever handle, adjustable stop screw, integral service stops and 1.5 gpm showerhead. Polished chrome finish. Symmons C-96-1-1.5-X. Other approved manufacturers: Chicago, Leonard Pam II

9. F-9

H.C. Shower:
Symmons Model C-96-500-B30-V-X-L\HD-1.5, pressure balanced mixing valve with lever handle, integral service stops, adjustable stop screw, hand held shower head, flexible metal hose, inline vacuum breaker, 30-inch adjusting bar diverter valve and fixed shower head. Other approved manufacturers: Chicago, Leonard Pam II.

10. F-10

Service Sink:
Floor mounted, Fiat TSB-100, 24-inchx24-inchx12-inch. Provide with stainless steel caps on all curbs. Faucet shall be Fiat 830-AA with 832-AA hose and bracket. Also provide Fiat MSG-2424 stainless steel wall guard. (Equal fixture by Stern-Williams) (Equal faucet by American Standard or Kohler)

11. F-11

Electric Water Cooler (Bi-Level):
Wall mounted, stainless steel finish, push button actuated, 7.8 GPH of 50 deg. F water at 90 deg. F ambient air temperature.
Cooler: Oasis P8AMSL. Other approved manufacturers: Halsey Taylor, Elkay, Haws, Sunroc

Trap shall be 1½-inch, 17 gauge adjustable "P" traps with cleanout and wall plate. Exposed surfaces shall be polished chrome. Manufacturers: Brass Craft, McGuire, EBC or Watts. See Note 1.
Stops shall be angle type ½ inch copper sweat extension tube inlet x ⅜ inch O.D. compression risers and loose key, lock shield. Risers shall be flexible copper one-piece with insert. Exposed surfaces shall be chrome plated. Provide bell escutcheon at wall. Brass Craft CS400A-S or McGuire 170 LK, EBC LA26K or Watts B892120CLK.

12. F-12

Work Sink:
Elkay model EWS2520W6C, Single compartment, wall mounted sink complete with gooseneck faucet with wrist blade handles and grid strainer drain.

Trap shall be 1½-inch, 17 gauge adjustable "P" traps with cleanout and wall plate. Exposed surfaces shall be polished chrome. Manufacturers: Brass Craft, McGuire, EBC or Watts.

Stops shall be angle type ½ inch copper sweat extension tube inlet x ⅜ inch O.D. compression risers and loose key, lock shield. Risers shall be flexible copper one-piece with insert. Exposed surfaces shall be chrome plated. Provide bell escutcheon at wall. Brass Craft CS400A-S or McGuire 170 LK, EBC LA26K or Watts B892120CLK.

13. F-13

Emergency Shower/Eyewash: Bradley model S19-310DC. Piping shall be galvanized steel with “Bradtect” safety yellow coating. The shower pull rod, eyewash bowl and hinged dust cover shall be constructed of stainless steel. Other approved manufacturers: Guardian, Acorn

14. F14

Emergency Eyewash: Bradley Model S19-220DC eyewash with wall bracket & dust cover. Eyewash bowl, hinged dust cover and push handle shall be constructed of stainless steel. Other approved manufacturers: Guardian, Acorn

15. F-15

Recessed Valve Box: Water Tite 9000 w/ valve installed Oatley 38680

D. Plumbing Fixtures Notes:

1. See Specification Section 220700, Plumbing Insulation, for piping insulation requirements.
2. Approved manufacturers for plumbing fixtures: Kohler, American Standard, TOTO, Crane, Eljer, Elkay, Just, Bradley, Acorn, or as specified in the schedule above.

2.18 DOMESTIC WATER HEATING SYSTEMS

A. Provide and install water heaters where shown. Units shall meet ASHRAE 90.1B-1992 energy efficiency requirements. Units shall have capacity as follows:

1. WH-1: Gas Fired, Storage Type:

   a. Recovery: The water heater shall be condensing, natural gas fired with an input of 399,000 BTU/hour and have a storage capacity of 130 gallons. The unit shall be rated at 95% efficiency.

   b. Basis of design: A.O. Smith Cyclone Xi, Model BTH 400. Other approved manufacturers: PVI and Lochinvar.

2. General Notes:

   a. See electrical drawings for wiring requirements.

B. Recirculating Pump, CP-1: Provide all bronze recirculating pump capable of pumping 5 GPM at 16 feet of head. Grundfos UP 25-64 SU. Other approved manufacturers: B & G or Taco.

C. Thermostatic Mixing Valve Assembly – Master Mixer at Water Heater: Shall be Symmons Tempcontrol model 5-1000-BM-T thermostatic controller with stainless steel surface mounted cabinet, swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid filled thermal motor with bellows mounted out of the water. Unit shall be able to flow 27 gpm with less than 5 psi pressure drop.

D. Thermostatic Mixing Valve Assembly – All Emergency Eye-Washes: Shall be Bradley Model S19-2000 with surface mounted cabinet. Unit shall be factory set at 85 deg. F. Other approved manufacturers: Haws, Lawler, Guardian, Leonard

E. Thermostatic Mixing Valve Assembly – All Emergency Showers/Eye Washes: Shall be Bradley Model S19-2200 with surface mounted cabinet. Unit shall be factory set at 85 deg. F. Other approved manufacturers: Haws, Lawler, Guardian, Leonard

F. Temperature and Pressure Relief Valve: Provide an ASME approved valve on each storage type water heater.

G. Thermal Expansion Tank: ASME rated, with steel outer shell, pre-charged air chamber, butyl diaphragm and polypropylene lines. Factory charge to 55 P.S.I., Watts DETA-12. Other approved manufacturers: Flexcon, AMTROL.

2.19 CONCRETE PAD

A. Provide 4-inch thick reinforced concrete pad under water heater. Chamfer around edges at 45-degree angle.

2.20 SPECIALTY ITEMS

A. Provide and install thermometers, ASME rated T&P relief valves, ball valves, check valves, piping, etc. as shown on piping diagram.

2.21 AIR COMPRESSOR

A. The air compressor shall be a packaged unit, electrically operated, single stage compressors mounted on a horizontal receiver. Unit shall come complete with pumps, motors, receiver, controls, check valve, service and safety valves, pressure gauge and switches, belt guard, etc. Provide cycling refrigerated air dryer, general purpose filter, high efficiency filter, valves, etc. for a complete and operable system.

B. Basis of Design:

1. Ingersoll Rand 2-2545E10-P. Other approved manufacturers: Kellogg American, Saylor-Beall.

2. Refrigerated Air Dryer. Ingersoll Rand D127NC. Other approved manufacturers: Kellogg American, Saylor-Beall.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install materials and equipment according to the codes and standards previously specified, and the manufacturer's printed instructions. When fixtures require both hot and cold water supplies, provide hot water supply left of the cold water supply.

B. Threaded Connections: Use Teflon pipe thread tape.

C. Solder End Valves: Remove stems and washers and other item subject to damage by heat during installation; reassemble valve after soldering. Valves without heat sensitive parts do not require disassembly but shall be opened at least 2 turns during soldering.

D. Dielectric Connections: Provide at all connections between non-ferrous and ferrous metal piping materials.

E. Valves: Install valves in positions accessible for operation and repair, and with the stems horizontal or above.

F. Utilities: The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves, which are supplied with integral stops, shall be equipped with a shut-off valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, showerheads, and flush valves shall be anchored to prevent movement.

G. Cutting and Repairing: The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired to match existing by mechanics skilled in the trade involved.

H. Cutting and Patching of Concrete: If cutting of concrete is required for underground pipe installation, the concrete shall be patched to match the type, strength and appearance of the surrounding concrete. This work shall be coordinated with the general trade contractor.

I. Protection to Fixtures, Materials, and Equipment: Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

J. Mains, Branches, and Runouts: Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Care shall be taken not to weaken structural portions of the building. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings will be kept a sufficient distance from other work and other services to permit not less than ½ inch between finished coverings on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. No water pipe shall be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted. Change in direction shall be made with fittings.

3.2 PRESSURE TESTS

A. Plumbing and associate systems shall be subjected to constant inspection and final approval of the CTDOT PM and code authorities having jurisdiction. Tests, in addition to those included in this section required to show compliance, shall be performed as directed.

B. Test shall be conducted as indicated in the following schedule. The specified test pressure shall be maintained for four hours. There shall be no drop in pressure during the test. All copper piping shall have the joints struck during the test.

C. Schedule:

Pipe System	**Test Pressure**	**Type Test**
Soil, Waste, Vent and Storm	10 Ft.	Water Head
Potable Water	150 PSI	Hydrostatic
Natural Gas	50-PSI	Air
Compressed Air	150-PSI	Air

D. All work found to be defective or indicating leakage shall be removed and replaced with new materials. Tests shall be repeated until systems are proved tight. Hydrostatic test shall not be conducted in freezing weather. Caulking of screwed and welded joints will not be acceptable.

3.3 CLEANING; PROTECTION AND ADJUSTING

A. The Trade Contractor shall remove from the job site all debris and left-over materials for which he is responsible, clean all fixtures and equipment and repair any blemishes in the finish. The Trade Contractor shall be held responsible for replacing fixtures where damage results from failure to provide protection.

B. Flush Out Pipes: After the plumbing piping has been installed, inspected and approved, the piping system (water) shall be flushed to remove any foreign matter from the pipes. The piping system shall be sterilized with chlorine HTH solution to sanitize the new piping at a ratio of 50 parts per million for 24 hours or 200 parts per million for 3 hours. After system has been cleaned, flush entire system.

C. Adjusting: All fixtures shall be tested to insure proper operation of all working parts and adjusted to provide proper water flow.

3.4 PAINTING

A. All exposed iron and steel hangers, angles, channels and clamps, furnished and installed by the plumbing trade contractor, shall be given at least one field coat of primer paint and one field coat of finish paint, color to be selected by the CTDOT PM.

B. Equipment shall be touched up or repainted where original finish was scratched or damaged during shipping or installation.

C. Exposed steel piping shall be given one coat of primer paint and one coat of finish paint, color to be selected by the CTDOT PM.

3.5 MAINTENANCE

A. All parts of the plumbing fixtures and associated equipment shall be maintained by the Trade Contractor throughout the guarantee period. One month after final acceptance of the building by the Owner, the Trade Contractor shall go over all fixtures and test all working parts and put everything in working order. All fixtures, including traps, shall be thoroughly cleaned and all parts put in working order. This work is in addition to that involved under the paragraph "Guarantee". Two copies of a report of completion of this requirement shall be forwarded to the CTDOT PM.

3.6 GUARANTEE

A. All equipment and materials furnished and all work performed under this section shall be guaranteed to be free of defective materials and workmanship for a period of eighteen months from date of substantial completion.

B. Upon notice from the Owner of failure of any part of the guarantee equipment during the guarantee period, the affected part or parts shall be promptly replaced with new parts by the Trade Contractor at no additional cost to the Owner. All labor required to perform guarantee shall be included as part of the complete guarantee warranty.

END OF SECTION 22 00 00

SECTION 22 07 00 – PLUMBING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section Includes:

1. Pipe system insulation.

B. Related Sections:

1. Mechanical General Provisions: Section 23 00 00
2. Common Work Results for HVAC: Section 23 05 00
3. Plumbing: Section 22 00 00
4. Fire stops: Division 07.

1.2 SUBMITTALS

A. Submit for each type of insulation and accessory. Include installation instructions and manufacturers recommendations.

B. Include manufacturer's product number, K-value, thickness, and accessories in tabular forms for each type of different application.

C. See Section 22 00 00 for additional general requirements.

1.3 QUALITY ASSURANCE

A. Conform to "National Commercial and Industrial Insulation Standards."

B. For All Insulation Above Ground: Flame spread index 25; smoke developed index 50.

C. Insulation and Ancillary Materials: Rated in accordance with ASTM E 84, NFPA 255, or UL 723. Affix manufacturer's stamp or label showing fire/smoke indexes on shipping containers or insulation.

1.4 DEFINITIONS

A. The term "concealed" used in this Section of Specifications shall apply to items located in furred spaces, pipe shafts, spaces above ceilings or below raised floors, and trenches with solid covers. The term "exposed" shall apply to items that are not concealed.

B. The term "fittings" used in this Section of Specifications refers to all types of fittings including solder type, weld type, screwed and flanged fittings, also all elbows, tees, wyes, valves, couplings, hubs, traps, strainers, thermometer wells and similar devices that are part of the piping system.

C. The term "valves" used in this Section of the Specifications refers to all types of manual valves, automatic valves, stops, cocks, flow regulators and similar devices.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Fiberglass Insulation:

1. For piping:
   a. Description: Conforming to ASTM C 547 Class 1.
   b. Conductivity: 0.23 Btu-in/hr-sq.ft.-deg F at 75 deg F.
   c. Pipe operating temperature range: 0-850 deg F.

2. For pipe fittings:
   a. Description: Preformed compressed fiberglass or batt as specified with piping system.

3. Acceptable manufacturers:
   a. CertainTeed Corporation.
   b. Knauf Fiber Glass GmbH.
   c. Johns Manville Corporation.
   d. Owens-Corning Fiberglas Corporation.

B. Flexible Unicellular Insulation:

1. For piping:
   a. Description: Flexible elastomeric, expanded closed cell, conforming to ASTM C 534 Type III.
   b. Thickness: 1 inch.
   c. R-value: 3.33 degrees F x sq. ft. x hour per BTU per inch at 75 degrees F.
   d. Color: White or field applied white finish sealant.

2. Acceptable manufacturers:
   a. Armstrong World Industries, Inc.
   b. Rubatex Corporation.

C. Molded Closed Cell Vinyl:

1. Description: Smooth closed cell vinyl, 3/16-inch thick, molded shapes for handicapped fixture insulation, internal ribs, weep hole, hinged caps for valve access.

2. Conductivity: 1.17 Btu-in/hr-sq ft-deg F.

3. Manufacturers: Truebro, Inc., ProWrap by McGuire.

2.2 JACKETING MATERIALS

A. All Service Jacket (ASJ):

1. Description: Kraft reinforced foil, factory applied to insulation.
2. Water vapor permeance: .02 perm per ASTM E 96.
3. Puncture resistance per ASTM D 781: 50 units.
4. Fasteners: Factory applied double pressure sensitive longitudinal joint.

B. PVC:

1. Description: White gloss finish, with UL 25/50 flame/smoke listing.
2. Water vapor permeance: 0.07 perm per ASTM E 96 at 0.022 inch thick.
3. Thickness: 0.020 inches.
4. Fasteners: Vapor seal mastic or tape, unless specified otherwise with piping system.

2.3 PIPING INSULATION APPLICATIONS

A. Plumbing Piping Receiving AC Condensate:

1. Location: Indoor, above ceilings.
   a. Type: Fiberglass.
   b. Thickness: 1 inch thick for piping up to and including 3 inch, 1-1/2 inches thick for piping over 3 inch.
   c. Jacket:
      1) Piping: All-service.
      2) Fittings: PVC.

2. Location: Indoor, where exposed in mechanical rooms.
   a. Type: Flexible unicellular.
   b. Thickness: 1/2 inch thick for piping under 2-1/2 inches, 1 inch thick for piping 2-1/2 inches and over.
   c. Jacket:
      1) Piping: None.
      2) Fittings: None.

