OUTLINE SPECIFICATIONS

Jordan Health
Pharmacy Relocation
LaBella Project No: 2223394

Jordan Health
82 Holland Street
Suite #200
Rochester, NY 14605

DESCRIPTION:

This project involves renovations to an existing 980 sf office suite into a new retail pharmacy which includes waiting, pharmacy work area and office space. Renovation consists of demolition, new partitions, doors, ceilings, millwork, interior finish upgrades, exterior window replacement & MEP upgrades.

DIVISION 1 - GENERAL REQUIREMENTS:

General Conditions of the Contract for Construction, AIA Document A201-1997 and any other documents as provided by Jordan Health are incorporated into the contract by reference.

Construction shall conform to current editions of the following:

- 2020 Building Code of New York State,
- 2020 Existing Building Code of New York State,
- 2020 Energy Conservation Construction Code of New York State,
- 2017 National Electrical Code (NEC),
- 2020 Plumbing Code of New York State,
- 2020 Mechanical Code of New York State,
- 2020 Fuel Gas Code of New York State,
- 2020 Fire Code of New York State,
- NFPA 101 Life Safety Code 2012 (NYS DOH, TJC and CMS),
- NFPA 99 Standard for Healthcare Facilities 2015 (NYS DOH, TJC and CMS),
- New York State Health Code (10NYCRR),
- Guidelines for Design and Construction of Hospital and Healthcare Facilities 2018 Edition (NYS DOH) and 2001 Edition (JCAHO)
- 2010 Americans with Disabilities Act (ADA)
- ADA Accessibility Guidelines (ADAAG 2004)
- Americans With Disabilities Act (ADA) Standards for Accessible Design (28 CFR Part 36, 1994),
- American National Standard for Accessible and Usable Buildings and Facilities (ICC/ANSI A117.1-2003),
- All other current local, state, and federal codes and regulations applicable to this project.

Manage construction to maintain ongoing operation of other occupants. Coordinate schedule with Owner and Project Manager.

References to “Owner” shall mean **Jordan Health** unless otherwise noted.

Contractor is responsible for all materials, construction methods and craftsmanship.

Contractor shall review any existing drawings on file with the Owner, prior to starting any work.

Contractor to verify all requirements, notes, and dimensions prior to the start of construction. Report all discrepancies to the Architect immediately.

Contractor shall be responsible for all changes to these documents. Site visits may not be made by the Architect to verify conformance.

In the event of a dimensional conflict, drawings take precedent over specifications. In the event of a material conflict, specifications shall take precedent over drawings.

Scope of work shall include patch to match (PTM) of any existing areas above, below or beside which are disturbed as a result of construction. The quality of PTM construction shall be equivalent to existing. All PTM materials are to match existing unless noted otherwise. When in question, the Contractor shall consult the Owner to determine what the building's "standard" is.

Contractor is responsible for all required NYSDOH compliant temporary protection required to maintain ongoing operations, exiting paths, dust control and occupant safety. It is the Contractor's responsibility to identify the requirements for temporary protection and project phasing and incorporate that cost into their base bid. Coordinate with the Owner for other requirements.

Finish material and color selections will be made by the Architect on behalf of the Owner unless otherwise specified or noted.

Submittals: Submit Shop Drawings, Product Data, and Samples (where indicated) for the following:

- Millwork (Architectural Woodwork)
- Overhead Coiling Grille
- Doors, Frames and Hardware
- Windows and Glazing
- Any / All finish selections
- Refer to Mechanical/Electrical Specifications for other requirements

DIVISION 1 – GENERAL REQUIREMENTS:

014000: QUALITY REQUIREMENTS:

A. SCHEDULE OF REQUIRED TESTS AND SPECIAL INSPECTIONS: The following tests are to be managed by the (Construction Manager) and paid for by the Owner. Testing to conform to Section 1704 of the Building Code of New York State. Contractor is to provide a copy of the inspection report and/or certification to the Architect upon completion of the test or inspection.

015000: TEMPORARY FACILITIES AND CONTROLS: Infection Control Risk Assessment (ICRA) requirements and temporary partitions:

A. Provide floor-to-deck dustproof, one hour rated partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise. Construct dustproof partitions with 5/8" type-x gypsum wallboard with joints taped on both sides, and fire-retardant plywood over the gypsum board on construction operations side. Install sound insulation and perimeter sealant.

B. Where one-hour rated partitions are deemed by the Owner & CM to be impractical, they may be modified if there are compensating provisions made for life safety with the agreement of the Owner's Fire Marshal. Dust separation shall be maintained. Sound isolation shall be maintained unless the adjacent occupancy is determined to be less sensitive to construction noise, in agreement with the Owner's Project Manager.

C. Provide walk-off mats at each entrance through temporary partitions.

D. During completion of finishes (including flooring, painting and installation of ceiling tile) and during Punch List completion, fire rated temporary partitions may be removed and replaced with appropriate measures to maintain Owner occupied areas dust-free. Final, installed HVAC systems shall not be utilized for temporary heat or ventilation until this stage of construction is reached.

E. Negative Pressure Ventilation System: Provide negative pressure ventilation units in renovation areas for dust control and/or infection control purposes. Direct exhaust to the exterior or into a space approved by the Owner (if units are equipped with HEPA filters). Negative air monitors shall be installed within each discrete renovation area and shall be checked and logged every 2 hours by the General Contractor. The Owner's Infection Control professional and Project Manager will periodically inspect measures and will coordinate with the contractor on the implementation of the measures.

F. Dust control: Patient occupied areas shall be maintained dust free through out construction. Public corridors used by construction personnel shall be cleaned (swept and mopped) at least twice a day as necessary to meet the Owner's standards for cleanliness.

G. Measures shall be taken to insure that installed ventilation systems are dust free. Components shall be sealed during transportation to the site. Open ends of ductwork shall be sealed off from the construction area to prevent dust from entering the ventilation system.

H. Submit an Infection Control Construction Permit, provided by the Owner. Occupants adjacent to the project area are in Infection Control Risk Group 1: Least Risk.

017320: SELECTIVE DEMOLITION: Removal of certain existing interior construction. Removal of certain existing items including millwork, HVAC, plumbing and electrical. Salvage of designated items for relocation. Review all removed items with the Owner regarding salvage and reuse.

017700: CLOSE OUT PROCEDURES:

A. REQUIREMENTS AT SUBSTANTIAL COMPLETION: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
   1. Prepare a list of items to be completed and corrected (punch list), and reasons why the Work is not complete.
   2. Advise Owner of pending insurance changeover requirements.
   3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   5. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
   6. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   7. Complete startup testing of systems.
   8. Submit test/adjust/balance records.
   9. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   10. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
   11. Complete final cleaning requirements, including touchup painting.
   12. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
   13. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect and or third partry will either proceed with inspection or notify
   14. Contractor with unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

B. REQUIREMENTS AT CLOSE OUT: Before requesting final inspection for determining date of Final Completion, complete the following:
   1. Submit a final Application for Payment.
   2. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
   4. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

C. SPECIAL REQUIREMENTS BY THE NYS DEPARTMENT OF HEALTH

	ITEM	ACTION BY
1.	Testing Certificate for Fume Hoods	Contractor
2.	Air Balance Report	Contractor
3.	Certificate of Inspection and Test of Sprinkler System and Material and Test Certificates	Contractor
4.	Testing Certificate for Smoke Detection & Fire Alarm System	Contractor
5.	Testing Certificate for Emergency Lighting	Contractor
6.	Underwriters Certificate for the Electrical System	Contractor
7.	Testing Certificate for Security System	Contractor or Owner's Vendor
8.	Flame Spread Certifications for Floor Coverings, Base, Wall Covering and Ceiling Systems	Contractor
9.	Certificate of Occupancy/ Compliance from the Town/City	Contractor
10.	O&M Manuals and Record of In-service Training	Contractor
11.	Fire Protection and Disaster Plans	Owner
12.	Maintenance, Housekeeping and Infection Control Manuals	Owner
13.	Punch List	Architect
14.	Certificate of Substantial Completion	Architect
15.	Architect's Letter of Certification	Architect

DIVISION 2 – EXISTING CONDITIONS: (NOT NEEDED FOR THIS PROJECT)

DIVISION 3 – CONCRETE: (NOT NEEDED FOR THIS PROJECT)

DIVISION 4 - MASONRY: (NOT NEEDED FOR THIS PROJECT)

DIVISION 5 - METALS: (NOT NEEDED FOR THIS PROJECT)

DIVISION 6 - WOOD & PLASTICS:

061053: MISCELLANEOUS ROUGH CARPENTRY: fire treated solid wood blocking where required for cabinets, equipment etc. No. 2 hem fir or better with minimums of: Fb = l,l50 psi.; Fv = 75 psi.; E = 1,400,000 psi. Coordinate locations for all equipment with Owner prior to installing gypsum board on framing.

062000: FINISH CARPENTRY: Finish carpentry includes carpentry work which is exposed to view, is non-structural, and which is not specified as part of other sections including interior running and standing trim and pre-finished plywood paneling.

A. GENERAL REQUIREMENTS:
   1. All lumber shall be fire-retardant treated.
   2. Protect finish carpentry materials during transit, delivery, storage and handling to

prevent damage, soiling and deterioration.

3. All plywood and hardwood lumber shall comply with the latest edition of Architectural Woodwork Institute (AWI) "Quality Standards." for custom grade woodwork.

B. Lumber for Transparent Finish (Stained or Clear): Use pieces made of solid lumber stock.

C. Lumber for Painted Finish: At Contractor's option, use pieces, which are either glued-up lumber or made of solid lumber stock. For exterior finish carpentry work use glued-up lumber complying with PS 56 for "wet use" and certified so by respective grading and inspecting agency for species and product indicated.

D. Standing and Running Trim for Transparent Finish: Plain Sawn Red Oak manufactured to sizes and patterns (profile) shown from selected First Grade lumber (NHLA); complying with following grade requirements of referenced woodworking standard, for quality of materials and manufacture.

064023: INTERIOR ARCHITECTURAL WOODWORK: Built-in shelving where shown. Colors, finishes and styles to be selected by Architect.

A. GENERAL REQUIREMENTS:
   1. Measurements: Before proceeding with fabrication of woodwork required to be fitted to other construction, obtain field measurements and verify dimensions and shop drawing details as required for accurate fit.

B. PLASTIC LAMINATE CLAD CABINETS:
   1. Quality Standard: Comply with AWI Section 400. Cabinet Construction: Flush overlay.
   2. Grade: As shown on details and elsewhere in the specifications, but no less than AWI Custom grade.
   3. Interior, semi-exposed, surfaces to be melamine finish.
   4. Exposed exterior finishes of all cabinets to be faced with plastic laminate.
   5. Cabinet doors to be 3/4" particle board with plastic laminate all surfaces. Provide thicker particle board where recommended by AWI. 2 hinges typical. 3 hinges for doors over 36" high. 4 hinges for doors over 60" high.
   6. Drawer: 3/4" particle board front with plastic laminate face. Drawer body to be ¾" poplar faced on all surfaces with melamine. Drawer bottom to be 1/4" melamine faced veneer core panel, 1/2" where noted.
   7. Provide tops and bottoms on all fillers and open corners of wall hung and full height cabinets. Delete tops when cabinets are installed with drywall or plastic Laminate soffits.

C. SOLID SURFACE COUNTERTOPS:
   1. ½" Corian on ¾" marine grade B-B plywood backing.
   2. Fabricate integral edges and back splashes as detailed.
   3. Colors, Patterns and Finishes: As scheduled.

D. PLASTIC LAMINATE:
   1. Colors to be selected from full range of available products by Wilsonart or approved equal.
   2. Horizontal Surfaces: GP-50 (0.048" nominal thickness).
   3. Postformed Surfaces: PF-42 (0.039" nominal thickness).
   4. Vertical Surfaces above 36" AFF: GP-50 (0.048" nominal thickness).
   5. Vertical Surfaces below 36" AFF: GP-50 (0.048" nominal thickness).
   6. Edges: PVC edge banding, 3.0 mm thick.

E. PARTICLE BOARD: Medium density industrial particle board.

F. PLYWOOD: Veneer core, APA rated, A-A. For use at counter supports and where noted.

G. HARDBOARD: Tempered hardboard, smooth 2 sides (2S2).

H. HARDWOOD: Hardwood shall be to be finished per finish schedule. (Refer to Section 09900, Painting)

I. COAT HOOKS: American Specialties No. 7382, satin #4 stainless steel. Mount on oak trim board as shown on drawings.

J. CABINET HARDWARE:

	ITEM	**MFR./MODEL NO.**	**FINISH**
1.	Hinges	Hafele A-Series 110 deg.	Standard
2.	Door and Drawer Pulls	Wurth, Allison Series 4" wire pull	Satin Nickel
3.	Cabinet Locks	Compx Timberline Cam Locks	
4.	Grommets	Hardware Concepts, Inc. 2" round w/ caps	Color black.
5.	Countertop Support Brackets	1/8" steel by A&M Hardware (Doug Mockett, Lyman) 18" D Countertop: 15"x21" LLV 24" D Countertop: 18"x24" LLV 30" D Countertop: 24"x24"	Black or Gray as selected from manufacturer's standards.
6.	Through Wall Countertop Support	Centerline Bracket (or approved equal) 18" x 12"	Black
7.	3Form Ready to Go Solutions – Resin Panel System	ILtuo Wall Mount & Floor to Ceiling	Clear Anodized

DIVISION 7 - THERMAL & MOISTURE PROTECTION:

072100: BUILDING THERMAL INSULATION [as required for any infills]

A. Blanket/Batt Insulation:
   1. Type: Glass fiber, ASTM C 665, Type I (unfaced).
   2. Owens Corning fiberglass batts or equal by Certainteed, Guardian or Knauf.
   3. Provide full thickness batts in all exterior stud walls.

B. Vapor Retarder (Not Integral with Insulation):
   1. Type: Polyethylene, ASTM D 4397, 6 mils, 0.13 perm vapor transmission rating.
   2. Vapor barrier tape as recommended by the manufacturer.

C. Accessories.
   1. Adhesives and mechanical anchors.
   2. Crack sealers and tapes.

078413: PENETRATION FIRESTOPPING: Review drawing cover sheet “Code Review Information” for fire separation requirements. Consult with Architect if unsure about required rating.

A. One-Part Fire-Stopping Sealant: For sealing openings around cables, conduit, pipes and similar penetrations through fire rated walls and floors and at joints between partitions and roof or floor decks. Sealant must be red in color. Use only at penetrations in fire rated walls and floors.
   1. "3M Fire Barrier Caulk CP-25WB+"; Electrical Products Div./3M.
   2. “FS-One”, Hilti
   3. “TPS Type I”, Isolatek
   4. “TPS Type C”, Isolatek
   5. “Series 100 Sealant”, Specified Technologies, Inc.
   6. “2000 Series Sealant”, 3M
   7. Or approved equal.

B. Fire-Stopping Systems: Where elastomeric sealants are not applicable to conditions encountered, provide UL listed fire-stopping systems including putty, mortar, foam, intumescent pillows or rigid board. Materials must be red in color or must consist of devices and hardware that are readily identifiable as being a part of a UL listed assembly. Manufacturers: 3M Fire Protection Products, Hilti, Isolatek International, Nelson Firestop Products, Specified Technologies, Inc., United States Gypsum Co.

079200: JOINT SEALANTS: Install appropriate sealant and foam backer rod where shown and at all joints exposed to weather.

A. ONE-PART NONACID-CURING SILICONE SEALANT: For exterior vertical applications, Type S; Grade NS; Class 25. Uses NT, M, G, A, and, as applicable to joint substrates indicated, O.
   1. "Chem-Calk 1200"; Bostik Construction Products Div.
   2. "Dow Corning 790"; Dow Corning Corp.
   3. "864"; Pecora Corp.
   4. "Spectrem 2"; Tremco, Inc.

B. ONE-PART POURABLE URETHANE SEALANT: for Horizontal surfaces, use T: Type S, Grade P, Class 25:
   1. "Chem-Calk 950"; Bostik Construction Products Div.
   2. "Vulkem 45"; Mameco International, Inc.
   3. "NR-201 Urexpan"; Pecora Corp.
   4. "Sonolastic SL-1"; Sonneborn Building Products Div., Rexnord Chemical Products Inc.

C. SILICONE LATEX JOINT SEALANTS: For exposed interior use. Pecora AC-20 + Silicone".

D. INTERIOR ACOUSTICAL SEALANTS FOR CONCEALED JOINTS:
   1. "BA-98"; Pecora Corp.
   2. "Tremco Acoustical Sealant"; Tremco Inc.

E. SANITARY SILICONE SEALANT: For use at plumbing fixtures (white) and countertops (clear). GE Sanitary SCS 1700 Sealant (Pecora)

DIVISION 8 - DOORS, WINDOWS, AND GLASS:

081113: STEEL HOLLOW METAL DOOR FRAMES:

A. MANUFACTURERS: Steelcraft, Ceco, Fleming, Curries, Pioneer or approved equal.

B. FRAMES: 16 gauge primed all interior locations: knock down typically. Welded at double doors, cross corridor doors, doors with automatic operators, doors 42" or more wide.

081416: FLUSH WOOD DOORS: Solid core flush wood doors.

A. MANUFACTURERS: Eggers Industries, or equal by Marshfield Door Systems or Algoma Hardwoods Inc.,.

B. FIRE RATED DOORS: Flush 1-3/4" mineral core, 5-ply, AWI Custom Grade. Heavy duty rails and lock blocks, laminated edges matching face veneer. Comply with NFPA 80.
   1. Veneer and edges: match existing.
   2. Finish: AWI System TR-6, Catalyzed polyurethane, open grain, semi-gloss, sealed top and bottom edges. Stain to be selected to match existing from manufacturer's full range of standard finishes.