B. Potable, and non-potable, water piping (includes make-up water for closed HVAC systems).

1. Location: Indoor.
   a. Type: Fiberglass.
   b. Thickness: 1/2 inch.
   c. Jackets:
      1) Piping: All-service.
      2) Fittings: PVC.

C. Potable Hot Water and Recirculating Piping:

1. Location: Indoor.
   a. Type: Fiberglass.
   b. Thickness: 1/2 inch thick for piping up to and including 1-1/4 inch, 1 inch thick for piping greater than 1-1/4 inch up to and including 2 inch, 1-1/2 inch thick for piping greater than 2 inch.
   c. Jackets:
      1) Piping: All-service.
      2) Fittings: PVC.

D. Potable Water and Drains at Handicapped Fixtures:

1. Location: Indoor, for P-trap, tailpiece, valves, offsets for wheel chair and all exposed piping and fittings.
   a. Type: Molded closed-cell, vinyl.
   b. Color: White.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean and dry surfaces prior to insulating.

B. Provide positive ventilation in enclosed areas where volatile materials are used to apply insulation.

3.2 INSTALLATION

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

B. See Section 23 00 00 for additional general requirements.

C. Install insulation on pipe systems after acceptance of leak test results, installation of heat tracing, and painting, where applicable.

D. Install insulation materials to obtain smooth and even surfaces. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be insulated. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

E. Maintain integrity of vapor retarder on insulation.

F. Extend insulation without interruption through walls, floors, and similar penetrations, unless otherwise indicated.

G. Do not apply insulation to hot surfaces.

H. Notify CTDOT PM two weeks before insulation work will begin to allow observation of uninsulated pipe systems.

3.3 PIPE INSULATION

A. Insulate the entire piping system for all systems indicated under Applications.

B. Insulate valves, fittings, and similar items with the same material and thickness of insulation as applied to adjoining pipe run. Install factory-molded, precut, or job-fabricated units except where otherwise indicated.

C. Butt pipe insulation against pipe hanger insulation inserts.

D. For hot pipes, apply 3-inch-wide vapor retarder tape or band over the butt joints.

E. For cold piping, apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3-inch-wide vapor retarder tape or band.

F. Unions and Strainers: Use removable insulation segments. Arrange segments to permit access to strainer removal cap or plug and unions by slitting tape at the joints.

G. Omit Insulation from the Following:

1. Chrome-plated exposed piping (except for handicapped fixtures).
2. Fire protection piping.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Pipe supports specified in Section 23 05 29 requirements for thermal pipe supports.

B. Fire stops specified in Division 07.

3.5 PROTECTION

A. Provide instruction required for protection of insulation to installers of related work during construction period, to avoid damage and deterioration.

3.6 CLEANING

A. Repair and clean insulation surfaces to achieve a new appearance.

B. Clean insulation, using materials and methods recommended by manufacturer.

3.7 GUARANTEE

A. All equipment and materials furnished and all work performed under this section shall be guaranteed to be free of defective materials and workmanship for a period of eighteen months from date of substantial completion.

B. Upon notice from the Owner of failure of any part of the guarantee equipment during the guarantee period, the affected part or parts shall be promptly replaced with new parts by the Trade Contractor at no additional cost to the Owner. All labor required to perform guarantee shall be included as part of the complete guarantee warranty.

END OF SECTION 22 07 00

SECTION 22 08 00 – PLUMBING SYSTEMS COMMISSIONING

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Trade Contract, including General and Supplementary Conditions and Notice to Trade Contractor Sections, apply to this Section. Refer to NOTICE TO TRADE CONTRACTOR – COMMISSIONING for a full description of the commissioning process and requirements.

1.2. SUMMARY

A. Commissioning consists of systematically documenting that specified components and systems have been installed and started up properly and then functionally tested to verify and document proper operation through all sequences of operation and conditions. In addition, training of the Owner's Operations Personnel will be verified and final project O&M Documents will be reviewed for completeness.

PART 2 – PRODUCTS

2.1. FUNCTIONAL PERFORMANCE TESTING EQUIPMENT AND INSTRUMENTS

A. The appropriate Trade Contractor(s) shall furnish all special tools and equipment required during the entire commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted to the Commissioning Authority for approval. The owner shall furnish necessary utilities for the commissioning process.

B. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the owner upon completion of the commissioning process.

PART 3 – EXECUTION

3.1. GENERAL

A. The Trade Contractor shall complete all phases of work so the systems can be started, tested, balanced, and acceptance procedures undertaken. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, and change orders.

3.2. PARTICIPATION IN ACCEPTANCE PROCEDURES

A. The Trade Contractor shall provide skilled technicians to startup and debug all systems within the project contracted work. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program. Work schedules, time required for testing, etc., shall be requested by the Commissioning Authority and coordinated by the trade contractor. Trade Contractor shall ensure that the qualified technician(s) are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

B. System performance problems and discrepancies may require additional technician time, Commissioning Authority time, reconstruction of systems, and/or replacement of system components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.

C. The Commissioning Authority reserves the right to question the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or sub-system. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the Commissioning Authority. Trade Contractor shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.3. DEFICIENCY RESOLUTION

A. In some systems, misadjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the Owner, with input from the trade contractor, equipment supplier, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Owner and/or CTDOT PM shall have final jurisdiction over any additional work done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to demonstrate system performance may be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority shall notify the Owner, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the trade contractor's responsibility.

3.4. SUSTAINING SYSTEM READINESS

A. Refer to Section 019100, General Commissioning Requirements for Pre-Functional Checklist requirements and expectations.

3.5. FUNCTIONAL PERFORMANCE TESTING

A. The trade contractor shall demonstrate to the Engineer and the Cx Authority the performance of the following Plumbing Systems to the performance level identified.

1. Domestic Hot Water System:

a. System / Equipment to be tested:
   1) Domestic Water Heaters
   2) Circulating Pumps
   3) Mixing Valves

b. Functions to be tested:
   1) Water temperature water heater inlet and outlet
   2) Water temperature and heating time at selected plumbing fixtures

c. Conditions of the test:
   1) System in normal operational condition.

d. Acceptance criteria:
   1) System heats water as designed

3.6. STARTUP

A. The trade contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in section 019100. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA and CM/GC. Beginning system testing before full completion does not relieve the Trade Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

END OF SECTION 22 08 00

SECTION 22 13 13 – FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 INTRODUCTION

A. The Work specified in this Section, includes furnishing and installing a sanitary sewer main at the locations and to the lines, grades, dimensions, and details shown on the drawings, complete as shown, specified and directed.

1.2 DESCRIPTION

A. Work included:

1. Trench excavation of earth.
2. Preparation of bed.
3. Installation of pipe and appurtenances.
4. Installation of manholes.
5. Installation of service connections.
6. Backfill of trench.
7. Testing of sewer.

B. Related work described elsewhere:

1. Section 01 25 00 – Substitution Procedures
2. Section 01 33 00 – Submittal Procedures
3. Section 01 33 00.13 – Document Control
4. Section 01 45 00 – Quality Control
5. Section 01 55 26 – Traffic Control
6. Section 01 57 26 – Site Watering for Dust Control
7. Section 03 30 00 – Cast-in-Place Concrete
8. Section 31 11 00 – Clearing and Grubbing
9. Section 31 23 23 - Fill
10. Section 31 23 16.13 – Trenching
11. Section 31 23 19 – Dewatering
12. Section 31 35 19.17 – Geotextile (Separation-High Survivability)
13. Section 31 41 00 – Shoring
14. Section 32 11 23 – Aggregate Base Courses
15. Section 32 12 16 – Asphalt Paving

16. Section 33 11 00 – Clearing and Grubbing

1.3 QUALITY ASSURANCE (See Section 01 45 00 – Quality Control)

A. Provide one person who shall be present at all times during execution of the work, who is thoroughly familiar with the types of materials used and execution of the work, and who shall direct all work under this section.

B. Use all means necessary to protect materials and appurtenances before, during, and after installation including proper storage. Follow the manufacturers' recommended procedures for unloading, storage and installation where applicable.

C. In the event of damage or theft, make all repairs and replacements necessary, subject to approval by the CTDOT PM, at no additional cost to the Owner.

D. Soils Testing: Compaction tests shall be Standard Proctor (ASTM D698) as required in Part 3 - Execution. Trade Contractor shall engage a soils testing and inspection service for sieve analysis and compaction tests during earthwork.

E. Trade Contractor shall provide the necessary equipment or secure a testing firm to conduct pressure, leakage, infiltration, deflection, and lamping tests on the installed utilities, and, if required, concrete testing and loaded truck test.

F. Comply with all applicable standards referenced herein and all conditions required by State or local permits.

1.4 SUBMITTALS (See Section 01 33 00 Submittal Procedures and Section 01 33 00.13 – Document Control)

A. Within 30 days after the Award of Trade Contract, and before materials and/or equipment are delivered to the site, submit to the CTDOT PM technical information on equipment to be furnished and certification of compliance with applicable standard tests for materials to be used, if materials and/or appurtenances are other than brand names specified.

B. Where the phrases "or equal" or "of equal quality" appear, substitution may be made only by approval of the CTDOT PM. Such substitution will be considered only when submitted with full and complete technical data and information for evaluation prior to installation. (See Section 01 25 00 Substitution Procedures).

C. An independent testing company, approved by the CTDOT PM, shall obtain samples and provide sieve analysis for the granular materials to be used.

D. An independent testing company, approved by the CTDOT PM, shall provide compaction tests as required.

E. An independent testing company, approved by the CTDOT PM, shall provide current concrete design mix with a 7 day and two 28 day compressive strength tests for any concrete requiring reinforcing steel.

F. Provide minimum of 48-hour notice to CTDOT PM, and a written authorization notice to proceed from the affected utility, before interrupting any utility.

G. Submit written results of all tests on the installed utilities and appurtenances to the CTDOT PM.

H. Verify that all materials and equipment will be available in time for orderly installation during the course of the work.

1.5 JOB CONDITIONS

A. Pipe lengths indicated on the drawings are for information only. Furnish lengths as required.

B. Perform no pipe work in fill areas until the embankment or fill has been completed to at least 2 feet above the top of the pipe and has been properly compacted. The CTDOT PM will request compaction tests at the Trade Contractor's expense. (See Section 01 45 00 Quality Control)

C. Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that the Owner shall not be responsible for interpretations or conclusions drawn there from by the Trade Contractor. Data are made available for the convenience of the Trade Contractor. Additional test borings and other exploratory work may be made by the Trade Contractor at no cost to the Owner.

D. Existing Utilities: Locate existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations.

1. The Trade Contractor shall contact Call Before You Dig (1-800-922-4455) or Dial 811 prior to excavation.

2. The Trade Contract Documents show existing underground utilities based on above ground observations or record drawings. The Trade Contractor shall anticipate that the actual location or existence of any utility may vary from that shown. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult the utility owner immediately for directions. Cooperate with the Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner.

3. Do not interrupt existing utilities serving facilities occupied and used by the Owner or others, except when permitted in writing by the affected utility and then only after acceptable temporary utility services have been provided.

4. Demolish and completely remove from the site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

5. If pipe adjustment is necessary due to the locations of other utilities, secure approval from the CTDOT PM.

E. Do not change pipe sizes without securing written approval of the CTDOT PM.

F. Use of Explosives: Do not bring explosives onto the site or use in work without prior written permission from authorities having jurisdiction. Trade Contractor is solely responsible for handling, storage, and use of explosive materials when their use is permitted.

G. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights as required in Section 01 55 26 – Traffic Control as modified herein.

1. Operate warning lights as recommended by authorities having jurisdiction.

2. Protect structures, utilities, sidewalks pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

H. Refer to Section 01 57 26 – Site Watering For Dust Control for dust control procedures during construction.

I. Refer to Section 31 11 00 – Clearing and Grubbing for procedures regarding the protection of existing trees and vegetation.

J. Trade Contractor shall comply with the latest rules of the Connecticut Occupational Safety and Health Administration (CONN-OSHA).

1.6 TESTING LABORATORY SERVICES (See Section 01 45 00 Quality Control)

At least 1 passing compaction test shall be conducted in each lift for each 100 cubic yards of material. The Trade Contractor shall conduct a sieve analysis for the subbase materials to insure that the materials are in accordance with the specifications and that compaction requirements can be met. All testing will be run at the Trade Contractor's expense.

PART 2 - PRODUCTS

2.1 SUITABLE BACKFILL

A. Suitable backfill shall consists of on-site or borrow material of soil or soil-rock mixture free from organic material and other deleterious substances. The material shall contain no rocks or lumps larger than 3 inches in diameter. Material must be approved by the CTDOT PM prior to use.

Sieve No.	Percent Passing Sieve	Sieve (metric)
3 inches	100	75 mm
No. 4	45 - 75	4.75 mm
No. 100	0 - 12	150 mm

No. 200	0 - 6	75 mm

B. Borrow material shall meet the requirements of this section and be granular in nature and show evidence of satisfactory compaction.

2.2 GRANULAR BACKFILL

Granular Backfill shall consist of broken or crushed stone, broken or crushed gravel, or reclaimed miscellaneous aggregate in conformance with the requirements of Section 31 23 23 – Fill.

2.3 PIPE BEDDING

Pipe bedding shall be No. 6 crushed or broken stone conforming to the requirements of Section 31 23 23 – Fill.

2.4 CONCRETE

Concrete shall be termed Class C (3000 psi) and meet the requirements of Section 03 30 00, Cast-in-Place Concrete.

2.5 REINFORCEMENT

Reinforcing bars shall meet the requirements of Section 03 20 00.

2.6 GEOTEXTILE (SEPARATION – HIGH SURVIVABILITY)

Geotextile shall conform to the requirements of Section 31 35 19.17.

2.7 POLYVINYL CHLORIDE PIPE (PVC)

A. Polyvinyl chloride pipe, SDR 35, meeting the requirements of ASTM D3034 with nominal inside dimensions as shown on the Trade Contract Drawings shall be provided.

B. Joints shall be of bell-and-spigot type, of the same composition as the pipe, and have a rubber ring factory installed and locked in place.

C. Fittings shall be compatible with and of the same class as the sewer pipe.

2.8 WARNING/IDENTIFICATION TAPE WITH TRACER WIRE

A. Tape shall be an inert, non-metallic plastic film formulated for prolonged underground use that will not degrade when exposed to alkalis, acids and other destructive substances commonly found in soil.

B. Tape shall be puncture-resistant and shall have an elongation of two times its original length before parting.

C. Tape shall be colored to identify the type of utility intended for identification. Printed message and tape color shall be as follows:

Printed Message	Tape Color
Caution: Waterline Buried Below	Blue
Caution: Gas Buried Below	Yellow
Caution: Sewerline Buried Below	Green
Caution: Cathodic Protection Cable Buried Below	Red
Caution: Electric Line Buried Below	Red

D. Ink used to print messages shall be permanently fixed to tape and shall be black in color with message printed continuously throughout.

E. Tape shall be a minimum of 4 mil thick x 6" wide with a printed message on one side.

F. Tracer wire shall be #14 AWG solid copper UF type wire with cross-linked polyethylene insulation. The insulation shall be white or yellow in color.

G. Wire splices (at pipe tees, crosses and laterals) shall be accomplished using a direct bury silicone-filled capsule tube with standard wire nut or silicone-filled wire nut connectors of the appropriate size.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to all work in this Section, become familiar with all site conditions, materials and equipment to be installed, procedures of installation and scheduling of work.

B. Do not cover any work until it has been observed by the CTDOT PM. Any such covered work will be uncovered at no additional cost to the Owner.

3.2 SEPARATION OF WATER MAINS AND SEWERS

A. General:

The following factors should be considered in providing adequate separation:

1. Materials and type of joints for water and sewer pipes
2. Soil Conditions
3. Service and branch connections into the water main and sewer line
4. Compensating variations in the horizontal and vertical separations
5. Space for repair and alterations of water and sewer pipes
6. Off-setting of pipes around manhole

B. Parallel installation:

Water mains shall be laid at least 10 feet horizontally from an existing or proposed manhole or sanitary sewer. This distance can be reduced to 5 feet for storm water. The distance shall be measured edge to edge. In cases where it is not practical to maintain a 10 foot separation, the reviewing authority may allow deviation on a case-by-case bases, if supported by data from the design engineer. Such deviation may allow installation of the water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.

C. Crossings:

Water mains crossing sewers shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. At crossings, one full length of water pipe shall be located so both joints will be as far from the sewer as possible. If the sewer main is over the water main, the first sewer pipe joints on each side of the water main must be concrete encased. Special structural support for the water and sewer pipes may be required. Water mains shall not pass through sewer manholes or be submerged in basins containing sewage or other grossly contaminated or hazardous material.

D. Force Mains:

There shall be at least a 10 foot horizontal separation between water mains and sanitary sewer force mains. There shall be an 18 inch vertical separation at crossings.

E. Other underground storage tanks:

Water distribution lines shall be placed not closer than twenty five (25) feet horizontal distance from underground storage tanks.

3.3 TRENCH EXCAVATION (See Section 31 23 16.13 – Trenching)

A. Prior to opening an excavation, effort will be made to determine where underground installations are located. When the excavation approaches the estimated location of such an installation, the exact location shall be determined and when it is uncovered, proper supports shall be provided for the existing installation. Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation. The Trade Contractor shall contact Call Before You Dig (1-800-922-4455) or Dial 811 prior to excavation.

B. Trees, boulders, and other surface encumbrances, involved in excavation work or in the vicinity thereof at any time during operations, shall be removed before excavating is begun.

C. In excavations, excavated or other material shall be effectively stored and retained at least 2 feet or more from the edge of the excavation.

D. Diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Water shall not be allowed to accumulate in the excavation.

E. Earth excavated shall be separated into topsoil and other clearly distinguishable soil types such that the best material may be used for backfill operations.

F. Excavate the trench 6 inches below the level of the distribution pipe and provide a minimum width for working and compacting backfill. Provide a maximum width of 2 feet beyond the outside of the pipe.

G. If ledge, boulders or large stones are encountered, remove them to provide a minimum of 6 inches of clearance on all sides of the pipe. Backfill and thoroughly compact with approved backfill; any excess material to be removed.

3.4 PIPE TRENCH BEDDING CLASSES

A. Unless otherwise directed, the pipe trench bedding shall be as detailed on the Trade Contract Documents.

B. Concrete encasement, where required by the Project Owner, shall consist of Class C concrete with a minimum encasement of 6 inches on all sides of the pipe.

3.5 PIPE INSTALLATION

A. Smooth the bottom of the stone bed to provide continuous support under the pipe. Where Type II bedding is authorized by the CTDOT PM, compact the granular material to 95% maximum density with an engine driven mechanical compactor (Standard Proctor).

B. Carefully lower the pipe into the trench, avoiding disturbance of the bed and trench walls, and damage to the pipe. Lay the pipe with the bells on the upgrade end.

C. Clean the coupling ring groove and install the rubber gasket. Lubricate the gasket with the lubricant supplied by the manufacturer of the pipe. Taking care to avoid the entrance of foreign material, join the sections. Check joints to insure proper seal. For ductile iron water mains install 2 brass wedges per joint.

D. Where a gland is used at a valve or fitting, the gland and rubber gasket will then be placed on the spigot end of the pipe. The pipe will then be pushed forward to seal the spigot end in the bell and the gasket pressed into place within the bell. The gland will then be moved into place and bolted. Tighten the bolts to a torque range of 60-90 foot pounds.

E. When pipe laying is not in progress, seal the open ends of the pipe with a water tight plug.

F. After installation of the pipe to the proper line and grade, place additional stone bedding to the crown of the pipe, carefully tamping under the haunches. Where Class C bedding is authorized, compact with an engine driven mechanical compactor to 90% maximum density (Standard Proctor).

G. Place the initial backfill above the pipe, ensuring the material is free of roots, stones, organic or frozen material.

H. Backfill the trenches in lifts. Compact each lift with an engine driven mechanical compactor to 90% maximum density where the trench will not be under a paved area, and to 95% maximum density where the trench is under a paved area (Standard Proctor). If trench is located in the road bed of an existing roadway, the fill below the existing road shall be gravel to the depth shown on the detail or as ordered by the CTDOT PM. The gravel shall be compacted with an approved power roller weighing between 8 and 10 tons.

3.6 TESTING SEWERS

A. Test the gravity sewer by a pressurized air test between consecutive manholes. Plug the two ends of the pipe and connect the air control equipment to the tapped end.

B. Supply air slowly to the pipe until reaching a constant pressure of 4.0 psi, throttle the air supply so that the pressure remains above 3.5 psi for at least 5 minutes to allow temperature stabilization in the pipe.

C. After stabilization, adjust pressure to 3.5 psi and shut off air supply. When the pressure reaches 3.5 psi start the stop watch and record the time it takes to reach 2.5 psi. The time required for the pipe size must be at least:

Pipe Size	Time Per 100 Ft. (Minutes)
4 inch	.3
6 inch	.7
8 inch	1.2

D. If laterals are included in the testing, or more than one pipe size exists in the section tested, calculate the test time for each size and add them to determine the total test time.

E. If there is ground water above the sewer line the air test pressure will be increased by 0.5 psi for each foot of water above the invert of the pipe.

3.7 DEFLECTION TEST

A. After a flexible pipe sewer, such as PVC, has been backfilled for 30 days, a pipe deflection test shall be performed.

B. The test shall be conducted using a rigid ball or mandrel having a diameter equal to 92.5% of the pipe diameter. This device will be pulled through the sewer by a rope without the means of mechanical equipment. The maximum allowable vertical deflection shall be 7.5%.

C. If the ball or mandrel cannot be successfully pulled through the sewer pipe, those sections of pipe not meeting the deflection requirements shall be excavated and the embedment and backfill replaced. If, in the opinion of the CTDOT PM, the pipe has been damaged, it shall be removed and replaced.

3.8 WARNING/IDENTIFICATION TAPE

A. Tape shall be placed at the top of the pipe zone 12" above and centered over the utility intended for identification.

B. Tape shall be installed with the printed side up and run continuously along the entire length of the utility intended for identification. Tape shall be installed on the main piping and all appurtenant laterals, including blowoffs, air valve assemblies, fire hydrants, and services. Tape splices shall overlap a minimum of 24” for continuous coverage.

C. Tape shall be installed prior to placement of the Trench Zone Backfill.

D. Tracer wire shall be installed with all water mains.

E. Wire shall be placed on the top centerline of the pipeline and shall run continuously along the entire length of pipe prior to placement of trench backfill. Wire shall be mechanically and electrically continuous throughout the pipeline, including within pipe casings.

F. Tracer wire shall be secured to the pipe at 6' intervals with plastic adhesive tape, duct tape or plastic tie straps. The wire may alternately be secured to the pipe by looping the tracer wire around itself such that tracer wire remains continuous atop the pipe during backfill operations.

G. Tracer wire access ports shall be installed in accordance with the Standard Drawings within the concrete splash pad of all fire hydrants installed as a part of the work. In addition, tracer wire may terminate within meter boxes, blow off boxes, CP test boxes or air valve enclosures as shown on the Approved Drawings or as directed by the CTDOT PM at intervals of not more than 1,000'.

H. Locations of all tracer wire access ports installed shall be noted on the field record drawings. Wire shall extend into the access port and shall terminate with a coiled 24" length of wire. All tracer wire not attached to piping shall be installed, without splices, within a conduit at a minimum depth of 24” in accordance with the Standard Drawings.

I. Splices shall be installed only when necessary and shall be made using wire connectors selected from the Approved Materials List.

J. The Trade Contractor shall test tracer wire for electrical continuity in the presence of the CTDOT PM prior to the installation of any paving over atop pipelines or appurtenances.

K. Testing shall be accomplished using a device capable of detecting improper connections or ground fault interruptions.

3.9 STABILIZATION

A. All disturbed areas shall be stabilized as noted on the Trade Contract Drawings or appropriate Section of the Specifications.

3.10 CLEAN UP

All extraneous material or construction debris shall be removed from the site before completion of construction as directed by the CTDOT PM. Disposal of this material is the responsibility of the Trade Contractor.

END OF SECTION 22 13 13

SECTION 22 13 73 – FACILITY FLOOR DRAIN WATER TANKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnishing and installation of new double wall fiberglass reinforced plastic underground storage tanks of the type, size and length with level and leak monitoring system as indicated on the drawings and in conformity with these specifications.

B. The tank shall have an 80% full alert and a 90% full alarm system, and a leak detection system alarm for the tank. These alarms shall report through the control panel.

1. Control (alarm) panel and sensor/probe shall be designed for Industrial wastewater tank (not oil & water). Control panel shall be located in the MOW Compressor Dryer Room 104 and preprogrammed prior to testing, training, and acceptance.

2. A test button for the high level warning system shall also be provided.

C. Visual and audio alarm devices shall be mounted on the outside of the MOW building, location near doors 103A (confirm location with CTDOT PM) with a sign including contact telephone number. Visual alarms shall remain active until the condition has been resolved. Audible alarms shall be able to be silenced before the condition resolution.

1.2 DEFINITIONS

A. API: American Petroleum Institute

B. ASME: American Society of Mechanical Engineers

C. AWS: American Welding Society

D. DI: Ductile Iron

E. DFT: Dry Film Thickness

F. GFI: Ground Fault Indicator

G. NEMA: National Electrical Manufacturers Association

H. NFPA: National Fire Protection Association

I. NPT: National Pipe Thread

J. PSIG: Pounds per Square Inch Gauge

K. SP: Surface Preparation

L. SSPC: Society for Protective Coatings

M. STI: Steel Tank Institute

N. UL: Underwriters Laboratories

1.3 SUBMITTALS

A. See Section 01 33 00 Submittal Procedures and Section 01 33 00.13 Document Control, for submittal requirements for this work except as modified here in.

B. Product Data: Include rated capacities, accessories, appurtenances, and furnished specialties for each facility floor drain water tank indicated.

C. Shop Drawings. Show fabrication and installation details for each facility floor drain water tank, including the following:

1. Tank, fittings, appurtenances, and openings.
2. Tank deadman and straps.
3. Plans, elevations, sections, details, and attachments to other work.
4. Structural loading and buoyancy calculations signed and sealed by the qualified professional engineer licensed in the State of Connecticut responsible for their preparation.
5. Power, signal, and control panel and wiring.
6. Tank monitoring systems.
7. Valves and fittings.

D. Qualification Data: For fabricator.

E. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:

1. Tank leak detection system
2. Tank level monitoring system.

1.4 RELATED REQUIREMENTS

A. Section 03 30 00 Cast-in-Place Concrete, for concrete classifications and related requirements.

B. Section 04 05 11 Masonry Mortaring and Grouting, for mortar and grout requirements.

C. Section 31 23 16.13 Trenching, for excavation and backfill.

D. Section 31 23 23 Fill, for granular fill and No. 6 Stone.

E. Section 33 49 00 Storm Drainage Structures, for drainage structure related requirements.

1.5 GOVERNING STANDARDS, AS APPLICABLE

A. Tank manufacturer shall be in the business of manufacturing tanks with materials conforming to the requirements of ANSI/AWWA D120-02 Thermosetting Fiberglass-Reinforced Plastic Tanks.

B. Tank manufacturer shall be in the business of manufacturing tanks to UL 1316 standards.

C. American Society for Testing and Materials (ASTM) Standards:

1. ASTM D883: Standard Terminology related to plastics

1.6 OPERATION AND MAINTENANCE DATA:

A. For the following include operation and maintenance manuals:

1. Tank level monitoring system.
2. Tank leak monitoring system.

1.7 CALCULATIONS

A. The manufacturer or Contractor shall supply the CTDOT PM with buoyancy calculations assuming a fully flooded excavation with an installed empty tank. The calculations shall also include the sizing of the concrete deadman and hold down straps that are included with the tank.

B. The manufacturer or Contractor shall supply the CTDOT PM with structural calculations demonstrating the tank and appurtenances can withstand vehicle loads specified below.

C. The sizing and construction of this tank shall be consistent with industry protocols and shall comply with the applicable regulations.

1.8 WARRANTY

A. Warranty shall be a minimum of 18 months after Substantial Completion and meet the requirements set forth within these contract documents in Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Xerxes 1000 gallon 4’ Double Wall FRP Tank MTO; similar products from other manufacturers may be provided.

B. Follow substitution procedures as listed in Section 01 25 00.

2.2 MATERIALS

The materials for this work shall conform to the following:

A. Double-Wall Fiberglass Reinforced Plastic (FRP) Underground Storage Tanks

1. Loading Conditions – Tank shall meet the following design criteria:

   a. Internal Load – Tank shall withstand a 5-psig air-pressure test with 5:1 safety factor. Contractor shall individually test tanks for leakage prior to installation. Maximum test pressure is 5 psig.

   b. Vacuum Test – To verify structural integrity, every standard 10 foot-diameter tank and smaller shall be vacuum tested by the manufacturer at the factory to 11.5-inch of mercury.

   c. Surface Loads – Tank shall withstand surface H-20 axle loads when properly installed according to manufacturers current Installation Manual and Operating Guidelines.

   d. External Hydrostatic Pressure and Burial Depth – Tank shall be capable of being buried in ground with 7 feet of overburden over the top of the tank, the hole fully flooded and a safety factor of 5:1 against general buckling.

   e. Tank shall support accessory equipment – such as drop tubes, submersible pumps and ladders – when installed according to tank manufacturers current Installation Manual and Operating Guidelines.

2. Product Storage

   a. Tank shall be capable of storing chemicals or Leachate with specific gravity up to 1.1.

   b. Tank shall be vented to atmospheric pressure.

   c. Tank shall be capable of storing hydrocarbon products and products identified in the manufacturer's current standard limited warranty.

3. Materials:

   a. Tank shall be manufactured with 100% premium resin and chopped glass. No fillers or extenders will be used.

   b. No General, Orthophthalic, or odd lot resin will be used.

   c. All associated internal mounting hardware shall be rustproof and corrosion resistant.