C. LIGHT FRAMES: Standard 18 gauge frames at rated doors. Refer to Section 08800 for glazing.

083113: ACCESS DOORS AND FRAMES: Flush mounted steel for drywall ceilings. 1-1/2 hour rated B label units. By Karp Assoc. or approved equal.

083326: OVERHEAD COILING GRILLES:

A. BASIS OF DESIGN: Cornell “Visionaire” Model ESG10, or approved equal.

B. MATERIALS:
   1. Curtain, straight pattern. 5/16 inch diameter, 5056 H32 aluminum alloy, spaced 2 inches on center. Clear anodized.
   2. Bottom Bar: 2 x 3-1/2 inch extruded aluminum tubular section, clear anodized.
   3. Guides, Wall Mounted: Heavy duty extruded aluminum sections with snap-on cover to conceal fasteners and polypropylene pile runners on both sides of curtain. Provide mounting angle as required for face of wall installation.
   4. Hood and Fascia: 24 gauge galvanized steel with reinforced top and bottom edges. Provide minimum 1/4 inch (6.35 mm) steel intermediate support brackets as required to prevent excessive sag. Baked-on polyester enamel finish coat.

C. OPERATION: Provide manual crank hoist operator including crank gear box, steel crank drive shaft and geared reduction unit. Fabricate gear box to completely enclose operating mechanism and be oil-tight.

084313: ALUMINUM FRAMED STOREFRONTS:

A. BASIS OF DESIGN: Manufactured by EFCO as follows:
   1. Window Types A & B: Series 526, 2-1/2” x 5” impact rated thermally broken storefront.
      a. Small Missile Level A Impact Test conducted on test units in accordance with TAS 201 or ASTM E 1886/E 1996.
      b. Large Missile Level (C or D) Impact Test conducted on test units in accordance with TAS 201 or ASTM E 1886/E 1996.
      c. Air Infiltration less than 0.06 cfm/sq. ft.
      d. CRF: 56 per AAMA 1530.
   2. Window Type B-1: X-Therm Series FX45 fixed 4-1/2” deep window system.
      a. AAMA rating AW150.
      b. Forced Entry Grade 40.
      c. Air Infiltration less than 0.10 cfm/sq. ft.
      d. CRF: 80 per AAMA 1530.

B. FINISH: Match existing windows.

C. Refer to Section 08800 for glazing.

085659: SERVICE WINDOW UNITS:

A. BASIS OF DESIGN: Stylmark rolling (sliding) window assembly, Model 610189, or approved equal.

B. DESCRIPTION: Provide aluminum top channel and bottom track recessed into soffit and countertop as shown on drawings with side molding each side, jambs, side pulls and locks. Provide top molding and shoe to hold tempered glass.

C. Refer to Section 08800 for glazing.

087100: DOOR HARDWARE: All hardware to match existing building standards.

A. HINGES: Steel, non-rising pins. Flat button tips. 3 hinges for door leaves 90" or less in height, one additional hinge for each 30" of additional height. 4½" wide except as noted. 4½" high on doors up to 38" wide. 5" high on doors over 38" wide.

B. LOCK CYLINDERS AND KEYING:
   1. 6 pin cylinders with interchangeable cores (verify with owner).
   2. Coordinate keying with owner. Provide temporary inserts during construction.

C. FINISHES: Match existing. If existing varies use US26D (satin chromium), US32D (satin stainless steel) for flat goods and paint at closers.

	ITEM	MANUFACTURER/MODEL
1.	Butts	Stanley FBB179- 4 1/2" x 4 1/2" (Hager, Lawrence, McKinney)
2.	Continuous Geared Hinge	Roton 780-111, (Stanley, Pemko)
3.	Card Reader	Provided & installed by Owner
4.	Lockset	Schlage AL Series cylindrical lock, "Saturn" lever. Schlage 6-pin 1345 restricted keyway cylinder.
5.	Cylinder Lock	Compatible with lockset
6.	Closer	LCN 4040 Series, Regular arm on in swing doors. Parallel arm on out swing doors and where door requires 180 degree opening.
7.	Electric Strike	HES 1006 Series, 24v.
8.	Kick Plate	Rockwood (C/S, HB Ives, McKinney, InPro), .050" thick., 8" high. Width of door less 2" on push side. Width of door less ½" on pull side.
9.	Armor Plate	Rockwood (C/S, HB Ives, McKinney, InPro), .050" thick, 36" high and UL listed for use on fire rated doors. Width of door less 2" on push side. Width of door less ½" on pull side.
10.	Acoustic/ Smoke Seal	National Guard 5050 (Zero, Pemko)
11.	Stop/Wall	Rockwood 409 concave.

087113: POWER DOOR OPERATORS:

A. BASIS OF DESIGN: Besam SW200i surface applied single swing door operator, or approved equal.
   1. Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components.

B. OPERATION: Electromechanical operating system. Coordinate the power door operator with the electric strike so that activation of the operator releases the strike.
   1. Activation Device: Square push-plate switch on each side of door to activate door operator.

C. Cover for Surface-Mounted Operators: Fabricated from 0.125-inch- thick, extruded or formed aluminum continuous over full width of operator-controlled door opening with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.

088000: GLAZING: Interior and exterior glass and glazing in windows, door lights or in hollow metal or wood borrowed light frames.

A. TEMPERED GLASS (TG): ¼" Uncoated Clear Heat-Treated Float Glass: Condition A, Type I, Class 1, Quality q3, Kind FT (fully tempered).

B. FIRE-LITE SAFETY GLAZING (FL): Technical Glass Products, FireLite Plus laminated safety rated glazing.

C. BALLISTIC INSULATED GLAZING (BG): Total Security Solutions, TSS IG-FE, or approved equal.
   1. U-Value: 0.25
   2. Thickness: 15/16 inch
   3. Layers:
      a. Exterior: 2 layers of clear heat-treated glass with manufacturer's standard interlayer.
      b. Air space.
      c. Interior: Clear heat-treated laminated glass with translucent white interlayer.

D. INSULATING GLASS (IG): Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
   1. U-Value: 0.27 winter; 0.24 summer.
   2. Thickness: 1 inch.
   3. Layers:
      a. Exterior: Clear heat-treated glass with low-e coating, 1/4 inch. Kind HS (heat strengthened), Type I, Class 1 (clear), Quality-Q3.
      b. Argon space, 1/2 inch.
      c. Interior: Clear heat-treated glass, 1/4 inch. Kind HS (heat strengthened), Type I, Condition A (uncoated), Class 1 (clear), Quality-Q3.

088113: DECORATIVE GLAZING:

A. GLAZING: 3-Form Varia, Interior glazing or approved, 3/8" thickness in color and pattern per finish legend.

B. PARTITION SUPPORT: 3-Form Iltuo partitioning system, floor-to-ceiling assembly with aluminum extrusion wall track and vertical posts supporting resin panel dividers.

DIVISION 9 - FINISHES:

092600: GYPSUM BOARD ASSEMBLIES:

A. Gypsum Board: 5/8" type X, unless otherwise noted. (G-P Gypsum, National Gypsum Co., USG Corp.)
   1. At wet locations provide mold-resistant gypsum board with moisture- and mold-resistant core and paper surfaces.

B. Trim: Galvanized steel sheet Corner Bead (USG No. 103), LC-Bead J-Trim (USG No. 200-A)

C. Joint Tape: Paper reinforcing tape.

D. Joint Compound: Factory-packaged vinyl-based.

E. Studs and tracks shall be 20 gage and formed from galvanized steel that conforms to ASTM A-645.

F. Sound attenuation blankets: Unfaced glass, slag wool, or rock wool, ASTM C 665.

G. Miscellaneous Materials: Laminating Adhesive, screws, spot grout.

095113: ACOUSTICAL PANEL CEILINGS:

A. Refer to the drawings for complete listing of Basis of Design Products for acoustical panel ceilings (ACT) and metal suspension system.

B. ACT-1:
   1. Ceiling Tile: USG Orion 75 square edge, 24” x 24” x 5/8”. ASTM E1264 mineral fiber, Type IV, Form 1 and 2, Pattern E.
   2. Suspension Grid: 15/16" wide exposed grid (USG, Chicago, Armstrong). White baked enamel.

096513: RESILIENT BASE AND ACCESSORIES:

A. Refer to drawings for complete listing of Basis of Design Products for resilient base (RB) and transition strips (TS).

B. Resilient Base: 1/8” thick, 4” high, 48” long (continuous roll) vinyl base: coved base for vinyl tile area.

C. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 6 inches in length. Form without producing discoloration (whitening) at bends.
   2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 6 inches in length. Miter or cope corners to minimize open joints.

D. Provide manufacturer’s recommended adhesives for compliance with warranty.

E. Seal all joints with clear silicone.

096519: RESILIENT TILE FLOORING:

A. Vinyl Composition Tile: 1/8" thick, 12" x 12".

B. Manufacturer: Armstrong Premium Excelon - patterns and color as indicated on drawings.

C. Moisture Testing: Proceed with installation only after substrates pass testing according to resilient sheet flooring manufacturer's written recommendations, but not less stringent than the following:
   1. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates are below a maximum relative humidity level recommended by flooring and adhesive manufacturer.

D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate. Basis of Design Product: Ardex Feather Finish
   1. Flash patch and double skim- coat in the areas scheduled to receive resilient flooring.

E. Seal any and all joints with clear silicone sealant.

F. Provide manufacturer’s recommended adhesives for compliance with warranty.

G. Lay tiles with grain running in one direction and square with room axis. Adhesive and floor patching materials as recommended by manufacturer.

099100: PAINTING:

A. Prepare existing surfaces as required to receive new finishes: clean, remove adhesives, patch and spackle, and sand. Colors as shown on drawings. Provide the following paint systems for the various substrates, as indicated.

B. MANUFACTURERS: Pratt and Lambert, (Benjamin Moore, ICI Devoe, Sherwin Williams)

C. GYPSUM DRYWALL SYSTEMS:
   1. Eggshell Emulsion Finish: 3 Coats.
      - First Coat: P&L Pro-Hide Gold Low Odor Primer
      - Second and Third Coat: P&L Pro-Hide Gold Low Odor Eggshell
   2. Semi-gloss Emulsion Finish: 3 Coats.
      - First Coat: P&L Suprime “1”
      - Second and Third Coat: P&L Accolade Interior Semi-Gloss

D. INTERIOR METAL:
   1. Semi-Gloss Emulsion Finish: 3 Coats.

- First Coat: P&L Suprime “3”
- Second and Third Coats: P&L Accolade Interior Semi-Gloss

DIVISION 10 - SPECIALTIES:

102123: CUBICLE CURTAINS AND TRACK

A. BASIS OF DESIGN: Click-eze “Optitrac” or approved equal.

B. Extruded-Aluminum Curtain Track: Not less than 1-1/4 inches wide by 3/4 inch high with 0.060 inch wall thickness. Surface mounted.
   1. Finish: Clear anodized.
   2. Fabricate accessories (end caps, connectors, end stops, and other accessories) from same material and with same finish as track.

C. Curtain Roller Carriers: Two nylon rollers and nylon axle with aluminum hook.

D. Cubicle Curtain: By Owner

102600: IMPACT-RESISTANT WALL AND DOOR PROTECTION:

A. Refer to drawings for complete listing of Basis of Design Products for wall protection and corner guards (HWP and CG).

B. Corner Guards - Height: top of base to 4’-0” AFF. Custom 135 degree where required. At end wall conditions infill with 0.040” sheet between corner guards.

105201: FIRE PROTECTION SPECIALTIES:

A. FIRE-PROTECTION CABINET (FEC)
   1. Cabinet Type: Semi-Recessed suitable for fire extinguisher.
      a. Basis-of Design Product – Semi-recessed Type: Academy 2027-F-10 with FE letters, JL industries, inc., Larsen’s Manufacturing Company. Confirm size of cabinet to accept fire extinguishers.
      b. Confirm size of cabinet to accept fire extinguishers and subject to compliance with requirements, provide basis of design or comparable product by one of the following:
         - Guardian Fire Equipment, Inc.
         - JL Industries, Inc.

B. FIRE EXTINGUSHERS: 10 lbs. capacity, multi-purpose ABC Dry Chemical.

DIVISION 11 - EQUIPMENT:

111000: MISCELLANEOUS EQUIPMENT:

A. Pharmacy Equipment: By Owner.

B. Office Equipment: By Owner

C. TV bracket: Owner Furnished, Contractor Installed Coordinate bracket with owner provided TV.
   1. Install in accordance with manufacturer's instructions. Provide wall blocking and electrical connections as required.

DIVISION 12 - FURNISHINGS:

125000: FURNITURE:

A. Desks, chairs, file cabinets, lamps, artwork and plants – Owner Furnished/Owner Installed.

DIVISION 13 - SPECIAL CONSTRUCTION: (NOT NEEDED FOR THIS PROJECT)

DIVISION 14 - CONVEYING SYSTEMS: (NOT NEEDED FOR THIS PROJECT)

DIVISION 22 - PLUMBING: (REFER TO SEPARATE SPECIFICATION ON MECHANICAL, PLUMBING, AND FIRE PROTECTION DRAWINGS & SPEC.)

DIVISION 23 - MECHANICAL: (REFER TO SEPARATE SPECIFICATION ON MECHANICAL, PLUMBING, AND FIRE PROTECTION DRAWINGS & SPEC.)

A. Rebalance system at completion of construction.

DIVISION 26 - ELECTRICAL: (REFER TO SEPARATE SPECIFICATION ON ELECTRICAL DRAWINGS & SPEC.)

A. Obtain all permits required by local authorities.

DIVISION 31 - EARTHWORK: (NOT NEEDED FOR THIS PROJECT)

END OF ARCHITECTURAL OUTLINE SPECIFICATION

JORDAN HEALTH CENTER - PHARMACY
DIVISION 22
PLUMBING SPECIFICATIONS
PAGE 1

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SECTION 220010 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 22.

1.2 SCOPE OF WORK

A. Include in bid all labor, materials, tools, plant, transportation, equipment, insurance, temporary protection, permits, taxes and all necessary and related items required to provide complete and operational systems shown and described.

B. References to Codes and Standards called for in the Contract Documents mean the latest edition, amendment and revisions to the codes and standards in effect on the date of these Contract Documents.

C. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:
   1. Miscellaneous Supports.
   2. Access Doors and Panels.
   3. Fire Stopping.
   4. Cutting and Patching.

D. Contract shall include, but not be limited to:
   1. Plumbing.

1.3 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state and local governmental agencies.

B. The following is a list of codes and standards that will apply to this project:
   1. 2020 Building Code of New York State (BCNYS).
   2. 2020 Existing Building Code of New York State (EBCNYS).
   3. 2020 Energy Conservation Construction Code New York State (ECCCNYS).
   4. ASHRAE Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings.
   5. 2020 Plumbing Code of New York State (PCNYS).
   6. New York State Department of Labor Rules and Regulations.
   7. New York State Department of Health.

8. Federal Occupational Safety and Health Administration - OSHA.
9. National Life Safety Code, NFPA 101.
10. Local Codes and Ordinances.
11. NEMA Standards.
12. Underwriters Laboratory (UL).
13. Factory Mutual and/or Owner's Insurance Carrier.
14. City of Rochester Bureau of Buildings and Zoning.
15. City of Rochester Plumbing Department.

1.4 LICENSING & PERMITS

A. The Contractor shall hold a license to perform the work as issued by the State of New York.

B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid.

C. Refer to General Conditions of the Contract for additional requirements.

1.5 GLOSSARY

ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
AWWA	American Water Works Association
EIA	Electronic Industries Association
FCC	Federal Communications Commission
FM	Factory Mutual Insurance Company
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	International Standards Organization
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYBFU	New York Board of Fire Underwriters

NYS/DEC	New York State Department of Environmental Conservation
NYS/UFBC	New York State Uniform Fire Prevention and Building Code
OSHA	Occupational Safety and Health Administration
SHI	Steel Boiler Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TIA	Telecommunications Industry Association
UFPO	Underground Facilities Protective Organization
UL	Underwriter's Laboratories, Inc.

1.6 DEFINITIONS

Approved / Approval	Written permission to use a material or system.
As Called For	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Equipment	Refer to the article, BASIS OF DESIGN.
Design Make	Refer to the article, BASIS OF DESIGN.
Equal or Equivalent	Equally acceptable as determined by Owner’s Representative
Exposed	Work not identified as concealed.
Final Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnish	Supply and deliver to installation location.
Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's site Representative.
Install	Mount and connect equipment and associated materials ready for use.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.
Or Approved Equal	Approved equal or equivalent as determined by Owner’s Representative.
Owner’s Representative	The Prime Professional
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Provide	Furnish, install and connect ready for use.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Rough-in	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.

Site Representative	Construction Manager or Owner's Inspector at the work site.

Refer to General Conditions of the Contract for additional definitions.

1.7 BASIS OF DESIGN

A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in work of all other trades, at no increase in any contract. Provide larger motors, electrical feeders, circuit breakers, equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.8 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, and fixtures. Exact locations are subject to the approval of the Owner's Representative.

1.9 ELECTRONIC CAD DRAWING FILES

A. The Engineer may provide the Contractor with AutoCAD .dwg or MicroStation .dgn format files for this project with the understanding that these CAD files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors' responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors' coordination shop drawings is to account for all trades and field conditions and identify any conflicts that shall be resolved prior to installation.

B. Any additional cost for changes due to conflicts as a result of the Contractors' failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

C. A request must be made in writing to the Engineer with the requested individual files. The contractor will then be sent a CAD Release Form and must sign the form to obtain electronic drawings.

1.10 QUALITY ASSURANCE

A. Manufacturers of equipment shall be firms regularly and currently engaged in the production of equipment and accessories provided. The design and size of each item of equipment provided for this project needs to have been in satisfactory and efficient operation on at least three (3) installations for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

C. Apply and install materials, equipment, and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the Owner's Representative for resolution.

D. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, access panels, cutting and patching.

E. All work shall be done in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL MINIMUM REQUIREMENTS

A. Provide Materials That Meet the Following Minimum Requirements:
1. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.
2. All equipment and material for which there is a listing service shall bear a UL label.
3. Potable water systems and equipment shall be built according to AWWA Standards.
4. Electrical equipment and systems shall meet UL Standards and requirements of the N.E.C. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with these requirements.
5. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.
6. The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment

and systems must conform to the Specifications.

2.2 SUBSTITUTIONS

A. The Materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.

B. Proposed substitutions must be submitted in writing to the Architect and Engineer a minimum of ten (10) days prior to the date for receipt of Bids.
   1. Each request shall include the name of the proposed material or equipment being substituted, cut sheets, installation drawings, performance and test data, warranties and location of three(3) similar installations with reference names of Owner or Facility personnel responsible for maintaining equipment.
   2. At that time the equipment or will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders.

C. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are unacceptable and will not be considered.

2.3 FACTORY-ASSEMBLED PRODUCTS

A. Provide maximum standardization of components to reduce spare part requirements.

B. Manufacturers of equipment assemblies which include components made by others shall assume complete responsibility for final assembled unit.
   1. All components of an assembled unit need not be products of same manufacturer.
   2. Constituent parts which are alike shall be product of a single manufacturer.
   3. Components shall be compatible with each other and with the total assembly for intended service.
   4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear manufacturer's name or trademark, model number and serial number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment which serve the same function must be the same make and model. Exception will be permitted if performance requirements cannot be met.

2.4 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

2.5 SPECIAL TOOLS

A. If any part of equipment requires a special tool for assembly, adjustment or maintenance thereof and such tool is not readily available on commercial tool market, it shall be furnished by the Contractor.

2.6 LIFTING ATTACHMENTS

A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered without bending or distortion of shape, such as rapid lowering and braking of load.

2.7 MISCELLANEOUS SUPPORTS

A. Metal bars, plates, tubing, etc. shall conform ASTM standards:
1. Steel plates, shapes, bars, and grating - ASTM A 36
2. Cold-Formed Steel Tubing - ASTM A 500
3. Hot - Rolled Steel Tubing - ASTM A 501
4. Steel Pipe - ASTM A 53, Schedule 40, welded

B. Metal Fasteners shall be Zinc-coated (type, grade and class as required)

2.8 ACCESS DOORS AND PANELS

A. Steel access doors and Frames shall be factory fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush.

B. Construction:
1. Frames:
   a. 16 gage steel with 1 inch wide exposed perimeter flange and adjustable masonry anchors for units installed in masonry, pre-cast, cast in place concrete, ceramic tile
   b. 16-gage steel, perforated flanges with bead for gypsum or plaster wall board.
   c. 16-gage steel with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame for full bed plaster applications.

2. Access Doors:
   a. Provide 14 gage sheet steel flush panel doors with concealed continuous piano hinge factory installed, primed and painted, set to open 175 degrees.
   b. Provide fire rated, insulated flush panel doors, with continuous piano hinge and self-closing mechanism rated for 1-½ hour “B” labeled, in fire rated partitions.

3. Provide flush, screwdriver operated cam locks on all access doors.

2.9 FIRE STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

B. Acceptable Manufacturers:
   1. Dow Corning Fire-Stop System Foams and Sealants.
   2. Nelson Electric Fire-Stop System Putty, CLK and WRP.
   3. Thomas & Betts - S-100 FS500/600,
   4. Carborundum Fyre Putty.

PART 3 - EXECUTION

3.1 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections.

B. Shop drawings shall be dated and contain the following information. Incomplete submittals will not be accepted. Number each submittal.
   1. Name of project.
   2. Name of prime professional.
   3. Name of prime contractor.
   4. Description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed.

C. All products specified in an individual Division 22 section shall be submitted at the same time.

D. Indicate deviations from contract requirements on Letter of Transmittal.

E. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

3.2 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings drawn at not less than 3/8" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings As Follows:

1. HVAC Contract will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be in AutoCAD format of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.
2. HVAC Contract will provide AutoCAD files and/or prints and submit the base plan to all major trades' Contractors.
3. Electrical and Plumbing Contracts will each draft location of piping, conduits and equipment on the base plan as provided by the HVAC Contract such that a complete coordination of all trades is represented and areas of conflict and recommended resolutions are noted.
4. Do not install equipment, equipment foundations or piping until Coordination drawings have been approved.

3.3 PROTECTION OF PERSONS AND PROPERTY

A. Contractor shall assume responsibility for Construction Safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature required to provide safe conditions for all workmen and site visitors.

3.4 EXISTING SYSTEMS AND CONDITIONS

A. Prior to beginning work inspect and test all existing systems that will be affected by the work in this contract. Provide a report to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.

B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the Owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, that is determined to have been caused by the work in this contract.

C. The Owner's representative shall determine if the contractor has damaged existing systems or construction and approve the repairs.

3.5 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the Owner's asbestos management plan. Prior to performing such work identify areas containing asbestos. Notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

3.6 REMOVALS

A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated, Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, tubing, supports, etc. Visit each room to determine total Scope of Work.

B. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all pipe, valves, fittings, insulation, conduit, panels, and all hangers, including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, conduits and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, and electrical drawings and specifications for additional facilities to be demolished or handled.

C. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction.

3.7 FREEZING AND WATER DAMAGE

A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no change in contract, any such damage to equipment, systems and building.

3.8 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. **DO NOT SCALE PLANS**. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the Owner's representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location and mounting height of all equipment in finished areas, such as thermostats, fixtures, communication and electrical devices, including panels. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for Diffusers, grilles, registers, air terminals, lighting fixtures, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.

2. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owner's representative or other contractor for any "rough ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by this contractor at no expense to the Owner.
3. For equipment and connections provided in this contract, prepare roughing drawings as follows:
   a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.
   b. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in drawings.

4. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

3.9 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch, cut or abandoned holes left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with

manufacturer's instructions.

3.10 CONCEALMENT

A. Conceal all contract work above ceilings and in walls, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

3.11 ACCESS DOORS AND PANELS

A. Install access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, valves and other plumbing equipment requiring access for maintenance or operation.

B. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.12 CHASES

A. In Existing Buildings:
   1. Drill holes for floor slab openings.
   2. Multiple pipes smaller than 1" properly spaced and supported may pass through one 6" or smaller diameter opening.
   3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2 inches above floors.
   4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

3.13 FIRE-STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Wall and Floor Assemblies:
   1. Provide materials and products listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

2. Provide fire-stop system seals at all locations where piping, tubing, conduit, and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.
3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.
4. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.
5. Apply fire stopping within the temperature and humidity limits permitted by the manufacturer.

3.14 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support plumbing work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

3.15 PAINTING

A. This Contract Includes the following:
   1. Painting for all cut and patch work performed as part of Division 22 contract.
   2. Painting required for touch-up of surfaces damaged due to the installation of division 22 work.
   3. Painting as required to repair finish of equipment furnished.
   4. Refer to Division 9 Sections for general description of materials and methods.
   5. Painting as called for on Division 22 Drawings.

3.16 ADDITIONAL ENGINEERING SERVICES

A. In the event that the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

B. In the event that the Consultant is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Consultant's expense in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

3.17 ALL TRADES TEMPORARY HEAT

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.

3.18 TEMPORARY FACILITIES

A. Refer to the standard General Conditions of the contract for Construction and Supplemental General Conditions.
   1. Continuity of operation of existing facilities will require temporary installation or relocation of equipment and piping.
   2. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.
   3. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining pressurized.

3.19 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:
   1. Thoroughly clean entire installation, both exposed surfaces and interiors.
   2. Remove all debris caused by work.
   3. Remove tools, surplus, materials, when work is finally accepted.

3.20 PLUMBING EQUIPMENT CONNECTIONS

A. Provide complete plumbing connections to all plumbing equipment. Provide control connections to equipment where indicated on the drawings. Provide valves on piping ahead of each piece of equipment.

B. Provide all piping, trim, accessories and connections as required for proper equipment operation of Equipment provided by this contract, Owner-Furnished Equipment and Equipment furnished by other contracts,

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to roughing.

3.21 PLUMBING INSTALLATIONS

A. All installations shall comply with the following requirements:
   1. Coordinate plumbing systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.
   2. The Architect shall control the placement of all wall and ceiling mounted plumbing equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.
   3. Verify all dimensions with field measurements.
   4. Arrange for all chases, slots and openings in other building components, which are not indicated on drawings, to allow for plumbing installations.
   5. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
   6. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule.

7. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.
8. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.
9. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
10. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
11. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the Owner's representative.
12. All finished equipment surfaces damaged during construction shall be brought to "as new" condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.
13. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
14. No plumbing equipment shall be hidden or covered up prior to inspection by the Owner's representative. All work that is determined to be unsatisfactory shall be corrected immediately.
15. All plumbing work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
16. Conceal all contract work above ceilings and in walls, below floors, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.
17. Install access panels or doors where units are concealed behind finished surfaces.

3.22 ELECTRICAL EQUIPMENT CONNECTIONS

A. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide disconnect ahead of each piece of equipment. Ground all equipment in accordance with the latest edition of the NEC.

B. Provide all power wiring, electric equipment, switches, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts. Provide control wiring where noted in the documents.

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to roughing.

3.23 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary plumbing and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing facilities or services.

3.24 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owner’s designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer’s certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e. variable frequency drive and pumps) both manufacturers shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.

C. Refer to Division 1 Sections for additional requirements.

3.25 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. Include one copy each of approved Shop Drawings, wiring diagrams, piping diagrams, spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, telephone number of supplier manufacturer Representative and service agency for all major equipment items. Bind above items in a three ring binder with name of project on the cover. Deliver to Owner's Representative before request for acceptance.

3.26 RECORD DOCUMENTS

A. Prepare and provide record documents in accordance with Division 1 Sections. In addition to those requirements provide the following:
   1. Utilities below floors: During construction, maintain accurate records of all final locations and inverts for all services inside the building, and below floors.
   2. Take dimensions from a given fixed bench mark, such as the corner of a building, and neatly and clearly indicate same on Record Drawings.
   3. Provide Record Drawings for all Contract Work.
   4. Incorporate all field changes, change orders and other modifications into the final Record Drawings.

B. Provide record documents electronically on a disk to Owner. Also provide one (1) set of prints to Owner.

END OF SECTION

SECTION 220502 - PLUMBING PIPING SYSTEMS AND ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. Schedule of all pipe materials, fittings and connections to be utilized on this Project.
   1. Pipe and fitting material data sheets identifying compliance with specified approvals and listings.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping and fittings used on this Project shall be new and marked with manufacturer's name; and shall comply with all applicable ASTM and ANSI Standards.

B. All water distribution pipe and fittings shall conform to NSF-61.

C. All drinking water system components, including pipe and fittings, shall conform to NSF-372.

2.2 COPPER PIPE AND SOLDER FITTINGS

A. Pipe, Above ground: Hard temper, ASTM B88; Type K, L, M, or DWV, as called for. Soft temper only as called for. Plans show copper tube sizes.

B. Tees, Elbows, Reducers: Wrought copper; solder end connections; ASME B16.22; ASTM B828.

C. Unions And Flanges:
   1. 2 inch and smaller: Unions, solder type, wrought copper, ground joint, 150 lb. swp.
   2. 2-1/2 inch and larger: Flanged, wrought copper, companion type, ASME drilled, solder connection, 150 lb. swp.

D. Solder Materials: No-lead solder, using alloys made from tin, copper, silver and nickel.
   1. No-lead solder and flux shall comply with requirements of NSF-372, ASTM B813, ASTM B32.
   2. Make: Harris "Bridgit", Lucas-Milhaupt Warwick "Silverbright 100", Canfield Technologies "100% Watersafe".

2.3 COPPER PIPE AND PRESS-CONNECT FITTINGS

A. Press-connect fittings shall not be used for sanitary, waste or pumped discharge piping systems.

B. Pipe, Above ground: Hard temper, ASTM B88; Type L or M, as called for. Plans show copper tube sizes.

C. Fittings and Couplings: Copper press-connect pressure fittings, ASME B16.51.

   1. 2 inch and smaller: Wrought copper or bronze fitting with EPDM rubber O-ring seal in each end.

D. Acceptable Manufacturer: ApolloPress, Mueller Streamline PRS, Nibco press fittings, Viega ProPress, or approved equal.

2.4 BRASS PIPE AND FITTINGS

A. Piping: ASTM B43, semi-annealed, red brass not less than 85% copper; chrome plated where called for.

B. Fittings: Cast brass, sps, malleable iron pattern, reinforced corresponding to weight of pipe; chrome plate where called for.

2.5 SOIL PIPE AND FITTINGS

A. No-Hub:
   1. Pipe: ASTM A888 no-hub cast iron, coated.
   2. Fittings: Cast iron no-hub pattern with neoprene gasket and 24 gauge, Type 304 stainless steel clamp assembly; ASTM C1540.
      a. Make: Charlotte Pipe, Clamp-All, Husky, Tyler “Widebody”.

2.6 SPECIAL FITTINGS

A. Copper To Cast Iron: Cast bronze, cast iron to sweat adapter.

B. No-Hub, Cast Iron: Proper adapter to piping being connected.

2.7 DIELECTRIC PIPE FITTINGS

A. Tensile strength, ASME B16.8, union 250 psi, or flange design, 175 psi, pressure rating, at 210 Deg. F, threaded or solder joint, constructed to prevent gasket from squeezing into internal opening.

B. Acceptable Manufacturer: Epco, Capitol Manufacturing, Watts, or approved equal.

2.8 HANGERS, INSERTS AND SUPPORTS

A. Hangers, Inserts, Clamps: Anvil International, Carpenter & Patterson, Cooper B-Line, PHD Manufacturing.

B. Hangers:
   1. Adjustable, wrought malleable iron or steel. Copper plated or PVC coated where in contact with copper piping. Cadmium plated or galvanized for non-copper piping.
   2. Adjustable ring type where piping is installed directly on hanger for piping 3 inch and smaller.
   3. Adjustable steel clevis type for piping 4 inch and larger.
   4. Nuts and rods with electroplated zinc or cadmium (0.005 inch minimum) finish.

C. Spacing Schedule:
   1. Pipe Hangers:
      a. Plumbing Piping: Hanger spacing shall comply with Section 308 and Table 308.5 of the 2020 Plumbing Code of New York State (PCNYS).

D. Cast Iron No-Hub Supports:
   1. In accordance with manufacturers recommendations.
   2. Vertical piping supported at each stack base and at each floor. Freestanding vertical pipe should be adequately staked or braced during construction to maintain alignment. Bases of stacks shall be supported on concrete, brick laid in cement mortar, metal brackets attached to the building construction or by other methods approved by the Owner's Representative.
   3. Horizontal piping supported within 24 inch each side of the coupling joint at 10 foot intervals for 10 foot pipe lengths, and at 5 foot intervals for 5 foot pipe lengths. Supports or hangers placed to maintain alignment and grade with provision made to prevent shear. Greater than 3 inch diameter pipe braced at changes of direction to prevent horizontal movement.

E. Piping systems with material not listed above, supported and protected in accordance with manufacturer's recommendations.

F. Supports:
1. For weights under 1000 lbs.: "Drill-In" inserts equal to Phillips "Red Head" "U" Channel, beam clamps or other structurally reviewed support. The factor of safety shall be at least four. Follow manufacturer's recommendations.
2. For weights above 1000 lbs.: Drill through floor slabs and provide flat flush plate welded to top of rod or provide additional "Drill-In" inserts and hangers to reduce load per hanger below 1000 lbs.
3. For metal decks: Drill hole through for hanger rods and imbed a welded plate in concrete or use Phillips "Red Head" devices designed for this application, with a safety factor of four.

G. Trapeze Hangers:
1. Hangers shall be supported with rod sized with a safety factor of four.
2. May be manufactured type "U" shaped channel, or suitable angle iron or channel.
3. Securely fasten piping to trapeze with "U" bolt or straps, dissimilar metals shall not touch, use isolation gaskets.
4. Acceptable Manufacturer: Globestrut, Kindorf, Unistrut, B-Line, or approved equal.

H. Pipe Insulation Shields:
1. Galvanized steel shields, minimum 180° arc, unless otherwise indicated. MSS SP-58 Type 40.
2. Shields for use with hangers and supports per the following schedule:

Pipe Size	Shield Length	Shield Gauge
1/2" – 3”	12”	18
4”	12”	16

2.9 PIPING ACCESSORIES

A. Escutcheon Plates: Steel or cast iron polished chrome, split hinge type with setscrew, high plates where required for extended sleeves. Chrome plated in finished areas and at plumbing fixtures.

B. Cleanout plugs, bushings, nipples, required for instruments and gauges to be brass.

C. Pipe Roll Stand: Cast iron roll stand. Make: Advanced Thermal Systems, Carpenter and Patterson, ITT Grinnell, Pipe Shields.

2.10 SLEEVES

A. Standard Type:
1. Schedule 40 black steel pipe sleeves, two pipe sizes larger than the pipe, for structural surfaces.

2. Sheet metal sleeves for nonstructural surfaces and existing construction. Sheet metal sleeves shall be 18-gauge minimum and braced to prevent collapsing.