4. Tank Dimensions:

   a. Tank shall have nominal capacity of 1,000 gallons.

b. Tank shall have nominal outside diameter of 4 feet.

5. Service Conditions and Requirements

a. Approval for each application of the tank, any limitations on use and any design considerations shall be provided by the Manufacturer.

6. Interstitial Space

a. Tank shall have a space between the primary and secondary walls to allow for the free flow and containment of leaked product from the primary tank. The space also allows the insertion of a monitoring device through a monitoring fitting.

7. Level and Leak Monitoring System

a. Shall be a complete system and designed by the Contractor meeting the requirements outlined on the plans and in these specifications.

B. Accessories

1. Anchor Straps

a. Straps shall be FRP anchor straps as supplied by tank manufacturer.

b. Number and location of straps shall be specified in current literature by tank manufacturer.

2. Manways

a. All tanks for chemical storage or Leachate shall require at least one manway.

b. All manways shall be flanged and 22-inch diameter, complete with UL-listed cover, gasket and hardware.

c. Location is shown on tank drawings.

d. Optional manway extensions shall be FRP supplied by the manufacturer.

3. Gauge Plates

a. Gauge plates shall be installed under each service fitting and manway opening.

4. Fittings

a. All fittings shall be located along the top centerline of the tank.

b. All standard NPT threaded fittings shall be constructed of carbon steel, FRP or 304 stainless steel.

c. All standard NPT threaded fittings shall be half-couplings or full coupling and 2-inch or 4-inch diameter. Reducers are to be used for smaller sizes where shown and provided by contractor.

d. All NPT fittings shall withstand a minimum of 150 foot-pounds of torque and 1,000 foot-pounds of bending, both with a 2:1 safety factor.

e. All optional FRP nozzles shall be flat-faced, flanged and gusseted, and shall conform to ANSI B16.5 150# bolting pattern.

C. Pipe Fittings: Wyes, Tees, Bends and adapters, and any other fittings required by the CTDOT PM shall be provided. Plans for such fittings showing cross sectional views with dimensions shall be provided, and the CTDOT PM prior to their use shall approve such plans and fittings. The materials used in the manufacture of fittings shall conform with the requirements for the Pipe/Tank with which they shall be used and any variation of such requirements shall be subject to approval of the CTDOT PM.

D. Flexible Couplings: As required shall be manufactured by Fernco, Inc. Davison, Michigan or approved equal.

E. Bedding material shall conform to Manufacturer's requirements.

F. Backfill material shall conform to Manufacturer's requirements.

G. Concrete for Deadman shall conform to Manufacturer requirements.

H. Manhole Covers shall conform to applicable requirements of Section 33 49 00 Storm Drainage Structures.

2.3 FACILITY FLOOR DRAIN WATER TANK APPURTENANCES

A. Waste-water Level Monitoring Controls: Automatic controls for monitoring water level in tank, with audible and visual alarms to indicate continuous level reading, 80% full alert and 90% full alarm with test button.

B. Leak Detection Monitor: Continuous interstitial space monitoring between the primary and secondary tank shells and primary and secondary containment pipe with audible and visual alarms for each.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that construction area for tanks indicated on the plans is ready for the Work as indicated.

3.2 PREPARATION

A. Layout the location indicated on the plans for the tank(s) prior to construction.

3.3 CONSTRUCTION METHODS

A. Tank shall be bed and backfilled with materials specified by the manufacturer's instructions.

B. Tank shall be installed according to the Manufacturers Installation Manual and Operating Guidelines for Fiberglass Underground Storage Tanks in effect at time of installation.

C. Contractor shall be trained by the tank manufacturer, the state or other approved agency.

D. During installation the plug shall not be removed until suitable provisions have been made to prevent water, earth, or other substances from entering the tank.

E. Methods of backfilling shall be in conformance with the manufacturer's instructions.

F. Excavate a trench to the required depth, the bottom of which shall be graded to the elevation of the bottom of the bedding material or to afford a uniform firm bearing for the tank throughout its entire length, whichever the case may be. When rock is encountered, it shall be excavated to not less than 12 inches below the bottom of the tank; and this depth shall be refilled with bedding material which shall be thoroughly tamped.

G. Where the tank is to be laid in a fill area, the embankment shall be placed and compacted to an elevation 12 inches above the top of the proposed tank, whereupon the trench excavation shall be made and the tank installed.

3.4 TESTING

A. Tank shall be tested according to the Manufacturers Installation Manual and Operating Guidelines for Fiberglass Underground Storage Tanks in effect at time of installation.

3.5 TRAINING

A. Provide a minimum of one hour of training to a minimum class size of eight students on the operation and maintenance of the tank, control panel and alarms.

END OF SECTION 22 13 73

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. HVAC demolition.
8. Equipment installation requirements common to equipment sections.
9. Concrete bases.
10. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, 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 chases.

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.

1.3 SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12.

G. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

B. Sealing Elements: **EPDM** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: **Stainless steel**. Include two for each sealing element.

D. Connecting Bolts and Nuts: **Stainless steel** of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.

2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

4. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.8 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 23 05 00

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:

1. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
3. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.

4. Inverter-Duty Motors: Class B temperature rise; Class Finsulation.

5. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors smaller than 1/2 HP shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Electronically Commutated Motor

B. Permanent-split-capacitor multispeed motors:

1. Variable-torque, type.

2. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

3. Motors 1/20 HP and Smaller: Shaded-pole type.

4. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

C. Electronically Commutated Motors:

1. Motors shall be General Electric ECM variable speed brushless DC motors specifically designed for use with a single phase, 120 or 277volt, 60 Hertz electrical input.

2. Motor shall be complete with and operated by a single phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator.

3. All motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero rotor losses. Motor shall have built-in soft start and slewed speed change ramps.

4. Motor shall be able to be mounted with shaft in horizontal or vertical orientation. Motor shall be permanently lubricated with ball bearings. Motor shall be direct coupled to the blower.

5. Motor shall maintain a minimum of 65% efficiency over its entire operating range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Non shrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in partitions.

B. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

C. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section Firestopping.

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-sheet sleeves

END OF SECTION 23 05 17

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

B. Related Sections:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
4. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use

operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

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

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

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Copper Clevis Hangers (MSS Type 1): For suspension of noninsulated stationary pipes NPS 1/2 to NPS 2.

F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

G. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23): For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

H. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

I. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

J. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following: Adjust list below to suit Project.

1. Elastomeric hangers.
2. Spring hangers.
3. Spring hangers with vertical-limit stops.
4. Restraining braces and cables.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Seismic Design Category; C.
2. Site Class as Defined in the IBC: E.
3. Assigned Seismic Use Group or Building Category as Defined in the IBC: II.

   a. Component Importance Factor: 1.0.
   b. Component Response Modification Factor: 3.0.
   c. Component Amplification Factor: 2.25.

4. Design Spectral Response Acceleration at Short Periods (0.2 Second): 24.3%.
5. Design Spectral Response Acceleration at 1-Second Period: 6.2%.

1.5 ACTION SUBMITTALS

A. Product Data for the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
   b. Annotate to indicate application of each product submitted and compliance with requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

E. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or

preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

B. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

C. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

D. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.2 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.

3. Cooper B-Line, Inc.; a division of Cooper Industries.

4. Hilti, Inc.

5. Kinetics Noise Control.

6. Loos & Co.; Cableware Division.

7. Mason Industries.

8. TOLCO Incorporated; a brand of NIBCO INC.

9. Unistrut; Tyco International, Ltd.

B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

C. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

G. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

2.3 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
4. Kinetics Noise Control.
5. Mason Industries.
6. Thybar Corporation.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

B. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

C. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

D. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or wind restraint.

a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.

b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

c. Minimum Additional Travel: 50 percent of the required deflection at rated load.

d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

a. Resilient Material: Oil- and water-resistant standard neoprene.

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

B. Install cables so they do not bend across edges of adjacent equipment or building structure.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Test at least four of each type and size of installed anchors and fasteners.
3. Test to 90 percent of rated proof load of device.
4. Measure isolator restraint clearance.
5. Measure isolator deflection.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Duct labels.

1.3 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 3 by 1 inch.
6. Minimum Letter Size: 1/2 inch. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.3 DUCT LABELS

A. Color coded self adhesive duct markers include a die cut or detachable directional arrow

B. Letter Color: White.

C. Background Color: Blue, yellow or green

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 16 x 2-1/4".

F. Minimum Letter Size: 1 inch.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible

C. Provide Bakelite nameplates on all equipment, motor starters, remote push button stations, insertion type thermostats, remote bulb thermometers, filter gauges, pump pressure gauges, fans, pumps, panel mounted controls and manual damper operators, multi-zone damper sections by room number, room designation, zone number, etc.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Condenser-Water Piping:

a. Background Color: Green.
b. Letter Color: White.

2. Refrigerant Piping:

a. Background Color: Yellow
b. Letter Color: Black

3. Condensate Drain Piping:

a. Background Color: Green
b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Green: For cold-air supply ducts.

2. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

3. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 23 05 53

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Packaged VAV Air Systems.
   b. Energy Recovery Air Systems.
   c. Specialty Exhaust Systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 ACTION SUBMITTALS

A. Submittals:

1. Air-Balance Report: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
2. TAB Report: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Trade Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Strategies and Procedures Plan: Within 30 days of Trade Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

C. Certified TAB reports.

D. Sample report forms.

E. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. TAB Conference: Meet with Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians.

1. Agenda Items:

a. The Contract Documents examination report.

b. The TAB plan.

c. Coordination and cooperation of trades and trade subcontractors.

d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by AABC or NEBB.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Notice: Provide five days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased and equipment with functioning controls is ready for operation.

J. Examine terminal variable-air-volume terminal units, and verify that they are accessible and their controls are connected and functioning.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.

2. Automatic temperature-control systems are operational.

3. Equipment and duct access doors are securely closed.

4. Balance, smoke, and fire dampers are open.

5. Isolating and balancing valves are open and control valves are operational.

6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and/or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

M. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.

    b. Measure static pressure directly at the fan outlet or through the flexible connection.

    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

N. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of sub-main and branch ducts.

a. Where sufficient space in sub-main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.

O. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

P. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.5 PROCEDURES FOR VARIABLE AIR VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

   a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.

9. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

   a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

10. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.6 PROCEDURES FOR ENERGY RECOVERY AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Where sufficient spaces in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, sub main ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of sub main and branch ducts.

a. Where sufficient space in sub main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Re-measure each sub main and branch duct after all have been adjusted. Continue to adjust sub main and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

3.7 Adjust patterns of adjustable outlets for proper distribution without drafts PROCEDURES FOR SPECIALTY EXHAUST SYSTEMS

A. Measure primary air at each exhaust fan outlet.

3.8 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.9 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.

5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.11 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent
2. Air Outlets and Inlets: Plus or minus 10 percent.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB contractor.

3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Trade Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. VFD settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Terminal units.
4. Balancing stations.
5. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:

a. Unit identification.

b. Location.

c. Make and type.

d. Model number and unit size.

e. Manufacturer's serial number.

f. Unit arrangement and class.

g. Discharge arrangement.

h. Sheave make, size in inches , and bore.

i. Center-to-center dimensions of sheave, and amount of adjustments in inches.

j. Number, make, and size of belts.

k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches , and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Filter static-pressure differential in inches wg.

f. Preheat-coil static-pressure differential in inches wg.

g. Cooling-coil static-pressure differential in inches wg.

h. Heating-coil static-pressure differential in inches wg.

i. Outdoor airflow in cfm.

j. Return airflow in cfm.

k. Outdoor-air damper position.

l. Return-air damper position.

m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.

b. Location.

c. Coil type.

d. Number of rows.

e. Fin spacing in fins per inch o.c.

f. Make and model number.

g. Face area in sq. ft..

h. Tube size in NPS

i. Tube and fin materials.

j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.

b. Average face velocity in fpm.

c. Air pressure drop in inches wg.

d. Outdoor-air, wet- and dry-bulb temperatures in deg F

e. Return-air, wet- and dry-bulb temperatures in deg F

f. Entering-air, wet- and dry-bulb temperatures in deg F

g. Leaving-air, wet- and dry-bulb temperatures in deg F

h. Water flow rate in gpm.

i. Water pressure differential in feet of head or psig.

j. Entering-water temperature in deg F

k. Leaving-water temperature in deg F

l. Refrigerant expansion valve and refrigerant types.

m. Refrigerant suction pressure in psig.

n. Refrigerant suction temperature in deg F

o. Inlet steam pressure in psig.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

g. Sheave make, size in inches , and bore.

h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches , and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.

b. Location and zone.

c. Traverse air temperature in deg F

d. Duct static pressure in inches wg.

e. Duct size in inches.

f. Duct area in sq. ft..

g. Indicated air flow rate in cfm.

h. Indicated velocity in fpm.

i. Actual air flow rate in cfm.

j. Actual average velocity in fpm.

k. Barometric pressure in psig.

I. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3.13 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

   a. Measure airflow of at least 10 percent of air outlets.

   b. Measure water flow of at least 5 percent of terminals.

   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

   d. Verify that balancing devices are marked with final balance position.

   e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Authority.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.

3. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply air.

B. Related Sections:

1. Division 23 Section "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

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

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.

4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).

5. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.

d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

5. Color: Aluminum.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
e. <Insert manufacturer's name; product name or designation>.

2. Width: 4 inches.

3. Thickness: 6.5 mils (0.16 mm).

4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 SECUREMENTS

A. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

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

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; Cupped Head Weld Pin.
3) Midwest Fasteners, Inc.; Cupped Head.
4) Nelson Stud Welding; CHP.

B. Bands:

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

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with closed seal.

3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.9 CORNER ANGLES

A. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):

1. Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).

1. Comply with requirements in Division 07 Section Firestopping and fire-resistive joint sealers.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-

applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.6 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Outdoor, exposed supply and return.

END OF SECTION 23 07 13

SECTION 23 08 00 – HVAC SYSTEMS COMMISSIONING

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. Commissioning consists of systematically documenting that specified components and systems have been installed and started up properly and then functionally tested to verify and document proper operation through all sequences of operation and conditions. In addition, training of the Owner's Operations Personnel will be verified and final project O&M Documents will be reviewed for completeness.

PART 2 – PRODUCTS

2.1. PRE-FUNCTIONIAL AND FUNCTIONAL PERFORMANCE TESTING EQUIPMENT AND INSTRUMENTS

A. The appropriate Contractor(s) shall furnish all special tools and equipment required during the entire commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted to the Commissioning Authority for approval. The owner shall furnish necessary utilities for the commissioning process.

B. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the owner upon completion of the commissioning process.

PART 3 – EXECUTION

3.1. GENERAL

A. The Contractor shall complete all phases of work so the systems can be started, tested, balanced, and acceptance procedures undertaken. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, and change orders.