2.11 FIRESTOP SYSTEM FOR OPENINGS THROUGH FIRE RATED WALL FLOOR ASSEMBLIES

A. Materials for firestopping seals shall be listed by an approved independent testing laboratory for "Through-Penetration Firestop Systems". The system shall meet the standard fire test for Through-Penetration Firestop Systems designated ASTM E814.

B. Firestop system seals shall be provided at locations where piping pass through fire rated wall, floor/ceiling, or ceiling/roof assembly.

C. Minimum required fire resistant ratings of the assembly shall be maintained by the Firestop System. Installation shall conform to the manufacturer's recommendations and other requirements necessary to meet the testing laboratory's listing for the specific installation.

2.12 PIPING MATERIALS AND SCHEDULE

A. See Exhibit P1, "Plumbing Piping Materials", at end of this Section for general plumbing piping systems.

PART 3 - EXECUTION

3.1 EQUIPMENT AND SYSTEMS

A. Install equipment and systems in accordance with provisions of each applicable Section of these Specifications, and Local/State Codes/Regulations having jurisdiction.

B. Accurately establish grade and elevation of piping before setting sleeves.

C. Install piping without springing or forcing (except where specifically called for), making proper allowance for expansion and anchoring.

D. Arrange piping at equipment with necessary offsets, unions, flanges, and valves, to allow for easy part removal and maintenance.

E. Offset piping and change elevation as required to coordinate with other Work. Avoid contact with other mechanical or electrical systems. Make changes in direction and branch connections with fittings.

F. Provide adequate means of draining and venting units, risers, circuits and systems.

G. Conceal piping unless otherwise called for. Do not install valves, unions and flanges in inaccessible locations.

H. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction.

I. Install piping parallel with lines of building, properly spaced to provide clearance for insulation.

J. Materials within a system and between systems shall be consistent. If this is not possible, install dielectric fittings.

3.2 HANGERS, INSERTS AND SUPPORTS

A. Piping shall not be supported by wires, band iron, chains, or from other piping, nor by vertical expansion bolts. Support piping with individual hangers from concrete inserts, welded supports, or beam clamps of proper configuration and loading design requirements for each location; replace if not suitable. Follow manufacturer's safe loading recommendations. Suspend with rods of sufficient length for swing, using proper diameter rod for pipe size.

B. Provide additional structural steel members, having one coat rustproof paint, where required for proper support.

C. Provide oversized hangers where insulation/supports must pass between pipe and hanger.
   1. Provide pipe insulation shield at all points of support for insulated piping. Center shields on all hangers and supports outside of insulation. Install shields in manner to prevent cutting or puncturing insulation jacket.

D. Hangers, when attached to joists, shall only be placed at the top or bottom chord panel point. Only concentric type hangers are permissible; "C" type not permitted on joists.

E. Provide riser clamps for each riser at each floor.

F. Use trapeze hangers where a group of piping can be installed.

3.3 PIPE CONNECTIONS

A. No-Lead Solder Connections: Nonacid flux; clean off excess flux and solder. Solder and flux shall comply with requirements of NSF-372.

B. Copper Press-Connect Joints: Cut tube ends shall be reamed to full inside diameter of the tube end. Joint surfaces shall be cleaned. Join copper tube and pressure seal joints with tools recommended by press-connect fitting manufacturer.
   1. Install press-connect fittings and couplings in accordance with manufacturer's written installation instructions.
   2. Installer shall be a qualified installer; trained per the manufacturer's requirements.

C. Dielectric Pipe Fittings: Protect fittings from excessive heat.

3.4 SLEEVES

A. Provide for pipes passing through floors, walls or ceilings. Not required for existing floors that are core-drilled, except where floor is waterproofed. Extend 1/8 inch above finished floor in finished areas. In above grade Mechanical Rooms and other areas with floor drains, use steel pipe sleeves 2 inch above floor.

B. Use steel pipe sleeves in bearing wall, structural slabs, beams and other structural surfaces, and where called for.

C. Sleeves shall be as small as practical, consistent with insulation, so as to preserve fire rating.

D. Fill abandoned sleeves with concrete.

3.5 SLEEVE PACKING

A. Seal Void Space At Sleeves As Follows:
   1. Interior locations: Firmly pack with fiberglass and caulk.
   2. Cored holes: Use sealing element.
   3. Fire rated, partitions and floor slabs: Use fire rated sealing elements, materials and methods.
   4. Waterproofed floors: Use waterproof sealing element, device or compound.

3.6 ESCUTCHEON PLATES

A. Provide polished chrome escutcheon plates for all exposed piping passing through floors, walls or ceilings, in all rooms except in Boiler, Fan and Mechanical Rooms.

3.7 TESTS

A. Refer to other Division 22 Sections for testing of Plumbing Systems.

3.8 PIPE LINE SIZING

A. Pipe sizes called for are to be maintained. Pipe size changes made only as reviewed by Owner's Representative. Where discrepancy in size occurs, the larger size shall be provided.

EXHIBIT "P1" – PLUMBING PIPING MATERIALS

SERVICE	PIPE MATERIALS	FITTINGS	CONNECTIONS
Domestic water interior/hot, cold and circulating 3" and smaller	Type L copper	Wrought copper Wrought copper pressure-connect pressure fittings and couplings	No-lead solder Press-connect joints
Sanitary and vent (not buried)	Service weight cast iron soil pipe, or Type DWV copper	Cast iron No-hub or wrought copper; drainage pattern	No-hub neoprene gasket and stainless steel clamp assembly, or no-lead solder
Pump Discharge (sink drain pump)	Type DWV Copper	Wrought copper	No-lead solder

END OF SECTION

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SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. All valves and accessories listed under “Part 2 – Products” of this Section.
   1. Submit cut sheets, specifications and dimensioned drawings.
   2. Show compliance with ANSI/NSF-372 for valves intended to supply drinking water.

PART 2 - PRODUCTS

2.1 VALVES - GENERAL

A. Valves shall have following requirements:
   1. Working pressure stamped or cast on bodies per MSS SP-25.
   2. Stem packing serviceable without removing valve from line and shall be free of asbestos.
   3. Valves intended to supply drinking water shall comply with requirements of ANSI/NSF-61 and ANSI/NSF-372.

B. Makes:
   1. Ball valves: Apollo (Conbraco), Hammond, Jomar, Milwaukee, Nibco, Watts.
   2. To establish a standard of quality and identify features, certain manufacturer's numbers are given in the following paragraphs.

2.2 BALL VALVES

A. 2 inch and smaller: Lead-free brass body with hard chrome-plated lead-free brass ball and stem, full port opening, teflon seats, end entrance, 600 #WOG, 150 #WSP. Threaded ends, Watts LFFBV-3C. Solder (sweat) ends, Watts LFFBVS-3C.
   1. Valve shall have separate packing nut and handle nut.

B. Press Fitting Connections:
   1. 2 inch and smaller: Lead-free brass or bronze body with stainless steel or lead-free brass ball and stem. Full port opening, 2 piece, teflon seats, Press Fitting end connections, 200 #WSP. Watts LFFBV-3-Press-M1.
   2. Sealing elements for end connections shall be EPDM, factory installed.

2.3 HOSE THREAD DRAIN VALVES

A. Lead-free copper silicon alloy body with 2-piece full port brass ball valve. Female NPT x 3/4 inch hose end, brass cap with polypropylene tether chain, 600 #WOG. Watts LFFBVS-3C-CC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Provide valves of type called for and where required to service equipment and fixtures.
   2. Use extreme care and caution when soldering valve connections to piping to prevent valve seat damage. Apply heat with the flame directed away from the center of the valve body. Inspect all valves after soldering, tighten valve packing nut and make adjustments if required to ensure valve operates properly. Replace all damaged valves.
   3. Install Press Fitting connection type ball valves in accordance with manufacturer's written installation instructions. Installer shall be a qualified installer; trained per the manufacturer's requirements.
      a. Ball valves shall be installed using the proper tool, actuator, jaws and rings as instructed by the manufacturer.
   4. Provide valves at major building and system sections, and where shown on Contract Drawings.
   5. Provide extended stem on insulated valves so valve handle is outside of insulation.
   6. Locate valves with stems at, or above, horizontal positions.
   7. Provide hose threaded drain valves at all low points, strainers, equipment, and as called for.

END OF SECTION

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 QUALIFICATIONS

A. All identification devices shall comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles.

1.3 SUBMITTALS

A. Submit product data for each identification material and device, and for all items specified under “Part 2 - Products” of this Section.

B. Submit valve schedule for all piping systems typewritten on 8 1/2 inch x 11 inch paper, indicating code number, location and valve function. Submit with O&M Manuals.

C. Submit schedule of piping, equipment and valve identification for review before labeling. Confirm naming/numbering is consistent with Owner’s naming/numbering convention prior to labeling.

1.4 ACCEPTABLE MANUFACTURERS

A. Brady Co., Brimar Industries, Craftmark, Seton, or approved equal.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide manufacturer's products of categories and types required for each application.

2.2 PIPING IDENTIFICATION

A. Pipe Labels (Inside buildings):
1. Piping/Insulation with outside diameter of 5-7/8 inches and less: Provide acrylic plastic wrap-around type markers with directional flow arrows, UV resistance and legend printed four (4) times for 360° visibility. Make: Seton “Setmark” snap-on wrap around type pipe markers.
2. Piping/Insulation with outside diameter of 6 inches and greater: Provide acrylic plastic strap-on type markers with directional flow arrows, UV resistance and legend printed two (2) times minimum. Make: Seton “Setmark” strap-on wrap around type pipe markers.

B. Pipe labels shall conform to the following identification table:

PIPE SERVICE	IDENTIFICATION/LABEL
Domestic Cold Water	DOMESTIC COLD WATER
Domestic Hot Water	DOMESTIC HOT WATER
Domestic Hot Water Re-circulation	DOMESTIC HOT WATER RETURN
Sanitary and / or Waste	SANITARY DRAIN
Plumbing Vent	SANITARY VENT

2.3 VALVE IDENTIFICATION

A. Valve Tags:
1. Standard brass valve tags, 2" diameter with 1/2" high numerals. Identify all plumbing services with 1/4" letters above the valve number (“PLBG.”). Attach to valves using brass “jack” chain and brass “S” hook. Make: Seton Style No. M4507 tags, Style No. 16182 chain and Style No. 16195, 6 and 7 No. hooks.

B. Valve Chart:
1. Provide valve chart for all valves provided as a part of this project. Frame and place under clear glass. Hang in Mechanical Room or in location as directed by the Owner’s Representative.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide valve tags for all valves provided on project. Provide a valve tag chart for all valves provided on the project.

B. Provide piping identification with directional flow arrows for all piping provided on project.
1. Provide labels on straight runs of piping at 20’-0” intervals, minimum.

2. Provide labels where piping enters and leaves a partition, wall, floor or ceiling.
3. Adhesive type of stenciled labeling is unacceptable. Provide wrap-around type labels only.

END OF SECTION

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SECTION 220580 - PLUMBING PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. All items specified under “Part 2 - Products” of this Section.

PART 2 - PRODUCTS

2.1 SINK DRAIN PUMPS (SP-1)

A. Sink drain pump shall be a packaged unit consisting of a submersible pump, controls and basin/tank. Pump and controls shall be factory tested.
   1. Pump shall be submersible type of stainless steel construction with a molded polymer impeller. Pump shall be rated at 18 gpm at 15 TDH, with a 1/3 hp, 115 volt, single phase motor.
   2. Provide automatic on/off float switch for pump operation. Pump shall have automatic thermal overload protection.
   3. Pump basin/tank shall be polypropylene with 1-1/2” female NPT ports to receive inlet, discharge and vent piping. Cover shall be secured to basin/tank with air-tight seal.
   4. Check valve shall be furnished with pump.

B. Make: Liberty Pumps model 404CV.

PART 3 - EXECUTION

3.1 SINK DRAIN PUMPS

A. Install packaged sink drain pump unit level and plumb. Install in accordance with manufacturer’s written instructions.
   1. Connect sink waste piping to basin/tank. Provide trap between the sink and the inlet connection.

2. Install isolation valve and check valve in pump discharge pipe. Locate valves above basin cover. Check valve furnished with pump. Provide isolation valve.

END OF SECTION

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SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

B. Plumbing insulation shall comply with the requirements of the 2020 Energy Conservation Construction Code (ECCCNYS).

1.2 SUBMITTALS

A. All items listed under “Part 2 – Products” of this Section.
   1. Submit manufacturer’s data sheets.

B. Schedule of all insulation applications for this project.

PART 2 - PRODUCTS

2.1 GENERAL

A. Insulation, Jackets, Adhesives, And Coatings, Shall Comply With The Following:
   1. Treatment of jackets or facings for flame and smoke safety must be permanent. Water soluble treatments not permitted.
   2. Insulation, including finishes and adhesives on the exterior surfaces of pipes, and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less; as tested by ASTM E84 (NFPA 255) and UL 723 methods.
   3. Asbestos or asbestos bearing materials are prohibited.

2.2 PIPE INSULATION (RIGID TYPE)

A. Preformed rigid sectional pipe covering, 4 lb. nominal density fiberglass; ASTM C547, Class 1. White Kraft outer surface bonded to aluminum foil and reinforced with fiberglass yarn.

B. Maximum thermal conductivity (k), in units of Btu/sq. ft. hr. °F/in.:

Fluid Operating Temperature	Max. Thermal Conductivity	Mean Rating Temperature
40° F - 60° F	0.27	75° F
105° F - 140° F	0.28	100° F

2.3 CELLULAR GLASS

A. Rigid, impermeable, noncombustible, without fillers or binders. 100 psi compressive strength. Conforms to ASTM C 552.

2.4 MAKE

A. Fiberglass: Certainteed, Knauf, Johns Manville, Owens-Corning, or approved equal.

B. Adhesives: Childers, Foster Products, Tremco; numbers designate quality of adhesive.

2.5 MATERIALS AND SCHEDULES

A. See Exhibits at the end of this section.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Provide Thermal Insulation:
1. Insulation is required on piping unless otherwise called for.
2. Install insulation only on clean, dry surfaces and after work has been tested.
3. Install insulation on cold surfaces with continuous unbroken vapor seal.
4. Exposed surfaces shall be white.
5. Pipes shall be individually insulated.

B. Do not cover inspection stampings, openings, handholes, access doors, air vents, or plugged openings.

C. Install insulation, accessories, coverings and jackets in accordance with manufacturer's installation instructions.

3.2 PIPE INSULATION

A. Insulate piping systems including fittings, valves, flanges, unions, strainers, and other attachments installed in piping system, whether exposed or concealed.

B. Piping In Exterior Walls, Spaces, Overhangs, Or Where Subject To Freezing: Insulate pipe with double the thickness called for.
1. Piping In Wall Chases: In addition to the above, pack chase with loose glass fiber insulation.

C. Plumbing Equipment:
1. Install insulation on exposed hot and cold plumbing piping.
2. Insulation is not required on valves, strainers and threaded piping, 1 inch and smaller.
3. Provide exposed domestic hot water and waste piping for plumbing fixtures designated for use by the handicapped with coverings to protect against contact. Refer to Section 224300, Healthcare Plumbing Fixtures, for additional information.

D. Joints In Section Pipe Covering Made As Follows:
1. Standard: Longitudinal laps and butt joint sealing strips cemented with Foster 85-20 or factory applied pressure sensitive adhesive lap seal. Stapled with outward clinching staples.
2. Vapor barrier: For cold services, Longitudinal laps and 4 inch vapor barrier strip at butt joints shall be sealed with white Foster 85-20. Seal ends of pipe insulation at valves, flanges, and fittings with white Foster 85-20.

E. Pipe Insulation Shields:
1. Refer to Section 220502, Plumbing Piping Systems and Accessories, for requirements.
2. Provide pipe insulation shield at all points of support for insulated piping. Center shields on all hangers and supports outside of insulation. Install shields in manner to prevent cutting or puncturing insulation jacket.

F. Fittings, Valves And Flanges:
1. Hot and cold water:
a. Concealed: Insulating cement of the same thickness as adjacent pipe insulation. Cold water to be vapor sealed with Foster 30-36 "Seal-Fas".
b. Exposed: Premolded fitting covers of the same material and thickness as the adjacent pipe insulation and finished with glass cloth applied and coated with Foster 30-36 "Seal-Fas."

2. Optional: In lieu of the standard method above, the Contractor has the option of using Zeston, Ceel-Co, or Proto. Tape all joints at covers.
a. Fitting covers shall have fiberglass insulation inserts from the factory. Insulation inserts shall have 1.5 pcf minimum density; ASTM C553, Type III.
b. PVC fitting covers shall be UV-resistant.

3.3 RECOVERING

A. Field apply 6 oz. white glass cloth, cemented and applied over standard jacket. Properly cut at fittings to avoid wrinkles and coat with Foster 30-36. Leave ready for painting. Provide as called for.

3.4 EXISTING INSULATION

A. Patch existing insulation damaged during the course of the work.

3.5 EXISTING WORK

A. Insulate existing piping and equipment as called for on the Contract Drawings. Insulation material and thickness shall comply with Exhibits in this Section.