3.2. PARTICIPATION IN ACCEPTANCE PROCEDURES

A. The Contractor shall provide skilled technicians to startup and debug all systems within the project contracted work. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program. Work schedules, time required for testing, etc., shall be requested by the Commissioning Authority and coordinated by the contractor. Contractor shall ensure that the qualified technician(s) are available and present

during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

B. System performance problems and discrepancies may require additional technician time, Commissioning Authority time, reconstruction of systems, and/or replacement of system components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.

C. The Commissioning Authority reserves the right to question the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or sub-system. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the Commissioning Authority. Contractor shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.3. DEFICIENCY RESOLUTION

A. In some systems, misadjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the Owner, with input from the contractor, equipment supplier, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Owner and/or CTDOT PM shall have final jurisdiction over any additional work done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to demonstrate system performance may be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority shall notify the Owner, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the contractor's responsibility.

3.4. ADDITIONAL COMMISSIONING

A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The contractor(s), suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their contractual obligations.

3.5. SEASONAL COMMISSIONING

A. Seasonal commissioning pertains to testing under full load conditions during peak heating and peak cooling seasons, as well as part load conditions in the spring and fall. Initial commissioning shall be done as soon as contract work is completed, regardless of season. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.

3.6. SUSTAINING SYSTEM READINESS

A. Refer to Section 019100, General Commissioning Requirements for Pre-Functional Checklist requirements and expectations.

3.7. FUNCTIONAL PERFORMANCE TESTING

A. The contractor shall demonstrate to the Owner's Representative and the Cx Authority the performance of the following HVAC Systems to the performance level identified.

1. HVAC Systems to be tested:
   a. Rooftop Units (100% Sampling)
   b. Energy Recovery Ventilators (100% Sampling)
   c. Fan Powered Terminal Units (25% Sampling)
   d. Exhaust and Ventilation Fans (100% Sampling)
   e. Gas Fired Radiant Heaters (100% Sampling)
   f. Split System Air Conditioning Units (100% Sampling)
   g. Building Automation Systems (100% Sampling)
   h. Building Automation System Interface (100% Sampling)

B. Detailed testing shall be performed on all installed equipment and systems to ensure that operation and performance conform to contract documents. All tests shall be witnessed by the Commissioning Authority. The following testing is required as part of the commissioning process:

1. Verification tests are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with contract documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.

2. Functional performance tests (FPT) shall determine if the HVAC system is providing the required cooling and heating services in accordance with the finalized design intent. These tests shall also determine the installed capacity of the cooling and heating equipment, and the individual heat transfer components.

3. Sampling and Failure Rates (Refer to Section 019100, 3.10.E for additional requirements):

   a. Table below:

Sampling Rate	**Failure Rate**	**Equipment Description**
100%	Retest Failed Unit	Rooftop Units
100%	Retest Failed Unit	Energy Recovery Ventilators
25% Sample	Retest Failed Unit	Fan Powered Terminal Units
100%	Retest Failed Unit	Exhaust and Ventilation Fans
100%	Retest Failed Unit	Gas Fired Radiant Heaters
100%	Retest Failed Unit	Split System Air Conditioning Units
100%	Retest Failed Unit	Building Automation Systems

Sampling Rate	Failure Rate	Equipment Description
100%	Retest Failed Unit	Building Automation System Interface

A. Refer to Appendix A at end of this section for a sample of Pre-Functional Commissioning Tests for systems included with this section.

B. Refer to Appendix B at end of this section for a sample of Functional Performance Tests for systems included with this section.

3.8. ROLES AND RESPONSIBILITIES

A. General Contractor / Construction Manager - General Construction Trade Representative

1. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the HVAC system commissioning program as described in the contract documents.
2. Attend commissioning meetings scheduled by the CA.
3. Coordinate inclusion of commissioning activities in the construction schedule.
4. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling pre-testing of the fire alarm system.
5. Issue a notice that fire alarm pre-testing has been scheduled.
6. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
7. Facilitate resolution of deficiencies identified by observation or performance testing.
8. Participate in the Functional Performance Tests as required to achieve design intent.
9. Participate in O&M Training as required by project specifications.

B. Mechanical Contractor

1. Include cost to complete commissioning requirements for mechanical systems in the contract price.
2. Include requirements for submittal data, O & M data, and training in each purchase order or sub-contract written.
3. Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, and TAB.
4. Ensure participation of major equipment manufacturers in appropriate training and testing activities.
5. Attend Construction Phase coordination meeting scheduled by the Commissioning Authority.
6. Assist the Commissioning Authority in all verification and functional performance tests.
7. Prepare preliminary schedule for mechanical system orientation and inspections, O&M manual submission, training sessions, pipe and duct system testing, flushing and

cleaning, equipment start-up, TAB, and task completion for use by the Commissioning Authority. Update schedule as appropriate throughout the construction period.

8. Attend initial training session.

9. Conduct mechanical system orientation and inspection at the equipment placement completion stage.

10. Update drawings to the record condition to date, and review with the Commissioning Authority.

11. Gather O&M data on all equipment, and assemble in binders as required by the Commissioning Specification. Submit to Commissioning Authority prior to the completion of construction.

12. Notify the Commissioning Authority a minimum of two weeks in advance, so that witnessing equipment and system start-up and testing can begin.

13. Notify the Commissioning Authority a minimum of two weeks in advance, of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.

14. Participate in, and schedule vendors and Contractors to participate in the training sessions as set up by the Commissioning Authority.

15. Provide written notification to the Construction Manager and Commissioning Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-systems are operating as required.

    a. HVAC equipment including all fans, air handling units, dehumidification units, ductwork, dampers, terminals, and all contracted equipment.
    b. Refrigeration equipment, pumping systems and heat rejection equipment.
    c. Fire stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
    d. Dedicated smoke control systems including stairway pressurization and atrium systems.
    e. Non-dedicated systems using the air handling units for smoke control.
    f. Fire detection and smoke detection devices furnished under other divisions of this specification as they affect the operation of the smoke control systems.
    g. Building control systems are functioning to control mechanical equipment and smoke control systems.

16. Provide a complete set of as-built records to the Commissioning Authority.

C. Test, Adjust, and Balance Contractor

1. Include cost for commissioning requirements in the contract price.

2. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.

3. Submit the TAB procedures to the Commissioning Authority and Design Professional for review and acceptance.

4. Attend the TAB review meeting scheduled by the Commissioning Authority. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the HVAC system.

5. Participate in training sessions as scheduled by the Commissioning Authority.

6. At the completion of the TAB work, and submittal of final TAB report, notify the mechanical Contractor and Construction Manager.

7. Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB report where required by the Commissioning Authority for verification or diagnostic purposes.

D. Automatic Controls and Building Automation System Contractors

1. Include cost for commissioning requirements in the contract price.

2. Review design for controllability with respect to selected manufacturers equipment;
   a. Verify proper hardware specification exists for functional performance required by specification and sequence of operation.
   b. Verify proper safeties and interlocks are included in design.
   c. Verify proper sizing of control valves and actuators based on design pressure drops. Verify control valve authority to control coil properly.
   d. Verify proper sizing of control dampers. Verify damper authority to control air stream. Verify proper damper positioning for mixing to prevent stratification. Verify actuator vs. damper sections for smooth operation.
   e. Verify proper selection of sensor ranges.
   f. Clarify all questions of operation.

3. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.

4. Provide the following submittals to the Commissioning Authority;
   a. Hardware and software submittals.
   b. Control panel construction shop drawings.
   c. Narrative description of each control sequence for each piece of equipment controlled.
   d. Diagrams showing all control points, sensor locations, point names, actuators, controllers and, where necessary, points of access, superimposed on diagrams of the physical equipment.
   e. Logic diagrams showing the logic flow of the system.
   f. A list of all control points, including analog inputs, analog outputs, digital inputs, and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each standalone control unit.
   g. A complete control language program listing including all software routines employed in operating the control system. Also provide a program write-up, organized in the same manner as the control software. This narrative shall describe the logic flow of the software and the functions of each routine and sub-routine. It should also explain individual math or logic operations that are not clear from reading the software listing.
   h. Hardware operation and maintenance manuals.
   i. Application software and project applications code manuals.

5. Verify proper installation and performance of controls / BAS hardware and software provided by others.

6. Integrate installation and programming schedule with construction and commissioning schedules.

7. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system.

8. Demonstrate system performance to Commissioning Authority including all modes of system operation (e.g. normal, abnormal, emergency).

9. Provide control system technician for use during system verification and functional performance testing.

10. Provide system modifications as required.

11. Provide support and coordination with TAB contractor on all interfaces between their scopes of work. Provide all devices, such as portable operator's terminals, for TAB use in completing TAB procedures.

12. Additional trend logs may be required to facilitate the commissioning process.

E. Equipment Suppliers and Miscellaneous Contractors

1. Include cost for commissioning requirements in the contract price.

2. Provide submittals, and appropriate O&M manual section(s).

3. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.

4. Participate in training sessions as scheduled by the Commissioning Authority.

5. Demonstrate performance of equipment as applicable.

3.9. STARTUP

A. The contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in section 019100. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA and CM/GC. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.10. COMMISSIONING STATUS TRACKING

A. The following table represents the equipment that will be commissioned under this section. The Contractor shall verify that the Tag designation as well as the number (count) of each unit listed is correct against those contained within the initial Contract Documents. This will be to ensure that the Contractor's Bid contains all of the equipment required to be commissioned. At the time of the Bid proposal the Contractor shall state that his bid incorporates all the equipment listed within the Contract Documents regardless if the following table incorporated all the designations or not. No additional cost associated with missed units shall be borne by this Contract based upon initial Contract Documents. It will be the Contractor's responsibility to ensure the unit commissioning costs have been clarified before the Contract is executed and included in their base bid.

Project Name: **Proj #:**	**Pre-Functional (PFC)**					**Start-Up (SU)**				**Post Startup Testing**		**Functional (FPT)**			**Notes**
Mechanical Tag Location/Service	**Submittal Received**	**OM Received**	**Form Developed**	**% Complete, PFC**	**doc received**	**Form Received**	**Form Reviewed**	**% Complete, SU**	**doc received**	**% Complete, PST**	**doc received**	**Form Developed**	**% Complete, FPT**	**doc received**	
Building Automation Systems															
BAS															
BAS Interface															
Air Handling Units															
Energy Recovery Ventilators															
Exhaust/Ventilation Fans (25% Sample)															
Unitary Heating and Cooling Systems (25% Sample)															

Project Name: **Proj #:**	**Pre-Functional (PFC)**					**Start-Up (SU)**				**Post Startup Testing**		**Functional (FPT)**			**Notes**
Mechanical Tag Location/Service	**Submittal Received**	**OM Received**	**Form Developed**	**% Complete, PFC**	**doc received**	**Form Received**	**Form Reviewed**	**% Complete, SU**	**doc received**	**% Complete, PST**	**doc received**	**Form Developed**	**% Complete, FPT**	**doc received**	
Chillers															
Boilers															
Pumps															
VAV Terminal Boxes (25% Sample)															

Project Name: **Proj #:**	**Pre-Functional (PFC)**					**Start-Up (SU)**				**Post Startup Testing**		**Functional (FPT)**			**Notes**
Mechanical Tag Location/Service	**Submittal Received**	**OM Received**	**Form Developed**	**% Complete, PFC**	**doc received**	**Form Received**	**Form Reviewed**	**% Complete, SU**	**doc received**	**% Complete, PST**	**doc received**	**Form Developed**	**% Complete, FPT**	**doc received**	
Chilled Water Piping System (25% Sample)															

END OF SECTION 230800

APPENDIX A – SAMPLE OF PRE-FUNCTIONAL COMMISSIOING TESTS

APPENDIX B – SAMPLE OF FUNCTIONAL PERFORMANCE TESTS

END OF SECTION 23 08 00

SECTION 23 09 23 – BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 GENERAL:

A. The building Automation System (BAS) trade contractor shall provide a fully integrated direct digital control (DDC) system with software designed around the open standards of web technology.

B. The BAS servers shall communicate using Internet Protocol ASHRAE's BACnet/IP or Ethernet IP protocol. The server shall be accessed using a standard web browser like Internet Explorer over Internet or Intranet or dedicated client computer.

C. The BAS shall use twisted pair copper conductor between fan powered terminal units to communicate in between controllers and 100Base-T Ethernet network to communicate between the RTU, ERU controllers and building controllers.

D. Approved Manufacturers: Johnson Controls, Siemens Building Automation or Automated Logic Corporation.

1.2 COORDINATION OF TRADES:

A. Mechanical Division installs all taps, dampers, flow stations, etc. furnished by BAS manufacturer.

B. Electrical Division provides:

1. 120V power to all BAS and/or Temperature control panels

2. Wiring of all power feeds through all disconnect starters to electrical motors

3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer

1.3 QUALITY ASSURANCE:

A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer factory trained personnel.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

C. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

1.4 SUBMITTALS:

A. Damper schedules

B. Equipment data cut sheets

C. System schematics, including:

1. Sequence of operations

2. Point names

3. Point addresses

4. Interface wiring diagrams

5. Panel layouts.

D. Auto-CAD compatible as-built drawings

E. PDF of actual Graphics

F. Submittal for Cx Review: Controls programming or block logic shall be submitted for review to verify that the programming conforms to the design intent by the Cx Agent. Submit for Cx Agent review once before implementation, once as a virtual simulation, and once again after implementation to verify proper performance. With each submittal include actual graphic. Sample, template or example graphics are not acceptable.

G. Upon project completion, submit operation and maintenance manuals, consisting of the following:

1. Index sheet, listing contents in alphabetical order

2. Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams

3. Description of sequence of operations

4. As-Built interconnection wiring diagrams

5. Operator's Manual

6. Trunk cable schematic showing remote electronic panel locations, and all trunk data

7. List of connected data points, including panels to which they are connected and input device (ionization detector, thermostat, etc.)

8. Conduit routing diagrams

1.5 WARRANTY:

A. BAS Section shall provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of eighteen months after substantial completion.

B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission, equipment and all sensors and control devices.

C. The on-line support services shall allow the local BAS trade subcontractor temporary use of campus network access using VPN remote access to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.

D. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the BAS trade subcontractor shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that the problem is reported.

1.6 TRAINING:

A. The trade contractor shall provide factory-trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The trade contractor shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 3:30 PM weekdays.

B. Provide training for Owner's designated operating personnel. Training shall include:

1. Explanation of drawings, operations and maintenance manuals

2. Walk-through of the job to locate control components

3. Operator workstation and peripherals

4. DDC controller and ASC operation/function

5. Operator control functions including graphic generation and field panel programming

6. Operation of portable operator's terminal

7. Explanation of adjustment, calibration and replacement procedures

8. Student binder with training modules

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Standards. The system shall conform to the following:

1. Graphic Display. The system shall display a graphic with 20 dynamic points with all current data within 10 seconds.

2. Graphic Refresh. The system shall update a graphic with 20 dynamic points with all current data within 8 seconds.

3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.

4. Object Scan. All changes of state and change of analog values will be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will have been current within the previous 60 seconds.

5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 60 seconds. When the alarm is dialed out by modem, this value shall not exceed 2 minutes.

6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Trade Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

7. Performance. Programmable controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

8. Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other.

9. Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in Table 1.