EXHIBIT "I" - PIPE INSULATION MATERIALS

SERVICE	INSULATION MATERIAL	PIPE SIZE	INSULATION THICKNESS	REMARKS
Domestic cold water	Glass fiber	1-1/2" and larger 1-1/4" and smaller	1" 1/2"	
Domestic hot water (up to 140°)	Glass fiber	1-1/2" and larger 1-1/4" and smaller	1-1/2" 1"	
Domestic hot water return (up to 140°)	Glass fiber	1-1/2" and larger 1-1/4" and smaller	1-1/2” 1"	

END OF SECTION

SECTION 221100 - FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 QUALITY ASSURANCE

A. Follow all requirements, recommendations and appendices of the following publications, codes, standards, and listings:
   1. New York State Health Department: Cross Connection Control Manual.
   2. 2020 Plumbing Code of New York State (PCNYS).
   3. ANSI/NSF-61, Drinking Water System Components – Health Effects.
   4. ANSI/NSF-372, Drinking Water System Components – Lead Content.

1.3 SUBMITTALS

A. All items specified under “Part 2 - Products” of this Section.

B. Written certification for domestic water system tests. Submit with O&M Manuals.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER SYSTEMS PIPING

A. Refer to Section 220502, “Plumbing Piping Systems and Accessories” for piping materials.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall conform to Article 1.2 of this section and shall be provided in a workmanlike manner as determined by the Owner's Representative and the Contract Specifications.

3.2 PIPING

A. Run all water piping slightly off level to low points. Provide drain valves and caps at all low points in the domestic water system.

B. Branch headers serving fixtures shall be run full size to the last fixture being served unless otherwise noted.

C. All exposed water piping under fixtures shall be chrome plated brass.

D. Provide dielectric pipe fittings when connecting systems of dissimilar metals. Refer to Section 220502, “Plumbing Piping Systems and Accessories”.

E. Supply piping to all fixtures and faucets shall be anchored to prevent movement. Provide additional structural members and supports as required.

3.3 ASBESTOS PIPE

A. General: Existing pipe insulation may contain asbestos. Cutting, drilling or other disturbance of this material shall be conducted as specified by New York State Department of Labor, Industrial Code Rule No. 56 "Asbestos". The methods and procedures specified in New York State Department of Labor, Industrial Code Rule 56 shall constitute minimum measures and shall in no way relieve the Contractor of sole responsibility for the means, methods, techniques, sequences or safety measures taken in connection with the work.

3.4 STERILIZATION

A. Provide sterilization of water piping in accordance with all requirements of the New York State Health Department, Public Water Supply Guides, Division of Sanitary Engineering, Bureau of Public Water Supply.

3.5 TESTS AND FLUSHING

A. Provide all necessary items to complete proper testing of all domestic water piping. Isolate existing systems as required.

B. Flush all water piping to remove debris, sediment, dirt, rust, corrosion and other foreign material. Flush all piping before connecting to fixture faucets. Refer to Section 224300, “Healthcare Plumbing Fixtures”. Utilize open pipe ends wherever possible.

C. Piping Supplying Domestic Water: Test at 125 psi hydrostatic pressure for two hours. All tests shall be witnessed by Engineer or Owner’s Representative.

D. A successful air test is not acceptable as the final test; however, the Division 22 contractor shall provide interim air testing of piping as construction progresses.

E. Make all leaks tight. No caulking of leaks shall be permitted. Remove and replace all defective fittings, piping and connections.

F. Collect bacteriological test samples after testing and flushing is complete. A minimum of two (2) samples shall be taken. Locations of samples shall be designated by the Owner's Representative. Collect samples in sterile bottles and send to NYS DOH approved laboratory for analysis.
   1. Submit sample test results to Owner's Representative.
   2. Contractor shall disinfect, flush and re-test domestic water piping until sample test results are satisfactory.

G. Pay all costs of tests. Perform all tests in a safe manner. Remove all discharged water resulting from testing procedures.

H. Certify in writing that all required domestic water tests have been conducted and successfully completed. Submit all certifications to the Owner's Representative.

END OF SECTION

SECTION 221301 - FACILITY WASTE WATER SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. All items specified under “Part 2 - Products” of this Section.

B. Submit written certification for sanitary and vent piping system tests. Submit with O&M Manuals.

PART 2 - PRODUCTS

2.1 PLUMBING DRAINAGE SYSTEM

A. Refer to Section 220502, “Plumbing Piping Systems and Accessories” for piping materials.

PART 3 – EXECUTION

3.1 GENERAL

A. Prior to commencing work, the Contractor shall verify all inverts and locations. Any discrepancy between the plans and field conditions shall be reported in writing to the Owner and Engineer within three (3) days of discovery. No work shall start until all discrepancies have been resolved. All costs related to Contractor's failure to verify and/or report discrepancies or problems will be borne by the Contractor.

3.2 INTERIOR PIPING INSTALLATION

A. Minimum Pitch:
   1. Piping 3 inches and smaller: 1/4 inch per foot.
   2. Piping 4 inches and larger: 1/8 inch per foot.

B. Paint exposed waste and vent piping 2 inches and over with chromium paint.

3.3 TESTING

A. Provide necessary items to complete proper testing of Work.
   1. Test all sections of sanitary, waste and vent piping installed by this Project. Test existing piping as called for.
   2. Maintain 10 feet head of water above highest point of section being tested for a minimum of two hours, or until all joints are inspected and proved tight.
   3. For interior piping, leaks of any volume detected in sewers or in floors or walls of appurtenant structures shall be permanently stopped. Should any leaks, defective joints or defective construction be found they shall be promptly made good. Should any defective pipes or specials be discovered they shall be removed and replaced with sound pipes or specials in a satisfactory manner at the Contractor's expense.
   4. Air test not acceptable as final test.
   5. Pay all costs of test.
   6. Provide written certification that tests have been conducted and successfully completed. Submit to Owner's Representative.

END OF SECTION

SECTION 224300 - HEALTHCARE PLUMBING FIXTURES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. Submit shop drawings for all items specified under “Part 2 - Products" of this Section.
   1. Fixture Cuts: Submit shop drawings in folders with cuts of all fixtures, brass trim and accessories before placing order for fixtures. Provide roughing sheets for all fixtures. Provide dimensions for all fixtures, trim and accessories.
   2. Samples: Submit fixture and accessory samples when requested by Owner and/or Owner’s Representative.
   3. Roughing Sheets: Submit roughing sheets in duplicate for each type of fixture when requested.
   4. Deliver cut out data for countertop fixtures to General Contractor.

B. Submit operations and maintenance information for each fixture, faucet, and trim piece. Include this information in the Operations and Maintenance Manual specified in Section 220010.

1.3 DESCRIPTION OF FIXTURES

A. All fixtures, trim and fixture accessories shall be similar and equal to the manufacturer’s plate numbers specified in this section. All fixtures and supply trim shall meet the requirements of the New York State Department of Environmental Conservation and shall be listed by that Agency. All exposed parts of fixture trim shall have a polished chrome finish. All tubular drainage products (“P” traps, nipples, etc.) for sinks shall be 17 gauge brass.

B. All fixtures, trim and fixture accessories shall comply with requirements of ANSI/NSF-61 and ANSI/NSF-372.

C. All fixtures, trim and fixture accessories shall be subject to compliance with the specified requirements and shall be manufactured by the following:
   1. Stainless Steel Sinks: Elkay.
   2. Faucets: Zurn.
   3. Lavatory Trim: Brass-Craft, Cambridge, McGuire.

4. Provide the Owner with special wrenches, tools and devices necessary for servicing plumbing fixtures and trim in a quantity of one device for each 5 (five) fixtures (provide a minimum of one device if fixture quantity is less than five). Provide the Owner with faucet repair kits complete with all parts in a quantity of 1 (one) kit for each 20 (twenty) faucets. Provide a minimum of 1 (one) kit for each faucet if fixture quantity is less than 20 (twenty).

PART 2 - PRODUCTS

2.1 SINKS (SINK)

A. Type SINK-B: (For the physically challenged)
1. Elkay Lustertone LRAD-1517 nickel bearing type 304 stainless steel single bowl sink, 6½ inch bowl depth, 2 faucet holes, 18 gauge, self-rimming, for countertop installation, fitted with the following:
   a. Zurn model Z812B4-XL-18F, deck mounted manual faucet, 4 inch centerset, 5-3/8 inch rigid/swing gooseneck spout, ceramic quarter-turn cartridge, wristblade handles, 1.5 GPM laminar flow outlet.
   b. McGuire No. 1152-WC, chrome-plated P.O. plug with open grid strainer and offset 1-1/2 inch, 17 gauge tailpiece.
   c. McGuire No. LF167LK, 3/8 inch chrome plated wall supplies with loose key angle stops, cast brass set screw escutcheons and 12 inch long flexible metal risers.
   d. Waste pipe routed to sink drain pump (SP-1) in casework.

PART 3 - EXECUTION

3.1 FIXTURES, EQUIPMENT AND SYSTEMS

A. Install fixtures, trim, accessories, equipment and systems as shown on the Drawings or as specified herein in accordance with the provisions of each applicable Section of these Specifications and in compliance with all Federal, State and Local codes having jurisdiction.

3.2 FIXTURES

A. Install fixtures, trim and accessories in accordance with manufacturer's installation instructions.

B. Chromium Plating:
1. All supply and drainage trim and accessories shall have a minimum thickness of 0.002 inch chromium applied over a nickel plating having a minimum thickness of 0.0002 inch.

C. Screws, Bolts and Nuts:
   1. All screws, nuts and bolts shall be of size, type and finish to fit requirements and to harmonize with adjacent material.
   2. Nut and bolt heads exposed at fixtures shall be hexagon with bonnet cap and chromium plated brass.

D. Erection:
   1. Properly install fixtures and associated supply and drainage piping and securely support.

E. Protection: Immediately after installation, thoroughly cover metal trimmings and fixture to prevent damage or scratches. Condition of all fixtures is the responsibility of the Division 22 contractor until the Owner takes final possession of the Project.

F. Cleaning: At completion of Work, clean all fixtures complete with their trimmings; put in working order and in first-class condition and appearance.

G. Installation:
   1. Exact mounting height to be determined by Owner's Representative, Architectural Drawings and (where applicable) all ADA requirements.
   2. Countertop sinks: Set countertop mounted sinks in a bed of approved setting compound, which will cover the entire perimeter of the sink that comes in contact with the countertop.

END OF SECTION

JORDAN HEALTH CENTER - PHARMACY
DIVISION 22
MECHANICAL SPECIFICATIONS
PAGE 1

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SECTION 230010 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 23.

B. Section 019113 - Commissioning Requirements

1.2 SCOPE OF WORK

A. All portions of the work shown in the construction documents shall be bid by the Mechanical Contractor. Responsibility for performance of subcontractors and trades as lower tier contracts, such as electrical, shall be included as part of the Mechanical Contractor's scope of work.

B. Include in bid all labor, materials, tools, plant, transportation, excavation, equipment, insurance, temporary protection, permits, taxes, services and all necessary and related items required to provide complete and operational systems shown and described.

C. References to codes and standards called for in the Contract Documents mean the latest edition, amendment and revisions to the codes and standards in effect on the date of these Contract Documents.

D. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:
   1. Miscellaneous Supports
   2. Access Doors and Panels
   3. Fire Stopping
   4. Cutting and Patching

E. Contract shall include, but not be limited to:
   1. HVAC
   2. General Contracting work as related to the HVAC Contract
   3. Temperature Controls
   4. Testing and Balancing of Mechanical Systems

1.3 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state and local governmental agencies having jurisdictional authority. In the event of conflict between these contract documents and the governing rules, regulations, and codes, the most stringent standards shall apply as directed by the Engineer and/or Authorities having jurisdiction.

B. Codes and standards that apply to this project include, but are not limited to:
1. 2020 Building Code of New York State (BCNYS)
2. 2020 Existing Building Code of New York State (EBCNYS)
3. 2020 Energy Conservation Construction Code of New York State (ECCCNYS)
4. 2020 Fire Code of New York State (FCNYS)
5. 2020 Fuel Gas Code of New York State (FGCNYS)
6. 2020 Mechanical Code of New York State (MCNYS)
7. 2020 Plumbing Code of New York State (PCNYS)
8. Facilities Guidelines Institute for Hospitals 2018
9. ASHRAE Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings.
10. Facilities Guideline Institute (FGI) – Guidelines for the Design and Construction of Health Care Facilities
11. New York State Department of Labor Rules and Regulations.
12. New York State Department of Health Regulations.
13. New York State Education Department - “Manual of Planning Standards”.
14. Federal Occupational Safety and Health Administration (OSHA) Regulations
15. Local Codes and Ordinances for Dansville, NY.
16. Factory Mutual and/or Owner’s Insurance Carrier
17. New York Board of Fire Underwriters.
18. Essential Electrical Systems for Health Care Facilities, NFPA 76A.
19. HEW Publication No. (HRA) 74-4000 (Hospital & Medical Facilities), NFPA 76A.

1.4 LICENSING & PERMITS

A. The Contractor shall hold a license all necessary licenses to perform the scope of work at the project location.

B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid.

C. Refer to General Conditions of the Contract for additional requirements.

1.5 GLOSSARY

ADA	Americans with Disabilities Act
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
EIA	Electronic Industries Association
FCC	Federal Communications Commission
FM	Factory Mutual Insurance Company
GAP	Global Asset Protection
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	International Standards Organization
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
NYS/UFBC	New York State Uniform Fire Prevention and Building Code
OSHA	Occupational Safety and Health Administration
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UL	Underwriter's Laboratories, Inc.

1.6 DEFINITIONS

Approved / Approval	Written permission to use a material or system.
As Called For	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Equipment	Refer to the article, BASIS OF DESIGN
Design Make	Refer to the article, BASIS OF DESIGN.
Equal or Equivalent	Equally acceptable as determined by Owner’s Representative
Exposed	Work not identified as concealed.
Final Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.

Furnish	Supply and deliver to installation location.
Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's Site Representative.
Install	Mount and connect equipment and associated materials ready for use.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.
Or Approved Equal	Approved equal or equivalent as determined by Owner's Representative.
Owner's Representative	The Prime Professional, Construction Management, or other entity contractually authorized by the Owner for the services referenced.
Prime Professional	Architect / Architectural Entity or Engineer / Engineering Entity having a contract directly with the Owner for professional services.
Professional Engineer	Individual or Entity licensed to perform Engineering services in the State of New York
Provide	Furnish, install and connect ready for use.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Roughing	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.
Site Representative	Construction Manager or Owner's Inspector at the work site.

Refer to General Conditions of the Contract for additional definitions.

1.7 BASIS OF DESIGN

A. The contract documents are prepared on the basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Contractor shall provide changes in work of all other trades at no increase in any contract. Provide larger motors, electrical feeders, circuit breakers, equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assumes responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings or floors required to install other than design make equipment. Contractor shall retain the ultimate responsibility for function of equipment and materials which are not the basis of design for the contract documents. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.8 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, and fixtures. Exact locations are subject to the approval of the Owner's Representative.

B. In the event of conflict between the drawings and specifications, or discrepancies within either, this shall be brought to the attention of the Engineer for resolution prior to submission of bids. In the event that the contractor fails to note these discrepancies prior to submission of bids or in writing within their bid submission, the Engineer shall resolve the discrepancy such that the design intent is provided. The contractor shall provide all labor, materials and equipment to correct the installation deficiencies as defined by the Engineer.

1.9 ELECTRONIC CAD DRAWING FILES

A. The Engineer may provide the Contractor with AutoCAD .dwg or MicroStation ‘dgn’ format files for this project with the understanding that these CAD files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors’ responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors’ coordination shop drawings is to account for all trades and field conditions and identify any conflicts that shall be resolved prior to installation.

B. Any additional cost for changes due to conflicts as a result of the Contractors’ failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

C. If the Contractor requests electronic CAD files from the Engineer and this request is granted, the Contractor shall submit application to the Engineer identifying each drawings to process the request.

1.10 QUALITY ASSURANCE

A. Manufacturers of equipment shall be firms regularly and currently engaged in the production of equipment and accessories provided. The design and size/capacity of each item of equipment provided for this project needs to have been in satisfactory and efficient operation on at least three (3) installations for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

C. Apply and install materials, equipment, and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the Owner's Representative for resolution.

D. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, cutting and patching.

E. All work shall be done in a neat and workmanlike manner. All methods of construction or details of workmanship, not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and construction indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL MINIMUM REQUIREMENTS

A. Provide materials that meet the following minimum requirements:
   1. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.
   2. All equipment and material for which there is a listing service shall bear a UL label.
   3. Gas-fired equipment and systems shall meet AGA Regulations and shall have an AGA label

4. Electrical equipment and systems shall meet UL Standards and requirements of the NEC. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with UL Standards and the requirements of the NEC.
5. Communications equipment shall meet all FCC Regulations
6. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.
7. The listing of a manufacturer as “acceptable” does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications.

2.2 SUBSTITUTIONS

A. The materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.

B. Proposed substitutions must be submitted in writing to the Architect and Engineer a minimum of ten (10) days prior to the date for receipt of Bids. Each request shall include the name of the proposed material, product or equipment being substituted, cut sheets, installation drawings, performance and test data, warranties and location of three (3) similar installations with reference names of owner or facility personnel responsible for maintaining equipment. At that time the equipment or will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders. Failure to follow the guidelines described above may result in equipment being rejected at submittal based solely on failure to follow the above guidelines.

C. Approval by the Architect and/or Engineer to proceed with a substitution does not relieve the contractor from meeting all of the dimensional requirements and maintaining the full functionality and performance of the material, product or equipment used as the basis of design.

D. Electrical Design Changes Due to Mechanical Substitutions – It shall be the responsibility of all Contractors to transmit all changes of electrical characteristics to the Electrical Contractor which result from any substitutions PRIOR to starting any work. Any and all extra charges by the Electrical Contractor due to these changes are to be paid by the Contractor making the change.

E. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are unacceptable and will not be considered.

2.3 FACTORY-ASSEMBLED PRODUCTS

A. Provide maximum standardization of components to reduce spare part requirements.

B. Manufacturers of equipment assemblies which include components made by others shall assume complete responsibility for final assembled unit.
1. All components of an assembled unit need not be products of the same manufacturer.
2. Constituent parts which are alike shall be products of a single manufacturer.
3. Components shall be compatible with each other and with the total assembly for intended service.
4. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear the manufacturer's name or trademark, model number and serial number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment which serve the same function must be the same make and model. Exception will be permitted if performance requirements cannot be met.

2.4 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

2.5 SPECIAL TOOLS

A. If any part of equipment requires a special tool for assembly, adjustment or maintenance thereof and such tool is not readily available in the commercial tool market, it shall be furnished by the Contractor as required for the duration of the project and turned over to the Owner in serviceable condition upon completion of the scope of work. Contractor shall obtain written sign off by the Owner certifying that the Owner is in receipt of such tools.

2.6 SAFETY GUARDS

A. Provide guards on all shafts and couplings and all V-belt and sheave assemblies to prevent damage to equipment and injury to personnel.

2.7 LIFTING ATTACHMENTS

A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered without bending or distortion of shape, such as rapid lowering and braking of load.

2.8 MISCELLANEOUS SUPPORTS

A. Metal bars, plates, tubing, etc. shall conform ASTM standards:
   1. Steel plates, shapes, bars, and grating - ASTM A 36
   2. Cold-Formed Steel Tubing - ASTM A 500
   3. Hot - Rolled Steel Tubing - ASTM A 501
   4. Steel Pipe - ASTM A 53, Schedule 40, welded

B. Metal fasteners shall be zinc-coated (type, grade and class as required).

2.9 ACCESS DOORS AND PANELS

A. Steel access doors and frames shall be factory fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush.

B. Provide access doors at all locations where equipment access for service, repair, and/or adjustment may be required. This shall include access to all air balance dampers. (In lieu of access to air balance dampers above hard ceilings or in chase walls, Contractor may submit for approval for use of remote regulators.)

C. Construction:
   1. Frames:
      a. 16 gage steel with 1 inch wide, exposed, perimeter flange and adjustable masonry anchors for units installed in masonry, pre-cast, cast-in-place concrete, or ceramic tile.
      b. 16 gage steel, perforated flanges with bead for gypsum or plaster wall board.
      c. 16 gage steel with galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame for full bed plaster applications.

   2. Access Doors:
      a. Provide 14 gage sheet steel, flush panel doors with concealed, continuous, factory-installed piano hinge, primed and painted, set to open 175 degrees in unrated partitions.
      b. Provide fire-rated, insulated, flush panel doors, with continuous piano hinge and self-closing mechanism rated for 1-½ hour “B” labeled, in fire-rated partitions.

   3. Provide flush, screwdriver operated cam locks on all access doors.

4. Access doors shall be gasketed type where installed in rooms or spaces required to maintain a positive or negative pressure requirement to adjacent rooms or spaces.

2.10 FIRE STOPPING

A. Refer to Specification Section 078413 for fire and smoke stopping requirements.

PART 3 - EXECUTION

3.1 SUBMITTALS: SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Incomplete submittals will not be accepted. All products specified in an individual Division 23 Section shall be submitted at the same time. Number each submittal. Indicate deviations from contract requirements on Letter of Transmittal. Corrections or comments made on the Shop Drawings during the review do not relieve the Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

B. Approval of shop drawings will not relieve this contractor from responsibility for deviations from the contract documents. It is the responsibility of the Contractor to meet the requirements of these documents. All errors or omissions in the product data are to be corrected by this contractor irrespective of any approvals by the Architect or Engineer.

C. Pre-test submittals must be written in report format, submitted and signed off on by the Owner and Engineer prior to the start of any construction work, including demolition.

D. Shop drawings include, but are not limited to, the submissions listed below. Refer to individual specification sections for specific requirements and additional submission requirements.

SECTION	DESCRIPTION	REQUIRED SUBMISSIONS

230010	Basic Mechanical Requirements	Access doors Fire Stopping Special requirements related to substitutions Sheet metal shop / coordination drawings Operation and Maintenance Manuals Record Documents / Drawings
230523	Valves	Valves and accessories
230553	Mechanical Identification	Manufactures technical product data and installation instructions for each identification material and device. Valve schedule for each piping system typewritten on an 8-1/2. X 11 in. (minimum) indicating code number, location and valve function. Schedule of pipe, equipment and name identification for review before stenciling or labeling. Confirm naming/numbering is consistent with Owner's convention.
230593	Testing, Adjusting and Balancing	Quality-Assurance Submittals Sample Report Forms Report of plan review for balancing devices necessary to achieve proper system balance but not specified Certified Testing, Adjusting, and Balancing Reports (including any specified pre-testing of systems) Warranty Documentation
230700	Insulation	Manufacturer data. Schedule of insulation applications. Certifications to demonstrate compliance specifications and governing regulations, including proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
230923	Temperature Controls	Control System Submittal Pre-Commissioning Report As-Built documentation and drawings Operations and Maintenance Manuals / Closeout Documentation Training Agenda and Documentation Warranty
232000	Piping Systems and Accessories	Schedule of pipe materials, fittings, connections and accessories by piping system.
232133	Water Systems Specialties	Shop drawings on water system specialties
233000	Sheet Metal and Ductwork Accessories	Shop drawings of all sheet metal equipment being provided. Submit a complete shop standard manual including construction details for all shop fabricated materials. Ductwork Detail Drawings. Exhaust and kitchen hood details.

233316	Fire and Smoke Dampers	Types, schedule of sizes, locations, and installation arrangements of all dampers. Manufacturers UL listed installation details for each mounting arrangement. Report of findings for all existing fire dampers to remain within or at the project perimeter.
238216	Coils	Coil Performance Data matching design schedules.
233713	Registers and Diffusers	Registers/Grilles/Diffusers. Room schedule listing size, throw, direction of throw, accessories, finish, material type and color chart.
238231	Radiant Ceiling Panels	Unit Schedule – Size, Performance Data Mounting hardware, accessories

3.2 COORDINATION DRAWINGS

A. **Before construction work commences**, Contractors for all trades shall submit Coordination Drawings in the form of color coded paper drawings or electronic files (dwg or rvt) not less than 3/8" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings as follows:

1. Division 23 shall prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be AutoCAD format of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, light fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Re-position proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc. Provide these adjustments as part of Base Bid Contracts.
2. Division 23 will provide AutoCAD files and prints and submit the base plan to all major trades' Contractors.
3. Division 26 (Electrical), Division 28 (Communications), Division 22 (Plumbing) and Division 21 (Fire Protection) will each draft location of piping, conduits, equipment, etc. on the base plan as provided by Division 23 such that a complete coordination of all trades is represented and areas of conflict and recommended resolutions are noted.

4. Do not install any equipment, equipment foundations, ductwork, or piping until Coordination Drawings have been approved. Failure to receive approval prior to installation of the aforementioned items, will put the risk on the contractor to remove and reinstall at the engineer's discretion. Additional time spent by the engineer in the field reviewing construction progress due to not receiving ductwork shop drawings and coordination drawings prior, will be considered an additional service by the consultant, which shall be paid by the contractor and deducted from any moneys owed to the contractor. The consultant's hourly rate will apply.

3.3 PROTECTION OF PERSONS AND PROPERTY

A. Contractor shall assume responsibility for Construction Safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature(s) required to provide safe conditions for all workmen and site visitors.

3.4 EXISTING SYSTEMS AND CONDITIONS

A. Existing conditions are taken from field observations and prior construction documents and are not guaranteed. The contractor shall field verify all existing conditions. No allowance will be made for additional costs due to Contractors failure to verify existing conditions.

B. Prior to beginning work, inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the Owner prior to beginning work. If existing damage is not documented and submitted, the Contractor shall repair all damage found at the completion of the project that is determined to have been caused by the work of this contract. Repairs shall restore the area to like new condition.

C. The Owner's Representative shall determine if the Contractor has damaged existing systems or construction and shall approve the repairs.

3.5 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The Contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the Owner's asbestos management plan. Prior to performing such work, identify areas containing asbestos. Notify the Owner so that arrangements may be made for abatement and/or containment prior to work proceeding. The Contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 Sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

3.6 REMOVALS

A. Demolition of mechanical systems will include removal and deprogramming of multiple control system devices and sensors. Coordinate with Owner for quantity and type of devices which they desire to retain. Remove all components in good condition and turn over to the Owner’s representative.

B. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that the Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by the Owner. Items that the Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated. Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, each crawl space and each roof to determine total Scope of Work. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all pipe, valves, fittings, insulation, conduit, panels, and all hangers, including the top connection and any fastenings to building structural systems. Where pipe and ductwork is removed and no new connections are planned or shown, cap, seal and insulate the pipe and ductwork which remains. Seal all openings, after removal of equipment, pipes, ducts, conduits and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

D. The shutting down of the existing HVAC systems shall be properly coordinated with the Owner. Provide the necessary personnel in shutting down the systems as necessary to facilitate the intended work. Water and glycol systems shall be fully drained prior to any removals. The Contractor shall propose to the Owner the points of isolation of the system to minimize the duration of the shutdown for draining, performing the necessary work and refilling of the system. Systems containing a glycol solution shall be drained in a manner to collect the solution in containers for storage or disposal. Glycol solution not utilized for refilling the systems upon completion of work shall be removed from the site and properly disposed of in a legal manner by the Contractor. Upon completion of removals and new work, the Contractor shall refill and vent the systems to return the systems back to their original operation condition.

3.7 STORAGE AND PROTECTION OF MATERIALS

A. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

3.8 FREEZING AND WATER DAMAGE

A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no change in contract, any such damage to equipment, systems and building. Perform first seasons winterizing in presence of Owner's operating staff.

3.9 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. **DO NOT SCALE PLANS**. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the Owner’s Representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location and mounting height of all equipment in finished areas, such as thermostats, fixtures, communication and electrical devices, including panels. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for Diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.
2. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owner's Representative or other contractor for any "rough ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the Contractor at no expense to the Owner.
3. For equipment and connections provided in this contract, prepare roughing drawings as follows:
   a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.
   b. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in drawings.
4. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and manufacturer's recommended service clearances to allow for required maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

D. All equipment requiring service and / or access shall be provided adequate clearances for this purpose. Any clearances described in manufacturer's information, code requirements, etc., shall be taken into account in determining final rough-in positions. Reasonable access for maintenance and service shall be maintained. The most stringent standard, as determined by the Engineer, shall apply.

3.10 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch, cut or abandoned holes left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

3.11 CONCEALMENT

A. **Conceal all contract work** above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

3.12 CHASES

A. In Existing Buildings:
   1. Drill holes for floor and/or roof slab openings.
   2. Multiple pipes smaller than 1" properly spaced and supported may pass through one 6" or smaller diameter opening.
   3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2" above floors

4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

3.13 ACCESS DOORS AND PANELS

A. Provide access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, duct mounted fire alarm detectors and other electrical equipment requiring access for maintenance or operation.

B. Provide access doors, sized to permit compete access for all items requiring adjustment, such as balance dampers above solid ceilings.

C. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.

D. Adjust hardware and panels after installation for proper operation.

E. Access doors and panels shall operate freely and be fully usable for their intended function.

3.14 FIRE-STOPPING Designer Note - coordinate with projects where 3rd party fire stop contract is to be provided

A. Fire-stopping for openings through fire and smoke rated wall and floor assemblies:
1. Provide materials and products listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.
2. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire-rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.
3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.
4. The methods used shall incorporate qualities, which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.
5. Apply fire stopping within the temperature and humidity limits permitted by the manufacturer.

6. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.15 FLASHING AND SEALING

A. Openings through roofs shall be flashed in a manner to not affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of the contract. Provide non-ferrous flashing pieces, skirts, hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

B. Where openings for pipe/duct penetrate through roofs into equipment pipe chases, mechanical spaces or penthouses, the penetration of the roof deck/slab shall be sleeved, sealed and firestopped as required. Insulate at base of pipe chase, mechanical space or penthouse to match insulation value of the roofing system.

C. Apply all flashing and sealers within the temperature and humidity limits permitted by the manufacturer.

3.16 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support mechanical/electrical work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

3.17 GENERAL INSTALLATIONS REQUIREMENTS

A. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed

B. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.

C. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

D. Set all equipment to accurate line and grade, level all equipment and align all equipment components.

E. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

F. No equipment shall be hidden or covered up prior to inspection by the Owner's Representative. All work requiring inspection which is concealed prior to approval shall be re-opened for inspection at the Contractor's expense. All work that is determined to be unsatisfactory shall be corrected immediately.

G. All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

H. Install access panels or doors where units are concealed behind finished surfaces.

3.18 ADDITIONAL ENGINEERING SERVICES

A. In the event the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

B. In the event the Consultant is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

C. In the event the Consultant is required to initiate design changes due to failure of the contractor to properly coordinate with the construction schedule, and / or other trades, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owned to the Contractor.

3.19 HVAC MAINTENANCE OF SYSTEMS DURING TEMPORARY USE PERIODS

A. Provide each air handling system with a set of pre-filters in addition to the permanent filters. Furnish four sets of pre-filters for each system for use when system is operated for temporary heating or cooling. During such use, change pre-filters as often as directed by Owner's Representative. Provide necessary temporary throwaway filters in all return openings to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply units only. Do not operate return fans.

B. Blank-off outside air intake opening during construction. Install first set of permanent filters and pre-filters. Install filters over all return air openings with adequate efficiency and capacity to keep construction dust and debris out of the duct systems. Contamination of the duct systems shall necessitate cleaning to dust free condition.

C. Adjust dampers on supply system.

D. Set all heating coil control valves for manual operation.

E. Do not install any grilles or diffusers at room terminal ends of ducts until permission is given.

F. Assume responsibility for systems and equipment at all times, even though used for temporary heat or ventilation.

G. Repair or replace all dented, scratched or damaged parts of systems.

H. Remove concrete, rust, paint spots, other blemishes, then clean.

I. Just prior to final acceptance, remove used final filter. Deliver all unused sets of pre-filters to the Owner and obtain written receipt. Properly lubricate system bearings before and during temporary use. Maintain thermostats, freeze stats, fire stats, overload devices, and all other safety controls in operating condition

3.20 TEMPORARY FACILITIES

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.
   1. Continuity of operation of existing facilities will require temporary installation or relocation of equipment and piping.
   2. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.
   3. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining pressurized.

3.21 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:
   1. Thoroughly clean entire installation, both exposed surfaces and interiors.
   2. Remove all debris caused by work.
   3. Remove tools, surplus, materials, when work is finally accepted.

B. Cleanliness of construction shall extend to include the interior and exterior surfaces of all equipment and systems provided under this contract. This includes, but is not limited to:
   1. Unitary equipment exposed to occupant use (cabinet heaters, baseboard systems, etc.) Shall be thoroughly cleaned for final use both inside and out prior to project completion.
   2. Equipment located in mechanical spaces shall be cleaned on the exterior such that no significant accumulation of debris or dirt is evident.
   3. Interiors of all air handling equipment (rooftop systems, air handlers, etc.) shall be thoroughly cleaned on the interior such that no evidence of dust, dirt or debris remains prior to project turnover.
   4. Ductwork systems – Ductwork shall be delivered to the job site with ends capped or covered to eliminate contamination during transportation and site storage. All open ends shall remain covered during the entire course of the construction process. Ductwork with evidence of dust, dirt or debris shall be thoroughly cleaned by an approved method prior project turnover.

3.22 HVAC EQUIPMENT CONNECTIONS

A. Provide final steam, condensate, hot water, glycol, chilled and condenser water, drain, vent, oil line and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, wiring, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and rail connections extended to floor drains.

B. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, as required.

C. Refer to manufacturer’s drawings and specifications for requirements of medical equipment, laboratory equipment and special equipment. Verify connection requirements before bidding and confirm prior to roughing.

3.23 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical facilities or services.

3.24 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owner’s designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed. Prior to acceptance repeat the instructions. If asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer’s certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e. adjustable speed drive and air handling unit) both manufacturers shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up, including problems that occurred and their method of resolution.

C. Refer to Section 017500 - Starting and Adjusting and Section 017700 – Closeout Procedures for additional requirements.

3.25 OPERATION AND MAINTENANCE MANUALS

A. In addition to requirements stated elsewhere in these specifications, provide Operating and Maintenance manual(s) which include the following:
   1. Approved Submittal documentation for all equipment stating size and selected options for each piece of equipment requiring maintenance.
   2. Manufacturer’s operation manuals and maintenance manuals for each piece of equipment requiring maintenance (excepting equipment not furnished as part of this project). Routine maintenance actions shall be clearly identified. The data shall include internal wiring diagrams and spare parts lists.
   3. Name and address of each equipment supplier and at least one service agency for each piece of equipment.

4. HVAC and service water controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings and at control devices or, for digital control systems, in programming instructions.
5. A narrative of how each system is intended to operate, including recommended setpoints. Include emergency operating instructions, seasonal changeover, freeze protection and precautions necessary for Owner operations of systems.
6. As-built drawings for the project (see Record Documents) and piping diagrams.

B. Bind above items in a three ring binder with name of project on the cover. Deliver to Owner's Representative before request for acceptance. Provide copy of O&M Manual in electronic format on CD or other media format acceptable to the Owner. All documents shall be in PDF format, with the exception of record drawings which shall be provided in AutoCAD compatible drawing format.