10. Stability of Control. Control loops shall maintain measured variable at set point within the tolerances listed in Table 2

11. Table 1: Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5ºC [±1ºF]
Ducted Air	±0.5ºC [±1ºF
Outside Air	±1.0ºC [±2ºF]
Dew Point	±1.5ºC [±3ºF]
Delta-T	±0.15ºC[±0.25ºF]
Relative Humidity	±5% RH
Airflow (terminal)	±10% of full scale *(see Note 1)*
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air Pressure (space)	±3 Pa [±0.01 "W.G.]
Electrical (A, V, W, Power factor)	1% of reading *(see Note 3)*
Carbon Dioxide (CO_2)	±50 ppm

Note 1: Accuracy applies to 10%-100% of scale
Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

12. Table 2: Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa [±0.2" w.g.}	0-1.5 kPa [0-6" w.g.]
	±3 Pa [±0.01" w.g.]	-25 to 25 Pa [-0.1 to 0.1" w.g.]
Airflow	±10% of full scale	
Space Temperature	±1.0ºC [±2.0ºF]	
Duct Temperature	±1.5.0ºC [±3.0ºF]	
Humidity	±5% RH	

2.2 GENERAL REQUIREMENTS

A. Sensors

1. All room sensors shall have LCD display for temperature and local set point adjustment knob. The local adjustment capability shall be locked by system software minimum 68°F to maximum 74°F otherwise specified for special range.

2. All duct sensors shall be RTD, PT100 or PT1000 type. No thermister type sensor allowed for fluid temperature measurement or duct temperature measurement. Outside air and AHU return air relative humidity measurement sensors shall be VAISALA HUMICAP model.

3. All static pressure sensor and relative humidity sensors shall be analytical grade solid state with an accuracy of +/ - 1.0%. All outside air and duct mounted relative humidity sensors shall be VAISALA only.

B. All new damper actuators shall be non-stall electronic types.

C. Each RTU and ERU shall have a discharge air temperature sensor including new terminal boxes with heating coils. Terminal units shall have a temperature sensor at the discharge airside.

D. All status for current drawing equipment shall use current transformer type sensor. No dry contact from starter allowed for proof.

E. In RTU, provide return air temperature sensor and relative humidity sensor. The system shall use enthalpy algorithm to measure return air BTU and compare with outside air BTU to use the lowest energy required to cool the source of air. Building systems shall switch to airside economizer mode base on adjustable outside air-dry bulb temperature and locked by adjustable high limit for outside air relative humidity.

F. Outside air wet bulb temperature shall be used to switch into waterside economizer mode. All cooling tower basin temperature set point shall maintain based on adjustable outside air wet bulb temperature.

2.3 GRAPHIC STANDARDS

A. Each floor shall have its own floor graphics converted from building Auto CAD file. All Auto CAD files will be provided to the control vendor.

B. All zones shall be colored differently to identify the zone boundary limits. Use construction drawing to identify zones. Show terminal box locations and sensor locations for each zone.

C. All HVAC equipment graphics shall be developed using clip art provided by software manufacturer. Do not use Auto CAD drawing to draw equipment graphics.

D. Provide all links for related graphics. Floor graphics shall link to related AHU graphics. Room temperature shall link with associated terminal box or AHU. All floor and equipment shall link with the parent building profile link. The building profile graphics shall be developed using building digital photograph. All links shall follow its source

E. All control logic shall request same as graphic links, like zone temperature sensor shall request heat or cooling from corresponding terminal unit, terminal unit shall request its source RTU.

2.4 CONTROLLERS

A. RTU and ERU shall be controlled by DDC controllers which shall be stand alone, multitasking, multi-user, real-time digital control processors modular type. DDC controllers shall communicate peer-to-peer within network level.

B. In the event of the loss of normal power, there shall be orderly shutdown of DDC controller to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum 48 hours. Upon restoration of normal power, the DDC controller shall automatically resume full operation without manual intervention.

C. If any reason DDC controller loose memory the system shall automatically reload the DDC controller from database server via network. The DDC controller shall have an additional RS-232C port to communicate via telephone line.

D. Terminal units may use “canned,” pre-programmed controllers.

E. Application specific controllers (ASC) may be used to provide operating equipment information over RS-485 serial communication for VFD, RTU, ERU. Physical output and input from primary DDC controllers indicated in sec.6.0 (a) shall be used to control all HVAC equipment.

2.5 DDC CONTROLLER:

A. DDC Controllers shall be stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.

B. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:

1. Control processes
2. Energy management applications
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
4. Historical/trend data for points specified
5. Maintenance support applications
6. Custom processes
7. Operator I/O
8. Dial-up communications
9. Manual override monitoring

C. Each DDC Controller shall support any combination of industry standard inputs and outputs.

D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

E. Operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.

F. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.

G. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

H. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

I. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

J. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 48 hours.

K. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.

L. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via campus Ethernet from a network workstation PC.

M. Provide a separate DDC Controller for each AHU or other HVAC system. It is intended that each unique system be provided with its own point resident DDC Controller.

N. DDC Controller Resident Software Features:

1. General:
   a. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher-level computer for execution.

2. Control Software Description:
   a. The DDC Controllers shall have the ability to perform the following pre-tested control algorithms:
   b. Two-position control
   c. Proportional control
   d. Proportional plus integral control
   e. Proportional, integral, plus derivative control
   f. Automatic tuning of control loops

3. DDC Controllers shall have the ability to perform any or all the following energy management routines:
   a. Time-of-day scheduling
   b. Calendar-based scheduling
   c. Holiday scheduling
   d. Temporary schedule overrides
   e. Start-Stop Time Optimization
   f. Automatic Daylight Savings Time Switchover
   g. Night setback control
   h. Enthalpy switchover (economizer)
   i. Peak demand limiting
   j. Temperature-compensated duty cycling

4. DDC Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
   a. A single process shall be able to incorporate measured or calculated data from any and all other DDC Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC Controllers on the network.

b. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a remote device such as a printer or text message to cell phone and radio.

5. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at the PC workstation, local I/O device or communications with other panels on the network.

   a. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

   b. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

   c. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs.

   d. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character or more alarm message to more fully describe the alarm condition or direct operator response.

6. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.

   a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing Data samples. All trend data shall be available for use in 3rd party personal computer applications.

   b. DDC Controllers shall also provide high-resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.

7. Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation or remotely using dial-in modems. For all loop-tuning functions, access shall be limited to authorized personnel through password protection.

8. DDC Controllers shall automatically accumulate and store run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O summary.

O. Application Specific Controllers (ASC)

1. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through LAN Device Networks.

2. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, and real-time digital control processor. Provide the following types of ASCs as a minimum:

   a. Terminal Equipment Controllers

   b. Provide for control of each piece of equipment, including, but not limited to, the following: Variable Air Volume terminal units, fans

   c. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 PSI pneumatic, allowing for interface to a variety of modulating actuators. Terminal controllers utilizing proprietary control signals and actuators shall not be acceptable. As an alternative, provide DDC Controllers or other ASCs with industry standard outputs for control of all terminal equipment including pneumatic actuation.

3. Connection of a POT to a DDC or ASC Controller shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally initiated commands and system modification.

4. Portable operator terminal access to controller shall be password-controlled.

2.6 WORKSTATION OPERATOR INTERFACE:

A. Basic Interface Description

1. Operator workstation interface software shall minimize operator training through the use of English language prompting, English language point identification and industry standard PC application software. The software shall provide, as a minimum, the following functionality:

   a. Real-time graphical viewing and control of environment

   b. Scheduling and override of building operations

   c. Collection and analysis of historical data and dynamic data (trend plot)

   d. Definition and construction of dynamic color graphic displays

   e. Editing, programming, storage and downloading of controller databases

   f. Alarm reporting, routing, messaging, and acknowledgement

B. Provide a graphical user interface, which shall minimize the use of keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection.

C. The software shall provide a multi-tasking type environment that shall allow the user to run several applications simultaneously. These Windows applications shall run simultaneously with the BAS software.

1. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows:

    a. Dynamic color graphics and graphic control

    b. Alarm management, routing to designated locations, and customized messages

    c. Week at a Glance Time-of-day scheduling

    d. Trend data definition and presentation

    e. Graphic definition and construction

    f. Program and point database editing on-line.

2. If the software is unable to display several different types of displays at the same time.

3. Report and alarm printing shall be accomplished via Windows program manager, allowing use of network printers.

4. Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password.

5. Reports shall be generated on demand or via pre-defined schedule and directed to CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:

    a. A general listing of all or selected points in the network

    b. List of all points currently in alarm

    c. List of all points currently in override status

    d. List of all disabled points

    e. List of all points currently locked out

    f. List of user accounts and access levels

    g. List all weekly schedules

    h. List of holiday programming

    i. List of limits and deadbands

    j. Excel reports

    k. System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points

    l. List of programs

6. Scheduling and override: Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Schedules reside in both the PC workstation and DDC Controller to ensure time equipment scheduling when PC is off-line; PC is not required to execute time scheduling. Provide override access through menu selection or function key. Provide the following spreadsheet graphic types as a minimum:

   a. Weekly schedules

   b. Zone schedules, minimum of 200 unique zones

   c. Monthly calendars

7. Collection and Analysis of Historical Data

   a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

   b. Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC trade contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC trade contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.

   c. Provide additional functionality that allows the user to view real-time trend data on trend graph displays. A minimum of six points may be graphed, regardless of whether they have been predefined for trending. The dynamic graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed.

D. Dynamic Color Graphic Displays

1. Create Color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems and hot water boiler systems, shall be provided by the BAS trade contractor as indicated in the point I/O summary of this specification to optimize system performance analysis and speed alarm recognition.

2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands. Graphics software shall permit the importing of AutoCAD or Bitmap drawings for use in the system.

3. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.

   a. Analog bars in 3 sizes shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.

   b. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.

   c. Equipment state may be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or setpoint.

4. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.

5. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

6. Off the shelf graphic software shall be provided to allow the user to add, modify or delete system graphic displays.

7. A clipart library of HVAC and automation symbols shall be provided including fans, AHU systems, and standard ductwork diagrams . The user shall have the ability to add custom symbols to the clipart library.

E. System Configuration & Definition

1. Network wide control strategies shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.

2. Provide automatic backup and restore of all DDC controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity.

3. System configuration, programming, editing, graphics generation shall be performed on-line.

F. Alarm Management

1. Alarm Routing shall allow the user to send alarm notification to selected printers or PC location based on time of day, alarm severity, or point type.

2. Alarm Notification shall be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. These alarm icons shall be displayed when

user is working in other Windows programs. The BAS alarm display screen shall be displayed when the user clicks on the alarm icon.

3. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message.

4. Alarm messages shall be customizable for each point to display detailed instructions to the user regarding actions to take in the event of an alarm.

2.7 DAMPER ACTUATORS

A. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with electric actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight closeoff.

B. Where two or more actuators are to be operated in sequence with each other, sequencing shall be by digital logic with separate analog outputs.

2.8 FIELD DEVICES:

A. Temperature Sensors - with accuracy of + 0.5 deg F @ 77 deg F)

1. Digital room sensors shall have day / night override button, and setpoint slide adjustment override options. The setpoint slide adjustment may be software limited by the automation system to limit the amount of room adjustment.

2. Built-in port allows connection of Portable operator terminal to query and modify operating parameters on room level sensor.

3. Room sensors shall have sensing accuracy of + 0.5 deg F, display accuracy and resolution shall be a minimum of + 1 deg F.

4. Humidity Sensors - with accuracy of + 2% RH @ 77 deg F, range of 20% to 95% RH, including hysteresis, linearity, and repeatability

5. Pressure Sensors – Setra

6. Dampers, sized for specific application

7. Damper Operators, sized for specific application

8. Smoke Detectors - BRK 120V ionization duct type

9. Low Temperature Detection Stat -

10. Electric Thermostats

11. Differential Pressure Switch

2.9 PROJECT MANAGEMENT:

A. Provide a designated project manager who will be responsible for the following:

1. Construct and maintain project schedule
2. On-site coordination with all applicable trades and trade subcontractors
3. Authorized to accept and execute orders or instructions from Owner/CTDOT PM
4. Attend project meetings as necessary to avoid conflicts and delays
5. Make necessary field decisions relating to this scope of work
6. Coordination/Single point of contact

2.10 NORMAL POSITIONS FOR DAMPERS

1. Sequences refer to normal damper positions. Where damper actuator are reused, it is not the intent to modify the damper to achieve the normal position referenced in the sequence. If normal position is not as specified, notify engineer.
2. Submittal data shall clearly identify damper normal or failed positions that differ from specifications.

2.11 AIR FLOW MONITORING STATIONS

A. Provide an airflow monitoring station minimum 6” upstream of intake and exhaust dampers in RTU-1 and ERV-1. The monitoring station shall include air flow traverse probes and electronic flow indicating transmitter.

1. Airflow transverse probes:
   a. Each airflow traverse probe shall use thermal dispersion technology, and shall contain multiple hermetically sealed thermistors flow sensors. Each airflow traverse probe shall be of extruded aluminum alloy tubing with stainless steel mounting brackets construction.
   b. The airflow traverse probe shall not incur a measurable pressure drop, nor shall the sound level within the duct be amplified due to probe. Each airflow measuring probe shall contain multiple factory-calibrated sensors placed at equal distances (for rectangular ducts) or at concentric area centers (for circular ducts) along the probe length. Sensors shall not required field calibration. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE or SMACNA standards for duct traversing and the manufacturer’s instructions. The airflow traverse probe shall be capable of producing steady, non-pulsating signals of airflow without need for flow corrections or factors, with a repeatability of 0.25%.
   c. The airflow traverse probe shall be the Ebtron Gold Series Model GP1.

2. Transmitter and Electronics Enclosure:

   a. The transmitter shall be able to integrate all of the required sensing points at the airflow measuring station. The transmitter shall be 24 VAC, and internally fused. All inputs and outputs shall be fused.

   b. The transmitter shall be capable of producing steady, non-pulsating signals of airflow without need for flow corrections or factors, with an instrument accuracy of 3%, over the velocity range of 0 to 5000 fpm

   c. Provide a 16 character alphanumeric display for airflow, temperature, and diagnostics.

   d. Output shall be either 0–10 VDC or 4-20 mA, field selectable.

   e. Provide an RS-485 interface if needed for interface to the HVAC control system .

   f. Transmitter shall continuously perform self-diagnostics, and shall ignore any malfunctioning sensor as well as alarm the User of the malfunction.

   g. Enclosure shall be NEMA-4R.

3. The airflow monitoring station shall be the Ebtron Gold Series Model GT*116-PD.

PART 3 - EXECUTION

3.1 START-UP AND COMMISSIONING:

A. See 23 08 00.

B. Demonstrate that all equipment operates as specified in every mode of operation described in the specifications and on the drawings

C. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the installer. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power.

D. Provide any recommendation for system modification in writing to owner. Do not make any system modification, including operating parameters and control settings, without prior approval of owner.

3.2 CONTROL SYSTEM CHECKOUT AND TESTING

A. Startup Testing: This testing shall be completed before the Owner’s Representative is notified of the system demonstration.

   1. Calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

   2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers' recommendations.

4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control dampers, magnetic starters, etc.) operate properly and that the normal positions are correct.

5. Verify that all analog output devices (actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct.

6. Check all automatic dampers to ensure proper action and closure. The Trade Contractor shall make any necessary adjustments to damper blade travel.

7. Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.

8. Alarms and Interlocks:

   a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

   b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

   c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.3 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration:

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Trade Contractor has completed the installation, started up the system, and performed its own tests.

2. The tests described in this section are to be performed in addition to the tests that the Trade Contractor performs as a necessary part of the installation, startup, and debugging process and as specified in the "Control System Checkout and Testing" in Part 3 of this specification. The CxA will be present to observe and review these tests.

3. Approved checklists and forms shall be completed for all systems as part of the demonstration.

4. Demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Trade Contractor.

5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

6. Demonstrate compliance with System Performance.

7. Demonstrate compliance with Sequences of Operation through all modes of operation.

8. Demonstrate complete operation of Operator Interface.

9. Additionally, the following items shall be demonstrated:

   a. DDC Loop Response. The Trade Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Trade Contractor.

   b. Demand limiting. The Trade Contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.

   c. Optimum Start/Stop. The Trade Contractor shall supply a trend data output showing the capability of the algorithm. The hour-by-hour trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

   d. Interface to the building fire alarm system.

   e. Operational logs for each system that indicate all set points, operating points, mode, and equipment status shall be submitted to the Engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Trade Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of Completion. Any tests that cannot be performed due to circumstances beyond the control of the Trade Contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.

2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

3.4 COORDINATION OF ELECTRCAL AND FIRE ALARM

A. Prior to bid, communicate to mechanical bidders all requirements and location of new taps, dampers, flow stations, etc. that will be furnished by BAS manufacturer.

B. Electrical Drawings show power to control panels. This Section responsible for transformers, power from control panel or junction box to actuators and other control components not shown on electrical.

C. Electrical power requirements for controls that are not shown on Electrical drawings or Division 26 specifications are responsibility of BAS sub. Power for controls shall meet Division 26 requirements. Power for controls shall be on separate circuits. Circuits shall not be shared with non-control loads.

D. Prior to bid, communicate all power requirements to electrical bidders. Communicate load and location of power required for BAS and controls to eliminate any gaps or overlap in scope of work between subs.

E. Prior to bid, communicate all power requirements to fire alarm system bidders. Prior to bid, coordinate line of demarcation to eliminate any gaps or overlap between fire alarm system bidders and BAS section.

END OF SECTION 23 09 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas by-pass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use silver copper phosphorous filler material to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.

4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).

5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.

2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.

3. Operator: Rising stem and hand wheel.

4. Seat: Nylon.

5. End Connections: Socket, union, or flanged.

6. Working Pressure Rating: 500 psig (3450 kPa).

7. Maximum Operating Temperature: 275 deg F (135 deg C).

2.3 REFRIGERANTS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atofina Chemicals, Inc.

2. DuPont Company; Fluorochemicals Div.

3. Honeywell, Inc.; Genetron Refrigerants.

4. INEOS Fluor Americas LLC.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines for Conventional Air-Conditioning Applications: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping adjacent to machines to allow service and maintenance.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

J. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

K. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

L. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Liquid lines may be installed level.

M. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

N. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

O. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

END OF SECTION 23 23 00

SECTION 23 29 23 VARIABLE FREQUENCY DRIVES

PART 1-GENERAL

1.1 DESCRIPTION

A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.

B. The drive manufacturer shall supply the drive and all necessary options as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. VFD's that are manufactured by a third party and "brand labeled" shall not be acceptable. All VFDs installed on this project shall be from the same manufacturer.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Institute of Electrical and Electronic Engineers (IEEE)
   a. Standard 519-1992, IEEE Guide for Harmonic Content and Control.
2. Underwriters laboratories
   a. UL508C
3. National Electrical Manufacturer's Association (NEMA)
   a. ICS 7.0, AC Adjustable Speed Drives
4. IEC 16800 Parts 1 and 2
5. National Electric Code (NEC)
   a. NEC 430.120, Adjustable-Speed Drive Systems
6. International Building Code (IBC)
   a. IBC 2006 Seismic – referencing ASC 7-05 and ICC AC-156

B. Qualifications:

1. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs with red label UL stickers, requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.
2. CE Mark – The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

3. The entire VFD enclosure, including the bypass shall be seismically certified and labeled as such in accordance with the 2006 International Building Code (IBC):
    a. VFD manufacturer shall provide Seismic Certification and Installation requirements at time of submittal.
    b. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake test data as defined by ICC AC-156.
    c. Seismic ratings based upon calculations alone are not acceptable. Certification of Seismic rating must be based on testing done in all three axis of motion.
4. Acceptable Manufactures
    a. ABB ACH Series.
    b. Alternate manufacturer's requests must be submitted in writing to the Engineer for approval at least 20 working days prior to bid. Approval does not relieve the supplier of specification requirements.
5. The VFD manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering VFD unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user's site. The CBT product shall be repeatable, precise and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID number. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.

1.3 SUBMITTALS

A. Submittals shall include the following information:
    1. Outline dimensions, conduit entry locations and weight.
    2. Customer connection and power wiring diagrams.
    3. Complete technical product description include a complete list of options provided. Any portions of this specification not meet must be clearly indicated or the supplier and trade contractor shall be liable to provide all additional components required to meet this specification.
    4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
        a. The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, no exceptions.

PART 2 – PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure, exceeding NEMA enclosure design criteria (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

1. Environmental operating conditions: VFDs shall be capable of continuous operation at 0 to 50^0 C (32 to 122^0 F) ambient temperature as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFD's that can only operate at 40° C intermittently (average during a 24 hour period) and therefore must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.
2. Enclosure shall be rated UL Type 1 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable. NEMA only type 1 enclosures are not acceptable (must be UL Type 1).

B. Standard Features:

1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of

circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.

6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).
7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
9. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add an AC line reactor.
10. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate.
11. The VFD shall include a coordinated AC transient surge protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
12. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.
13. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure / jam condition causing motor overload
14. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control.
15. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the serial communication bus.
16. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

C. All VFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.

2. Two (2) PID Set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.

3. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (ie. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.

4. Two (2) programmable analog inputs shall accept current or voltage signals.

5. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.

6. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC or 24VAC.

7. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.

8. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display “start enable 1 (or 2) missing”. The safety input status shall also be transmitted over the serial communications bus.

9. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 – 120 seconds. Start delay shall

be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications), and when switching from drive to bypass.

10. Seven (7) programmable preset speeds.
11. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.
12. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
13. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
14. The VFD shall include password protection against parameter changes.

D. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:

1. Start-up assistant
2. Parameter assistants
   a. PID assistant
   b. Reference assistant
   c. I/O assistant
   d. Serial communications assistant
   e. Option module assistant
   f. Panel display assistant
   g. Low noise set-up assistant
3. Maintenance assistant
4. Troubleshooting assistant
5. Drive optimizer assistants

E. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

Output Frequency
Motor Speed (RPM, %, or Engineering units)
Motor Current
Motor Torque
Motor Power (kW)
DC Bus Voltage
Output Voltage

F. Serial Communications

1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.

2. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

   a. Data Sharing – Read Property – B.

   b. Data Sharing – Write Property – B.

   c. Device Management – Dynamic Device Binding (Who-Is; I-Am).

   d. Device Management – Dynamic Object Binding (Who-Has; I-Have).

   e. Device Management – Communication Control – B.

3. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.

4. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

5. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.

G. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.

H. All VFD's through 100 HP at 480 V shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not sustain damage from this power mis-wiring condition.

I. OPTIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

1. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor per section 2.01K below.

J. BYPASS CONTROLLER

1. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses are required. UL Listed motor overload protection shall be provided in both drive and bypass modes.
2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before either enclosure may be accessed.
3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the UL data label.
4. The drive and bypass package shall be seismic certified and labeled to the IBC:
   a. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake table test data as defined by ICC AC-156.
5. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the bypass, will not be accepted.
6. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
7. The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
8. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.
9. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.

10. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall include ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet.

11. Serial communication capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and / or via a Form-C relay output – keypad "Hand" or "Auto" selected, bypass selected, and broken belt indication. The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 50 field serial communications points shall be capable of being monitored in the bypass mode.

12. The bypass serial communications shall allow control of the bypass' digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The bypass' digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the bypass' digital inputs shall be capable of being monitored by the DDC system.

13. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and / or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause only a warning or a fault and / or system shutdown.

14. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate an internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.

15. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open (motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman's override / smoke control mode.

16. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to fire a Form-C relay output, and / or over the serial communications protocol.

17. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the

motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

18. There shall be a keypad adjustment to select manual or automatic transfer bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to the bypass mode and which faults require a manual transfer to bypass. The user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:

    a. Over current

    b. Over voltage

    c. Under voltage

    d. Loss of analog input

19. The following operators shall be provided:

    a. Bypass Hand-Off-Auto

    b. Drive mode selector

    c. Bypass mode selector

    d. Bypass fault reset

20. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.

21. The bypass shall include a supervisory control mode. In this bypass mode, the bypass shall monitor the value of the VFD's analog input (feedback). This feedback value is used to control the bypass contactor on and off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps even with the VFD out of service.

22. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include "FireStat", "FreezStat", "Over pressure" and "Low suction". The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.

23. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User's Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties as required by UL 864/UUKL. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.

24. Fireman's Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be

programmed for “Run-to-Destruction”. The user may also force the unit into Override 2 via the serial communications link.

25. Class 10, 20, or 30 (programmable) electronic motor overload protection shall be included.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Installation shall be the responsibility of the mechanical trade contractor. The trade contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.

B. Power wiring shall be completed by the electrical trade contractor, to NEC code 430.122 wiring requirements based on the VFD input current. Caution: VFDs supplied without internal reactors have substantially higher input current ratings, which may require larger input power wiring and branch circuit protection. The trade contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.2 START-UP

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.3 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line shall be available.

B. A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

3.4 WARRANTY

A. The VFD Product Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty will include all parts, labor, travel time and expenses. A toll free 24/365 technical support line shall be available.

END OF SECTION 23 29 23

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.
5. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of bottom of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.

d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.

2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.

4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

5. Shop-Applied Coating Color: Black

6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.

3. Shore A Hardness: Minimum 20.

4. Water resistant.

5. Mold and mildew resistant.

6. VOC: Maximum 75 g/L (less water).

7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.

8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.

2. Type: S.

3. Grade: NS.

4. Class: 25.

5. Use: O.

6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2.5 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.

2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Loos & Co.; Cableware Division.
6. Mason Industries.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

B. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

J. Where ducts pass through fire-rated interior partitions, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
2. Conditioned Space, Exhaust and Return-Air Ducts: Seal Class C.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: structural-steel fasteners appropriate for construction materials to which hangers are being attached.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Terminal Units:

   a. Pressure Class: Positive 1-inch wg.
   b. Minimum SMACNA Seal Class: B
   c. SMACNA Leakage Class for Rectangular: 12
   d. SMACNA Leakage Class for Round and Flat Oval: 12

2. Ducts Connected to Roof Top Units:

   a. Pressure Class: Positive 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 6

3. Ducts Connected to Energy Recovery Units:

   a. Pressure Class: Positive 3-inch wg
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Return Ducts:

1. Ducts Connected to Return Air Shafts:

   a. Pressure Class: Negative 1-inch wg.
   b. Minimum SMACNA Seal Class: B
   c. SMACNA Leakage Class for Rectangular: 12.

D. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Velocity 1000 fpm (5 m/s) or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
   c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Control dampers.
3. Fire dampers.
4. Combination fire and smoke dampers.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.

B. Related Requirements:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
3. Division 28 Section "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Submittals:

1. Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.

b. Manual volume damper installations.

c. Control-damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

e. Duct security bars.

f. Wiring Diagrams: For power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: [G60 (Z180)] [G90 (Z275)].

2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. McGill AirFlow LLC.
    d. Nailor Industries Inc.
    e. Pottorff.
    f. Ruskin Company.
    g. Trox USA Inc.
    h. Vent Products Company, Inc.
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
    a. 16-gauge galvanized steel.
    b. Mitered and welded corners.
    c. flangeless frames for installing in ducts.
6. Blades:
    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized, roll-formed steel, 0.064 inch (1.62 mm) thick.
7. Blade Axles: Galvanized steel.
8. Bearings:
    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Vinyl.
10. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

2.4 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Lloyd Industries, Inc.
6. McGill AirFlow LLC.
7. Metal Form Manufacturing, Inc.
8. Nailor Industries Inc.
9. NCA Manufacturing, Inc.
10. Pottorff.
11. Ruskin Company.
12. Vent Products Company, Inc.
13. Young Regulator Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. 16 gauge galvanized sheet steel.

D. Blades:

1. Multiple blade with maximum blade width of 8 inches.
2. Opposed-blade design.
3. Galvanized-steel
4. Blade Edging: Closed-cell neoprene

E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Oil-impregnated bronze

2.5 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. NCA Manufacturing, Inc.
7. Pottorff.
8. Prefco; Perfect Air Control, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.05 –inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical.

H. Blades: Roll-formed, interlocking, 0.024-inch- thick, galvanized sheet steel. Not all manufacturers use blade locks for horizontal units.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.

3. Greenheck Fan Corporation.

4. Nailor Industries Inc.

5. Pottorff.

6. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg and 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with mechanically attached corners and mounting flange.

F. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.

G. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel.

H. Leakage: Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application.

K. Master control panel for use in dynamic smoke-management systems.

L. Damper Motors: Modulating action.

M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." Division 26 Sections.

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf

5. Electrical Connection: 115 V, single phase, 60 Hz.

N. Accessories:

1. Test and reset switches, damper mounted.

2.7 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Elgen Manufacturing,Inc
3. Nexus PDQ; Division of Shilco Holdings Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.8 TURNING VANES

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO Incorporated.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Elgen Manufacturing.
5. Flexmaster U.S.A., Inc.
6. Greenheck Fan Corporation.
7. McGill AirFlow LLC.
8. Nailor Industries Inc.
9. Pottorff.
10. Ventfabrics, Inc.
11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.

4. Ventfabrics, Inc.

5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).

2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.

3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

2.11 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.

2. McGill AirFlow LLC.

3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylenevapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 10 to plus 160 deg F.

4. Insulation R-value: 4.2.

C. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

2. Install aluminum volume dampers in aluminum ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install fire and smoke dampers according to UL listing.

F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

2. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.

3. Control devices requiring inspection.

4. Elsewhere as indicated.

G. Install access doors with swing against duct static pressure.

H. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches

2. Two-Hand Access: 12 by 6 inches

3. Head and Hand Access: 18 by 10 inches

4. Head and Shoulders Access: 21 by 14 inches

5. Body Access: 25 by 14 inches

6. Body plus Ladder Access: 25 by 17 inches

I. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

J. Install flexible connectors to connect ducts to equipment.

K. Connect terminal units to supply ducts with maximum 48-inch lengths of flexible duct. Do not use flexible ducts to change directions.