3.26 RECORD DOCUMENTS

A. In addition to all requirements elsewhere in the Contract Documents, prepare and provide record documents of the as-constructed work which meets the following minimum standards:
1. Utilities below floors, slabs and grade: During construction, maintain accurate records of all final locations and inverts for all services inside and outside of the buildings, beneath grade and below floors.
2. Ductwork and Piping:
   a. All ductwork and piping shall be clearly dimensioned with its outside dimensions (diameter or length X width) at each unique section/piece.
   b. Elevations of all ductwork and piping shall be clearly identified. Elevation should be taken in respect to the finish floor and bottom of ductwork or pipe.
   c. X/Y dimensions should be included for all ductwork and piping to provide precise location from a fixed bench-mark such as the corner of a building, column, etc., and neatly and clearly indicate same on reproducible prints.
3. Provide Record Drawings for all Contract Work. Document the location of control devices isolation valves, safety devices and equipment.
4. Incorporate all field changes, change orders and other modifications into the final Record Drawings.
5. Record drawings shall contain all corrections from construction documents to as-built conditions and shall be submitted for review and approval.
6. Drawing format:
   a. Documents shall be provided in PDF formant or, where fully developed in CAD, in AutoCAD compatible file format. Submittal media shall be as acceptable to the Owner and Engineer

b. Drawings scale shall not be less than 3/8" = 1'-0".
c. Marked up PDFs of the contract documents will not be acceptable

3.27 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the Owner. Instruction shall be given to the Contractor whether the Owner will remove salvageable materials, or whether contractor is to remove and deliver salvageable materials to a pre-designated site.

B. HVAC items normally accepted as salvage by the Owner:
1. Temperature control and automation hardware

3.28 INFECTION CONTROL REQUIREMENTS

A. Infection control requirements shall be set forth by the Owner and Architect. Refer to front end of project manual for requirements. This project shall be assumed CLASS IV for all indoor locations.

B. The following minimum standards of infection control shall be maintained for each area of work. The “Class” of work shall be as directed by the Architect or Engineer.
1. CLASS I: Least Risk.
   a. TYPE A: Inspection, non-invasive activity
   b. TYPE B: Small scale, short duration, minimal dust generating activity
   c. Requirements:
      1) Executes work by methods to minimize raising dust from construction operations.
      2) Immediately replace any ceiling tile displaced for visual inspection.
      3) Minor Demolition for Remodeling

2. CLASS II: Medium Risk
   a. TYPE C: Activity that generates moderate to high levels of dust, requires greater than one work shift for completion
   b. Requirements:
      1) Provide active means to prevent air-borne dust from dispensing into atmosphere.
      2) Water mist work surfaces to control dust while cutting.
      3) Seal unused doors with duct tape.
      4) Block off and seal air vents.
      5) Wipe work surfaces with disinfectant.
      6) Contain construction waste before transport in tightly covered containers.
      7) Wet mop and vacuum with HEPA filtered vacuum before leaving work area.
      8) Place dust mat at entrance and exit of work area.

9) Remove isolation and HVAC system in areas where work is being performed.

3. CLASS III: Medium/High Risk
   a. TYPE D: Major duration and construction activities occurring during consecutive work shifts.
   b. Requirements:
      1) Isolate HVAC system in the area where work is being done to prevent contamination of duct system.
      2) Complete all critical barriers or implement control cube method before construction begins.
      3) Maintain negative 0.03 inch water gauge air pressure within work site.
      4) Use HEPA filtration for all air transferred to adjacent interior building space.
      5) Do not remove barriers from work area until:
         a) Complete project is thoroughly cleaned by the Environmental Services department.
         b) Vacuum work with HEPA filtered vacuum.
         c) Wet mop area with disinfectant.
         d) Remove barrier material carefully to minimize spreading of dirt and debris associated with construction.
      6) Contain construction waste before transport in tightly covered containers.
      7) Cover transport receptacles or carts. Tape covering.

4. CLASS IV: Highest Risk
   a. Requirements:
      1) Isolate HVAC system in area where work is being done to prevent contamination of duct system.
      2) Complete all critical barriers or implement control cube method before construction begins.
      3) Maintain negative 0.03 inch air pressure within work site.
      4) Use HEPA filtration for all air transferred to adjacent interior building space.
      5) Construct anteroom and require all personnel to pass through this room.
      6) Use assigned route of exit from site.
      7) All hospital personnel entering work site are required to wear shoe covers and cover gowns. Shoe covers and gowns must be removed before exiting the work site.
      8) Do not remove barriers from work area until:
         a) Complete project is thoroughly cleaned by the Environmental services Department.
         b) Vacuum work areas with HEPA filtered vacuums.
         c) Wet mop area with disinfectant.

d) Remove barrier material carefully to minimize spreading of dirt and debris associated with construction.

9) Contain construction waste before transport in tightly covered containers.
10) Cover transport receptacles or carts. Tape covering.

C. General Demolition and Above Ceiling Work
1. Any work requiring significant demolition and / or above ceiling scope must be reviewed with the Owner and Architect prior to commencement. The Owner retains the option of collecting spore samples to test for Aspergilli fungus and if tests are determined to be positive, additional scope of work will be coordinated, including proper containment and abatement activities. Dust mask or proper protective equipment shall be worn when working above ceilings.

D. Indoor Air Quality
1. Review with the Owner and Architect is required prior to the start of the demolition phase of all projects. Contractors are required to provide HEPA filtered vacuum collection equipment appropriately sized to maintain particulate levels within the construction zone. Establish a negative pressure work area to exhaust construction dust outside (if at all possible). Keep path of dust from re-circulating or entering mechanical equipment. Dirty filters shall be placed in plastic bags and sealed for disposal. Pressure gradients shall be measurable. The Mechanical Contractor shall provide a temporarily installed “isolation room monitor” device for the duration of the project in order to determine that a measurable and consistent negative 0.03 inch pressure is being generated. The monitor shall alarm if a negative pressurization of at least 0.002” out of set point is not maintained for a period of 30 seconds.

END OF SECTION

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SECTION 230523 – VALVES

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment, and services as required for the complete installation and related work designated in contract documents.

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

1.3 SUBMITTALS

A. Valves and accessories.

PART 2 – PRODUCTS

2.1 VALVES:

A. General: Valves shall meet the following requirements:
   1. Working pressure shall be stamped or cast on bodies.
   2. Stem packing shall be serviceable without removing valve from line.
   3. To establish a standard of quality and identify features, certain manufacturer's numbers are given in the following paragraphs.

B. Gate Valves – HVAC Systems (Non-Potable Water Systems):
   1. **GV-01** - Bronze 2" and Under (Threaded End Connection):
      a. Valves shall be suitable for 125 SWP/200WOG, 150 SWP/300 WOG or 300 SWP/ 1000WOG, solid wedge disc, rising stem, union bonnet.
      b. Body and Bonnet: Bronze ASTM B62.
      c. Stem: Bronze ASTM B61, ASTM B62, ASTM B371.
      d. Seat: Bronze ASTM B62 (Class 125 and Class 150) or Stainless-Steel ASTM A240 Type 304/ASTM A276 Type 410 (Class 300).
      e. Wedge Disc: Bronze ASTM B62.
      f. Packing: Graphite.
      g. Handwheel: Malleable iron.

h. Acceptable Makes: Milwaukee 1152 (Class 125), 1151 (Class 150) or 1184 (Class 300), Hammond IB617 (Class 125), IB629 (Class 150) or IB654 (Class 300), Crane 428UB (Class 125), 431UB (Class 150) or 634E (Class 300), Nibco T-111 (Class 125), T-134 (Class 150) or T-174-SS (Class 300), Jenkins Figure 47CUJ (Class 150) or Figure 2280UJ (Class 300).

2. **GV-02** - Cast Iron 2 ½" and Larger (Flanged End Connection):
   a. Valves shall be Class 125 or Class 250, outside screw and yoke, rising stem.
   b. Body and Bonnet: Cast iron ASTM A126, Class B.
   c. Stem: Bronze ASTM B16 or Alloy ASTM B371.
   d. Seat: Cast bronze ASTM B62 or Bronze ASTM B61
   e. Wedge Disc: Cast iron ASTM B126, Class B, or Bronze ASTM B61, ASTM B62, ASTM B584.
   f. Packing: Graphite.
   g. Handwheel: Malleable or ductile iron.
   h. Acceptable Makes: Milwaukee F-2885A (Class 125) or F-2894A (Class 250), Crane 465½ (Class 125) or 7½E (Class 250), Powell Figure 1793 (Class 125) or Figure 1797 (Class 250), Lunkenheimer Figure 1430 (Class 125) or Figure 1436 IBBM (Class 250), Jenkins Figure 454J (Class 125) or Figure 204J (Class 250), Nibco F-617-O (Class 125) or F-667-O (Class 250).

3. **GV-03** - Cast Steel 2 ½" and Larger (Flanged End Connection):
   a. Valves shall be Class 150 or Class 300, outside screw and yoke, rising stem.
   b. Body and Bonnet: Cast steel ASTM A216 WCB.
   c. Stem: Stainless steel ASTM 410 or ASTM 182.
   d. Seat: Carbon steel ASTM A105+Co-Cr-W
   e. Wedge Disc: Cast steel ASTM B216 WCB+13Cr HF.
   f. Packing: Graphite.
   g. Handwheel: Malleable or ductile iron.
   h. Acceptable Makes: Milwaukee 1550CB2 (Class 150) or 3050CB2 (Class 300), Crane Figures 47 (Class 150) or Figures 33 (Class 300), Powell Figure 1503 (Class 150) or Figure 3003 (Class 300), Lunkenheimer Figure 1512 (Class 150) or Figure 3012 (Class 300)

C. Globe Valves – HVAC Systems (Non-Potable Water Systems):
   1. **GLV-01 -** Bronze 2" and Under (Threaded End Connection):
      a. Valves shall be suitable for 150 SWP/300 WOG/200 SWP/400 WOG or 300 SWP/ 1000WOG, solid wedge disc, rising stem, union bonnet, threaded connections.
      b. Body and Bonnet: Bronze ASTM B62.
      c. Stem: Bronze ASTM B61, ASTM B62, ASTM B371.
      d. Seat: Stainless steel ASTM A276.
      e. Wedge Disc: Stainless steel ASTM A276.

f. Packing: Graphite.
g. Handwheel: Malleable iron.
h. Acceptable Makes: Milwaukee 591A (150 SWP) or 593A (300 SWP), Hammond IB434 (Class 200) or IB444 (Class 300), Crane 14 ½ P (Class 150) or 382P (Class 300), Nibco T-256-AP (Class 200) or T-276-AP (Class 300), Jenkins Figure 2032J (Class 150) or Figure 592J (Class 300).

2. **GLV-02 -** Cast Iron 2 ½" and Larger (Flanged End Connection):
   a. Valves shall be Class 125 or Class 250, bolted bonnet, outside screw and yoke, rising stem.
   b. Body and Bonnet: Cast iron ASTM A126, Class B.
   c. Stem: Brass ASTM B16 or Bronze ASTM B584.
   d. Seat: Brass ASTM B62, ASTM B61.
   e. Disc: Cast iron ASTM A126, Class B, or Bronze ASTM B62, ASTM B584.
   f. Packing: Graphite.
   g. Handwheel: Malleable or ductile iron.
   h. Acceptable Makes: Milwaukee F-2981A (Class 125) or F-2983-M (Class 250), Crane 351 (Class 125) or 21E (Class 250), Powell Figure 241 (Class 125), Lunkenheimer Figure 1123 IBBM (Class 125), Jenkins Figure 2342J (Class 125 or Figure 162J (Class 250), Nibco F-718-B (Class 125) or F-768-B (Class 250).

3. **GLV-03 -** Cast Steel 2 ½" and Larger (Flanged End Connection):
   a. Valves shall be Class 150 or Class 300, bolted bonnet, outside screw and yoke, rising stem.
   b. Body and Bonnet: Cast steel ASTM A216 WCB.
   c. Stem: Stainless steel ASTM 410 or ASTM 182.
   d. Seat: Carbon Steel ASTM A105+Co-Cr-W
   e. Disc: Cast steel ASTM A105/B216 WCB+13Cr HF.
   f. Packing: Graphite.
   g. Handwheel: Malleable or ductile iron.
   h. Acceptable Makes: Milwaukee 1560CB2 (Class 150) or 3060CB2 (Class 300), Crane Figures 143 (Class 150) or Figures 151 (Class 300), Powell Figure 1531 (Class 150) or Figure 3031 (Class 300), Lunkenheimer Figure 1532 (Class 150) or Figure 3032 (Class 300).

D. Swing Check Valves – HVAC Systems (Non-Potable Water Systems):
   1. **CV-01 -** Bronze 2" and Under (Threaded and Soldered End Connections):
      a. Valves shall be suitable for 125 SWP/200WOG, 150 SWP/300 WOG or 300 SWP/ 1000WOG, renewable disc, T-Pattern or Y-Pattern.
      b. Body and Cap: Bronze ASTM B62.
      c. Lever: Stainless steel or brass.
      d. Disc: Bronze ASTM B16, ASTM B453, or ASTM B61.

e. Acceptable Makes: Milwaukee 509/1509 (Class 125), 515/1515 (Class 150) or 507 (Class 300), Hammond IB904//IB912 (Class 125), IB515Y (Class 150) or IB949 (Class 300), Crane 37/ (Class 125), 137 (Class 150) or 36E (Class 300), Nibco T-413/S-413 (Class 125), T-433/S-433 (Class 150) or T-473 (Class 300), Apollo 161T (Class 125), 164T (Class 150).

2. **CV-02 -** Stainless Steel 1½" and Under (Threaded and Butt Welded End Connections):
   a. Valves shall be suitable for Class 600, renewable disc, T-Pattern.
   b. Body and Cover: Stainless steel ASTM A351 Grade CF8M.
   c. Hinge: Stainless steel ASTM A351 Grade CF8M.
   d. Disc: Stainless steel ASTM A351 Grade CF8M.
   e. Acceptable Makes: Aloyco Figure 4370/Figure 4374 (Class 600), Velan Figure 2114C-14SX (Class 600).

3. **CV-03 -** Cast Iron 2 ½" and Larger (Flanged End Connection):
   a. Valves shall be Class 125 or Class 250, bolted cap.
   b. Body and Bonnet: Cast iron ASTM A126, Class B.
   c. Seat Ring: Bronze ASTM B62
   d. Disc: Cast iron ASTM A126, Class B or cast bronze ASTM B62
   e. Hinge: Ductile iron ASTM A536 or cast bronze ASTM B62.
   f. Acceptable Makes: Milwaukee F-2974A (Class 125) or F-2970-M (Class 250), Crane 373 (Class 125) or 39E (Class 250), Powell Figure 559 (Class 125), Lunkenheimer Figure 1790 IBBM (Class 125), Nibco F-918-B (Class 125) or F-968-B (Class 250).

4. **CV-04 -** Cast Steel 2 ½" and Larger (Flanged End Connection):
   a. Valves shall be Class 150 or Class 300, bolted cap, flange connection.
   b. Body and Bonnet: Cast steel ASTM A216 WCB.
   c. Seat Ring: Carbon Steel ASTM A105+Co-Cr-W
   d. Disc: Cast steel ASTM B216 WCB+13Cr.
   e. Hinge: Cast Steel ASTM A216 WCB.
   f. Acceptable Makes: Milwaukee 1570CB2 (Class 150) or 3070CB2 (Class 300), Crane Figures 147 (Class 150) or Figures 159 (Class 300), Powell Figure 1561 (Class 150) or Figure 3061 (Class 300), Lunkenheimer Figure 1572-C/1573-C (Class 150) or Figure 3072-C/3073-C (Class 300).

5. **CV-05 -** Stainless Steel 2" and Above (Flanged End Connection):
   a. Valves shall be suitable for Class 150 or Class 300, renewable disc, T-Pattern.
   b. Body and Cover: Stainless steel ASTM A351 Grade CF8M.
   c. Hinge: Stainless steel ASTM A351 Grade CF8M.
   d. Disc: Stainless steel ASTM A351 Grade CF8M.
   e. Acceptable Makes: Aloyco Figure 377 (Class 150) or Figure 2377 (Class 300), Velan Figure 0114C-13SX (Class 150) or Figure 1114C-13SX (Class 300).

6. **CV-06 -** Grooved Type 2 ½" and Larger: Designer Note – Primarily for non-critical duty. Verify use of grooved check valves with client prior to permitting on project and be specific on where allowed.
   a. Valves shall be rated for 300 psi CWP (2½" to 12") and 230 psi CWP (14" to 24")
   b. Body: Ductile iron conforming to ASTM A536, Grade 65-45-12.
   c. Seat: EPDM (rated for minimum of 230°).
   d. Disc: Stainless steel with elastomer seal or ductile iron conforming to ASTMA536, Grade 65-45-12.
   e. Shaft Packing: EPDM.
   f. Spring and Shaft: Series 300 stainless steel.
   g. Acceptable Makes: Victaulic Series 716 (2½" to 12") and Series W715 (14" to 24"), Gruvlok Series7800 (2½" to 12") and Figure CV890 (14" to 24").

E. Silent Check Valves – HVAC Systems (Non-Potable Water Systems):
1. **SCV-01** - Bronze 1½" and Under (Threaded End Connection):
   a. Valves shall be suitable for 400 psi at 150°F, globe style, two piece design, center guided disc.
   b. Body and Cap: Bronze ASTM B62 or ASTM B585.
   c. Guide Pin: Stainless steel
   d. Seat of Seal: EPDM A240 Type 304/ASTM A276 Type 410 (Class 300).
   e. Spring: Stainless steel.
   f. Acceptable Makes: Mueller 303, Apollo 61-500.