L. Connect flexible ducts to metal ducts with draw bands.

M. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fan-powered air terminal units.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

1.4 ACTION SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SERIES FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Anemostat Products; a Mestek Company.
2. Carnes.
3. Environmental Technologies, Inc.
4. Krueger.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Price Industries.
8. Titus.
9. Trane; a business of American Standard Companies.
10. Tuttle & Bailey.

B. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud for installation above a ceiling.

C. Casing: 0.034-inch steel double wall.

1. Casing Lining: Adhesive attached, 2-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
5. Fan: Forward-curved centrifugal.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

E. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.

F. Motor:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2. Type: Electronically commutated motor.

3. Fan-Motor Assembly Isolation: Rubber isolators.

4. Enclosure: Totally enclosed, fan cooled.

5. Enclosure Materials: Cast aluminum.

6. Efficiency: Premium efficient.

7. Service Factor: 1.10.

8. Motor Speed: Multispeed.

   a. Speed Control: Infinitely adjustable with electronic controls.

G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Material: 1 inch, glass fiber treated with adhesive; having 80 percent arrestance and 5 MERV.

H. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

1. Stage(s): 2.

2. Access door interlocked disconnect switch.

3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)

4. Nickel chrome 80/20 heating elements.

5. Airflow switch for proof of airflow.

6. Fan interlock contacts.

7. Fuses in terminal box for overcurrent protection (for coils more than 48 A).

8. Mercury contactors.

9. Magnetic contactor for each step of control (for three-phase coils).

I. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.

2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.

3. Disconnect Switch: Factory-mounted, fuse type.

J. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

K. Electric Controls: 24-V damper actuator with wall-mounted electric thermostat and appropriate mounting hardware.

L. Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:

1. Occupied and unoccupied operating mode.

2. Remote reset of airflow or temperature set points.

3. Adjusting and monitoring with portable terminal.

4. Communication with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC."

2.2 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Steel Cables: Galvanized steel complying with ASTM A 603.

C. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.3 SEISMIC-RESTRAINT DEVICES

A. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

C. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; with an automatic-locking and clamping device or double-cable clips.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on air terminal units that are suspended with vibration isolators.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

F. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the CTDOT PM if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Set anchors to manufacturer's recommended torque, using a torque wrench.

5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.4 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

3.5 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00

SECTION 23 51 00 – LISTED TYPE III VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Listed double-wall vents.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Type III vents.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.

2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated breeching, chimneys, and stacks; accessories; and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Breeching, Chimneys, and Stacks: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of anchorage devices on which the certification is based and their installation requirements.

B. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED TYPEY III VENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Heat-Fab, Inc.
2. Metal-Fab, Inc.
3. Selkirk Inc.; Selkirk Metalbestos and Air Mate.

B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously with positive or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.

D. Inner Shell: ASTM B 959, Type 29-4C stainless steel.

E. Outer Jacket: Aluminized steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Simpson-Duravent sidewall cap

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 APPLICATION

A. Listed Type III Vents: Vents for certified gas appliances.

3.3 INSTALLATION OF LISTED VENTS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Lap joints in direction of flow.

F. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.

G. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.

H. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 235100

SECTION 23 55 23 - GAS-FIRED RADIANT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes tubular gas-fired, high-intensity infrared radiant heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of gas-fired radiant heater indicated. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of gas-fired radiant heater that fails in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 TUBULAR INFRARED HEATERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Detroit Radiant Products, Inc.
2. Combustion Research Corporation.
3. Gas-Fired Products Inc.; Space-Ray Div.
4. Reznor/Thomas & Betts Corporation.
5. Roberts-Gordon, Inc.
6. Schwank Inc.
7. Solaronics, Inc.
8. Sterling HVAC Products; Div. of Mestek Technology Inc.

D. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.20/CSA 2.34.

E. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

F. Combustion Tubing: 4-inch- diameter steel with high-emissivity, high-temperature, corrosion-resistant external finish.

G. Tubing Connections: Stainless-steel couplings or flared joints with stainless-steel draw bolts.

H. Reflector: Polished aluminum, 97 percent minimum reflectivity, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Provide for rotating reflector or heater around a horizontal axis for minimum 30-degree tilt from vertical.

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.
2. Include hanger kit.

I. Burner Safety Controls:

1. Gas Control Valve: Single-stage, regulated redundant 24-V ac gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

2. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.
3. Control Panel Interlock: Stops burner if panel is open.
4. Indicator Lights: Burner-on indicator light.

J. Burner and Emitter Type: Gravity-vented power burner, with the following features:

1. Emitter Tube: 4-inch- diameter, aluminized-steel tubing with sight glass for burner and pilot flame observation.

2. Venting: Connector at exit end of emitter tubing for vent-pipe connection

a. Vent Terminal: Horizontal.

3. Burner/Ignition: Power gas burner with electronic spark and electronic flame safety.
4. Burner/Ignition: Stainless-steel burner cup and head with balanced-rotor draft fan and spark ignition with electronic flame supervision.
5. Combustion-Air Connection: Duct connection for combustion air to be drawn directly from outdoors by burner fan.

2.2 CONTROLS

A. Thermostat: 2-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.

1. Control Transformer: Integrally mounted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired radiant heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

B. Suspended Units: Suspend from substrate using chain hanger kits and building attachments.

C. Maintain manufacturers' recommended clearances to combustibles.

D. Install piping adjacent to gas-fired radiant heaters to allow service and maintenance.

E. Gas Piping: Comply with Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

F. Vent Connections: Comply with Division 23 Section "Breechings, Chimneys, and Stacks."

G. Electrical Connections: Comply with applicable requirements in Division 26 Sections.

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

H. Adjust initial temperature set points.

I. Adjust burner and other unit components for optimum heating performance and efficiency.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 55 23

SECTION 23 74 13 - PACKAGED, OUTDOOR, ROOFTOP AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Gas furnace.
3. Economizer outdoor- and return-air damper section.
4. Integral, space temperature controls.
5. Roof curbs.

1.2 DEFINITIONS

A. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

B. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

D. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.3 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Performance:

1. Basic Wind Speed: 150.
2. Building Classification Category: III.

3. Minimum 10 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.

2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigerant system safety.

2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawing or a comparable product by one of the following:

1. AAON, Inc.
2. Addison Products Company.
3. Carrier Corporation.
4. Engineered Air.
5. Lennox Industries Inc.
6. McQuay International.
7. Trane; American Standard Companies, Inc.
8. YORK International Corporation.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.052 inch thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.034 inch thick, perforated 40 percent free area.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 2 inch.
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple both sides of drain pan.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, backward inclined, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

C. Return-Air Fan: Backward inclined, shaft mounted on permanently lubricated motor.

D. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.

E. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor. Epoxy coating for coastal environment.
2. Stainless steel coil casing.
3. Coil Split: Interlaced.
4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor. Epoxy coating for coastal environment.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Four.

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant: R-407C or R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: Minimum 90 percent arrestance, and MERV 13.

2.7 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel.

1. Fuel: Natural gas.

2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Stainless steel.

D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension.

E. Safety Controls:

1. Gas Control Valve: Modulating.

2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with motorized damper filter.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.

2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in over current protection.

2.10 CONTROLS

A. Control equipment is specified in Division 23 Section "Instrumentation and Control for HVAC."

2.11 ROOF CURBS

A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Curb Height: 24 inches.

C. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

C. Install wind and seismic restraints according to manufacturer's written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

E. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

F. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. Install normal-weight, 3000-psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified in Division 03.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 74 13

SECTION 23 74 33 – ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes energy recovery rooftop replacement-air units.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Include details of installation and wiring diagrams.

C. Startup service reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON, Inc.
2. Addison Products Company.
3. Des Champs Laboratories, Incorporated.
4. LCSystems.
5. Reznor-Thomas & Betts Corporation; Mechanical Products Division.

2.2 CABINET

A. Construction: Double wall.

B. Exterior Casing: Galvanized steel with baked-enamel paint finish with lifting lugs and knockouts for electrical and piping connections.

C. Interior Casing: Galvanized steel.

D. Base Rails: Galvanized-steel rails for mounting on roof curb.

E. Service Doors: Hinged access doors with neoprene gaskets.

F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.

1. Thickness: 2 inches.
2. Insulation Adhesive: Comply with ASTM C 916, Type I.
3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

G. Condensate Drain Pans: Formed sections of stainless-steel sheet designed for self-drainage. Fabricate pans and drain connection to comply with ASHRAE 62.1-2004.

H. Roof Curb: Full-perimeter curb of sheet metal, minimum 24 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

I. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.3 SUPPLY AND EXHAUST AIR FANS

A. Fan: backward-inclined plenum centrifugal; statically and dynamically balanced, aluminum, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings.

B. Motor: Totally enclosed, variable-speed motor.

C. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.

2.4 HEAT WHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advanced Thermal Technologies.
2. Airxchange Inc.
3. American Energy Exchange, Inc.
4. Loren Cook Company.
5. SEMCO Incorporated.
6. Trane; American Standard Companies, Inc.

B. Casing:

1. Stainless steel.
2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
3. Casing seals on periphery of rotor and on duct divider and purge section.
4. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearing.

C. Rotor: Aluminum segmented wheel strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating.

1. Maximum Solid Size for Media to Pass: 500 micrometer.

D. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

E. Controls:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2. Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust temperature above freezing and air differential temperature above set point. Rotor speed shall increase to maximum when exhaust-air temperature is less than outdoor-air temperature.
3. Pilot-Light Indicator: Display rotor rotation and speed.
4. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

F. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
3. Factory-fabricated, viscous-coated, flat-panel type.
4. Thickness: 2 inches.
5. Minimum Arrestance: 80, according to ASHRAE 52.1.
6. Minimum Merv: 13, according to ASHRAE 52.2.
7. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
8. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

2.5 INDIRECT-FIRED GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."

1. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners: Stainless steel.

1. Minimum AFUE: 93 percent.
2. Minimum Thermal Efficiency: 80 percent.
3. Fuel: Natural gas.
4. Ignition: Electronically controlled electric spark with flame sensor.

C. Heat-Exchanger Drain Pan: Stainless steel.

D. Venting: Gravity vented.

E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

F. Safety Controls:

1. Gas Control Valve: Electronic modulating.
2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.6 OUTDOOR-AIR INTAKE AND DAMPERS

A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.

B. Damper Operators: Electric.

C. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.

D. Outdoor-Air Intake Hoods: Stainless steel, with bird screen complying with ASHRAE 62.1-2004 and finish to match cabinet.

2.7 CONTROLS

A. Factory-wire connection for controls' power supply.

B. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.

C. Unit Controls: Solid-state control board and components with field-adjustable control parameters.

D. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.

1. Timer: Seven-day electronic clock.
2. Electrically interlock kitchen hood fire-extinguishing system to de-energize replacement-air unit when fire-extinguishing system discharges.

E. Unit-Mounted Status Panel:

1. Cooling/Off/Heating Controls: Control operational mode.
2. Damper Position: Indicates position of outdoor-air dampers in terms of percentage of outdoor air.
3. Status Lights:
   a. Filter dirty.
   b. Fan operating.
   c. Cooling operating.
   d. Heating operating.

F. Heating Controls:

1. Factory-mounted sensor in supply-fan outlet with sensor adjustment located in control panel modulates gas furnace burner to maintain space temperature.

G. Damper Controls: When exhaust fans stop, set outdoor- and return-air damper to 75 percent outdoor air. When exhaust fans start, close return-air damper and fully open outdoor-air damper.

H. DDC Temperature Control: Stand-alone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC." Links shall include the following:

1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.

2. Hardware interface or additional sensors for the following:

a. Discharge air temperature.

b. Enthalpy wheel operating

c. Furnace operating.

2.8 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof curb on roof structure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure rooftop replacement-air units on curbs and coordinate roof penetrations and flashing with roof construction.

B. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.

C. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Install piping adjacent to machine to allow service and maintenance.

1. Gas Burner Connections: Comply with requirements in Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.

E. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to rooftop replacement-air units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

F. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.2 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to furnace combustion chamber.
2. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
3. Inspect casing insulation for integrity, moisture content, and adhesion.
4. Verify that controls are connected and operable.
5. Clean outside coil and inspect for construction debris.
6. Clean furnace flue and inspect for construction debris.
7. Inspect operation of power vents.
8. Purge gas line.
9. Verify bearing lubrication.
10. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
11. Adjust fan belts to proper alignment and tension.
12. Start unit.
13. Start refrigeration system when outdoor-air temperature is within normal operating limits.
14. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
15. Operate unit for run-in period.
16. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure flue-gas temperature at furnace discharge.
    d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
17. Calibrate thermostats.
18. Adjust and inspect high-temperature limits.
19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
20. Verify operational sequence of controls.

21. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-limit heat exchanger.

    b. Alarms.

B. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

D. Prepare written report of the results of startup services.

3.3 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop replacement-air units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 74 33

SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

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

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five years from date of Substantial Completion.

b. For Parts: Eighteen months from date of Substantial Completion.

c. For Labor: Eighteen months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.

2. SANYO North America Corporation; SANYO Fisher Company.

3. LG.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

2. Insulation: Faced, glass-fiber duct liner.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.

4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.

5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

7. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

b. Multitapped, multispeed with internal thermal protection and permanent lubrication.

c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

9. Filters: Permanent, cleanable.

10. Condensate Drain Pans:

a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

2) Depth: A minimum of 2 inches deep.

b. Single-wall, stainless-steel sheet.

c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by CTDOT PM, and discharge drain pans with drain connection.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.

3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

4. Fan: Direct drive, centrifugal.

5. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

b. Multitapped, multispeed with internal thermal protection and permanent lubrication.

c. Enclosure Type: Totally enclosed, fan cooled.

d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.

e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

f. Mount unit-mounted disconnect switches on exterior of unit.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

7. Condensate Drain Pans:

a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

2) Depth: A minimum of 1 inch deep.

b. Single-wall, stainless-steel sheet.

c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

8. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.

2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.

3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:

1) Factory-fabricated, viscous-coated, flat-panel type.

2) Thickness: 1 inch.

3) Initial Resistance: 0.1 inches wg.

4) Recommended Final Resistance: 0.5 inches wg.

5) Arrestance according to ASHRAE 52.1: 80.

6) Merv according to ASHRAE 52.2: 13.

7) Media: Interlaced glass fibers sprayed with nonflammable adhesive.

8) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by CTDOT PM, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

   a. Compressor Type: Scroll.

   b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

   c. Refrigerant Charge: R-410A.

   d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.

4. Fan: Aluminum-propeller type, directly connected to motor.

5. Motor: Permanently lubricated, with integral thermal-overload protection.

6. Low Ambient Kit: Permits operation down to 45 deg F.

7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC."

B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.

2. 24-hour time control of system stop and start.

3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.

4. Fan-speed selection including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounted, compressor-condenser components on 4-inch- thick, reinforced concrete base that is 4 inches larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

E. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

F. Install seismic restraints.

G. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. See Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

H. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts" Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

END OF SECTION 23 81 26