2. **SCV-02** - Cast Steel 2" and Larger (Flanged End Connection):
   a. Valves shall be Class 150 (285 psi at 100°F) or Class 300 (740 psi at 100°F), globe body design, guided disc.
   b. Body and Bonnet: Cast steel ASTM A216 WCB.
   c. Spring: Stainless steel ASTM 182, Grade F-316.
   d. Seat: Stainless steel ASTM 351, Grade CF8M.
   e. Disc: Stainless steel ASTM 351, Grade CF8M.
   f. Acceptable Makes: Mueller 105MDT (Class 150) or 109MDT (Class 300), Keckley Style CG (Class 150 and Class 300), Dezurik CSC 600A (Class 150 and Class 300).

F. Non-Return/Stop Check Valve:

1. **NRCV-01 -** Cast Iron 2½" to 10" (Flanged End Connection):
   a. Valves shall be Class 250, bolted bonnet, "Y" pattern, outside screw and yoke, rising stem.
   b. Body and Bonnet: Cast iron ASTM A126, Class B or ASTM 536.
   c. Stem: Brass ASTM B16 alloy C36000 or stainless steel Type 410.
   d. Seat: Brass ASTM B62 or copper alloy ASTM B584 alloy C84400.
   e. Disc: Cast iron ASTM A126, Class B, or ductile iron ASTM A536.
   f. Packing: Graphite.
   g. Handwheel: Cast iron ASTM A126, Grade B..

h. Acceptable Makes: Crane 28E, Jenkins Figure 541J, Nibco F-869-B.

G. Knife Type Gate Valve:

1. **KGV-01 -** Cast Steel 1" to 2" (Flanged End Connection):
   a. Valves shall be Class 300, 605 psi WSP at 500°F.
   b. Body and Cover: Cast steel ASTM A216 WCC.
   c. Stem: Stainless steel ASTM 410.
   d. Seat: Brass ASTM B62 or copper alloy ASTM B584 alloy C84400.
   e. Disc: Stainless steel Type 440C.
   f. Packing: Graphite.
   g. Quick Opening Lever: Cast steel ASTM A216 WCC.
   h. Slow Opening Gear Operator: bronze body, stainless steel drive screw, bronze worm gear, ductile iron hand wheel, bronze bearing.
   i. Acceptable Makes: United Brass Works Model 625 (quick opening) and Model 725 (slow opening), Everlasting Figure B-6661 (quick opening) and Figure 6671 (slow opening).

H. Ball Valves: Domestic - Potable Water:
1. **BV-01 -** Bronze 2" and Under (Threaded and Soldered End Connections):
   a. Valve shall be suitable for 600 psi WOG non-shock, 150 psi WSP full port with blowout proof stem.
   b. Lead Free.
   c. Body: Bronze.
   d. Stem: Type 316 Stainless Steel ASTM A276.
   e. Ball: Type 316 Stainless Steel ASTM A276.
   f. Seats and Seals Stem Packing and Thrust Washer: PTFE.
   g. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.
   h. Adjustable stem packing.
   i. Acceptable Makes: Watts LFB6080-G2-SS (threaded) and LFB6081-G2-SS (solder), Apollo 77CLF-140-C (threaded) and 77CLF-240-C (solder), Milwaukee UPBA400S (threaded) and UPBA450S (solder), Nibco T-585-66-LF (threaded) and S-585-66-LF (solder), Hammond UP8303A (threaded) and UP8313A (solder).

2. **BV-02 -** Bronze or Brass 2" and Under (Pressure Sealed Fit):
   a. Valve shall be suitable for 200 psig at 250°F, full port with blowout proof stem.
   b. Stem: Type 316 Stainless Steel ASTM A276.
   c. Ball: Type 316 Stainless Steel ASTM A276.
   d. Seats and Seals Stem Packing and Thrust Washer: PTFE.
   e. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.

f. Adjustable stem packing.
g. Acceptable Makes: Watts LFB6080-G2-SS (threaded valve with press end adapters), Milwaukee UPBA-480S, Apollo 77WLF-140, Nibco PC-585HP-66-LF, Hammond UP8303A P2 (threaded valve with press end adapters)

I. Ball Valves – HVAC Systems (Non-Potable Water Systems):

1. **BV-03 -** Bronze 2" and under (Threaded and Soldered End Connections)
   a. Valve shall be suitable for 600 psi WOG non-shock, 150 psi WSP full port with blowout proof stem.
   b. Body: Bronze.
   c. Stem: 316 Stainless Steel.
   d. Ball: 316 Stainless Steel.
   e. Seats and Seals Stem Packing and Thrust Washer: PTFE.
   f. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.
   g. Adjustable stem packing.
   h. Acceptable Makes: Watts LFB6080-G2-SS (threaded) and LFB6081-G2-SS (solder), Apollo 77C-140 (threaded) and 77C-240 (solder), Milwaukee BA400S (threaded) and BA450S (solder), Nibco T-585-66 (threaded) and S-585-66 (solder), Hammond 8303A (threaded) and 8313A (solder).

2. **BV-04 -** Bronze or Brass 2" and under (Pressure Sealed Fit):
   a. Valve shall be suitable for 200 psig at 250°F, full port with blowout proof stem.
   b. Body: Bronze or brass.
   c. Stem: Type 316 Stainless Steel ASTM A276.
   d. Ball: Type 316 Stainless Steel ASTM A276.
   e. Seats and Seals Stem Packing and Thrust Washer: PTFE.
   f. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.
   g. Adjustable stem packing.
   h. Acceptable Makes: Watts LFB6080-G2-SS (threaded valve with press end adapters), Milwaukee BA-480S, Apollo 77W-140, Nibco PC-585HP-66, Hammond 8303A P2 (threaded valve with press end adapters).

3. **BV-05 -** Carbon Steel 2" and under (Threaded End Connection):
   a. Valve shall be suitable for minimum of 1500 psig CWP, 150 psig saturated steam, full port or standard port with blowout proof stem.
   b. Body: Two-piece construction, Carbon steel ASTM A216.
   c. Stem: ASTM A276 Type 316 Stainless Steel.
   d. Ball: ASTM A276 316 Stainless Steel.
   e. Seats and Seals Stem Packing and Thrust Washer: PTFE or RPTFE.

f. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.
g. Adjustable stem packing.
h. Acceptable Makes: Apollo 72-100, Nibco TC-580-CS-R-66, Milwaukee 20CS.

4. **BV-06 -** Carbon Steel 2" and under (Threaded and Socket Welded End Connections):
   a. Valve shall be suitable for minimum of 1000 psig CWP, 150 psig saturated steam, full port with blowout proof stem.
   b. Body: Three-piece construction, Carbon steel ASTM A216.
   c. Stem: ASTM A276 Type 316 Stainless Steel.
   d. Ball: ASTM A276 316 Stainless Steel.
   e. Seats and Seals Stem Packing and Thrust Washer: PTFE or RPTFE.
   f. Handle: Zinc-plated carbon steel or stainless steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.
   g. Adjustable stem packing.
   h. Acceptable Makes: Apollo 83A-140 (threaded) or 83A-240 (socket weld), Nibco TM-595-CS-R-66 (threaded) or KM-595-CS-R-66 (socket weld), Milwaukee 30CS (threaded or socket weld).

5. **BV-07 -** Stainless Steel 2" and under (Threaded and Socket Welded End Connection):
   a. Valve shall be suitable for minimum of 1000 psig CWP, 150 psig saturated steam, full port with blowout proof stem.
   b. Body: Three-piece construction, Type CF8M stainless steel ASTM A351.
   c. Ball: 316 SS.
   d. Stem: 316 SS.
   e. Seats and Seals Stem Packing and Thrust Washer: Glass reinforced or carbon impregnated RPTFE.
   f. Body Gasket: RPTFE.
   g. Actuator: - 300 stainless steel lever, with handle extension for insulation. Provide locking lever.
   h. Acceptable Makes: Apollo 85A-100 (threaded) or 85A200 (socket weld), Series, Milwaukee 30SS (threaded or socket weld), Nibco TM-595-S6-R-66 (threaded) or KM-595-S6-R-66 (socket weld)

6. **BV-08 -** Carbon Steel 2 1/2" to 12" (Flanged End Connection):
   a. Valve shall be Class 150 designed for 285 psi WOG non-shock, 150 psi at 365°F saturated steam or Class 300 designed for 740 psi WOG non-shock, full port, split body, raised face flange, with blowout proof stem conforming to ANSI/ASME B16.34, ANSI/ASME B16.10, ANSI/ASME B16.5, MSS SP-25 and MSS SP-72

b. Body: ASTM A216 GR WCB Carbon Steal.
c. Stem: Stainless steel Type 316 ASTM A276.
d. Ball: Stainless steel Type 316 ASTM A276.
e. Seats and Seals Stem Packing and Thrust Washer: PTFE/RPTFE.
f. Handle: Lever for valves below 6” and gear operators for 6” through 12”.
g. Adjustable stem packing (graphite).
h. Acceptable Makes: Milwaukee F20CS, Nibco F-515-CS-F-66-FS (Class 150) or F-535-CS-F-66-FS (Class 300), Jamesbury 9150 (Class 150) or 9300 (Class 300), Apollo 87A-200 Series (Class 150) or 87A-900 (Class 300).

7. **BV-09 -** Stainless Steel 2 ½” to 12” (Flanged End Connections):
a. Valve shall be Class 150 designed for 275 psi WOG non-shock, 150 psi at 365°F saturated steam or Class 300 designed for 720 psi WOG non-shock, 250 psi at 406 °F saturated steam, full port, split body, raised face flange, with blowout proof stem conforming to ANSI/ASME B16.34, ANSI/ASME B16.10, ANSI/ASME B16.5, MSS SP-25 and MSS SP-72
b. Body: Type CF8M stainless steel ASTM A351.
c. Ball: Stainless steel Type 316 ASTM A276.
d. Stem: Stainless steel Type 316 ASTM A276.
e. Seat: Glass reinforced or carbon impregnated RPTFE for Class 150. Multi-Fil PTFE for Class 300.
f. Packing: Glass reinforced or carbon impregnated PTFE.
g. Handle: Lever for valves below 6” and gear operators for 6” through 12”.
h. Acceptable Makes: Apollo 87A-200 Series (Class 150) or 87A-900 (Class 300), Milwaukee F20SS Class 150 or Class 300), Nibco F-515-S6-F-66-FS (Class 150) or F-535-S6-F-66-FS (Class 300), Jamesbury 9150 (Class 150) or 9300 (Class 300).

8. **BV-10 -** Carbon Steel 1” (DN 25) to 16” (DN 500) (Butt Welded End Connection):
a. Working pressure 232 psig at 248°F, one piece, ASTM A53 Grade B steel, reduced bore, Class 150, Schedule 40 1” to 8’, Standard weight 8” and above.
b. Ball and Stem: Stainless steel.
c. Seat: Teflon,
d. Provide lever actuator for valves 6" and smaller and gear operated actuator with hand wheel for valves 8" and larger. And chain operator for valves above finish floor.
e. Acceptable Make: Vexve.

9. **BV-11 –** Polyvinyl Chloride (PVC Sch. 40) or Chlorinated Polyvinyl Chloride (CPVC Sch. 80) 2" and Under (Threaded, Sock Welded or Flanged End Connections):
   a. Valve shall be suitable for 250 psi WOG non-shock water service at 70°F, full port, true union, Flanged shall be pressure rated for 150 psi at 70°F.
   b. Body: Polyvinyl Chloride (PVC Type 1, Grade 1 ASTM D1784, Cell Classification 12454) or Chlorinated Polyvinyl Chloride (CPVC ASTM D1784, Cell Classification 23447).
   c. Stem: Polyvinyl Chloride (PVC) or Chlorinated Polyvinyl Chloride (CPVC).
   d. Ball: Polyvinyl Chloride (PVC) or Chlorinated Polyvinyl Chloride (CPVC).
   e. Seats Polyvinyl Chloride (PVC), Chlorinated Polyvinyl Chloride (CPVC), Teflon or PTFE.
   f. Seal: EPDM
   g. Handle: Orange PVC or ABS
   h. Acceptable Makes: Nibco Chemtrol Style U45TB-E (PVC socket weld or threaded), F45TB-E (PVC flanged), U51TB-E (CPVC socket weld or threaded) or F51TB-E (CPVC flanged), Hayward Series TBH.

J. Valves for Gauges and Instruments – HVAC Systems (Non-Potable Water Systems):
   1. Ball valve ½" in size meeting the requirements above for the services specified.

K. Butterfly Valves – HVAC Systems (Non-Potable Water Systems):
   1. **BFV-01 -** Standard Performance 2 ½" and Larger (Lugged Type Connection):
      a. Valves shall be rated at 200 psi CWP (2 ½" to 12") and 150 psi CWP (14" to 24"), ASNI 125/200 flange pattern, extended neck, integral mounting pad for actuator, fully rated for dead end bidirectional service.
      b. Body: Ductile Iron ASTM A536.
      c. Seat: EPDM ASTM D20000
      d. Shaft: Type 316 stainless steel or Type 416 stainless steel.
      e. Disc: Type 316 stainless steel ASTM A351.
      f. Bushing: Duralon or bronze
      g. Handle: Lever for valves below 6" and gear operators for 6" and larger.
      h. Acceptable Makes: Watts DBF, Crane 44, Milwaukee Series ML, Nibco LD 2022, Jenkins Series 225, Keystone Figure 322.

   2. **BFV-02 -** High Performance 2 ½" and Larger (Lugged Type Connection):
      a. Valves shall be Class 150 or Class 300, bi-direction bubble tight shutoff, extended neck, double offset disc, integral mounting pad for actuator,

b. Body: Carbon Steel ASTM A216 WCB.
c. Seat: RTFE.
d. Shaft: 17-4 PH ASTM A564 Condition H1075 or H1100.
e. Disc: Type 316 stainless steel ASTM A351 CF8M.
f. Shaft Packing: PTFE
g. Shaft Bearing: Type 316 stainless steel /nitride
h. Handle: Lever for valves below 6" and gear operators for 6" and larger.
i. Acceptable Makes: Keystone K-LOK Figure 362 (Class 150) or Figure 372 (Class 300), Jamesbury Series 815 (Class 150) or Series 830 (Class 300), Milwaukee Series HP (Class 150 or Class 300), Nibco LD S-6822 (Class 150) or LCS-7822 (Class 300).

L. Natural Gas and Fuel Oil Valves:

1. **FBV-01 -** Bronze 1" and under (Threaded End Connection)
   a. Valve shall be suitable for 600 psi CWP, 2-piece, full port ball valve with blowout proof stem, U.L. Listed
   b. Body: Bronze ASTM B584 or Brass ASTM B283.
   c. Stem: Brass ASTM B16, silicon bronze ASTM B371 alloy C69430 or ASTM B99 alloy C65100.
   d. Ball: Chrome plated brass ASTM B16 alloy C36000, ASTM B125 alloy C37700 or ASTMB282 alloy C37700.
   e. Seats and Seals Stem Packing and Thrust Washer: PTFE and RPTFE.
   f. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.
   g. Adjustable stem packing.
   h. Acceptable Makes: Apollo 77G-UL, Nibco T-585-70-UL, Watts Series FBV-3C-UL/FM.

2. **FBV-02 -** Cast Iron 1½" to 12" (Flanged End Connection):
   a. Valves shall be Class 125, U.L Listed 200 psi at -20°F to 125°F, lubricated plug valve, U.L. Listed
   b. Body and Bonnet: Cast iron ASTM A126, Class B.
   c. Stem: Stainless steel.
   d. Plug: Cast iron ASTM B126, Class B.
   e. Stem Seal: Buna-N.
   f. Wrench: provide wrench for valves below 6" and gear operators for 6" and larger.
   g. Acceptable Makes: Nordstrom (Flowserve) Figure 143, Homestead Figure 602, Resun (R&M Energy Systems) Figure R-1431.

M. Hose Threaded Drain and Manual Vent Valve (Non-Potable Heating Hot Water, Chilled Water, Heating Glycol and Cooling Glycol Systems Operating at a maximum pressure of 125 psi and temperature of 200°F or Below):
1. **DBV-01** - Bronze ½" and ¾" (Threaded and Soldered End Connections)
   a. Valve shall be suitable for 400 psi CWP, 2-piece, full port ball valve with blowout proof stem, ¾" hose connection.
   b. Body: Bronze ASTM B584 or Brass ASTM B283.
   c. Stem: Brass ASTM B16, silicon bronze ASTM B371 alloy C69430 or ASTM B99 alloy C65100.
   d. Ball: Chrome plated brass ASTM B16 alloy C36000, ASTM B125 alloy C37700 or ASTMB282 alloy C37700.
   e. Seats and Seals Stem Packing and Thrust Washer: PTFE and RPTFE.
   f. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.
   g. Adjustable stem packing.
   h. Acceptable Makes: Watts LFFBV-3C-CC (threaded) and LFFBVS-3C-CC (solder), Apollo 70-100-HC (threaded) and 70-200-HC (solder), Milwaukee BA100H (threaded) and BA150H (solder), Nibco T-585-70-HC (threaded) and S-585-70-HC (solder), Hammond 8501H (threaded) and 8511H (solder).

N. Fusible Link Fuel Oil Valves:
1. **FLV-01** – ½" and ¾" Globe Type and 1" Ball Type:
   a. Body: Bronze.
   b. Hand Wheel: Malleable iron.
   c. Quick closing, spring-loaded
   d. Thermally-actuated replaceable fusible element rated at 165°F to close.
   e. Designed for manual open/close for isolation of fuel oil.
   f. U.L. Listed for fuel oil.
   g. Designed to meet NFPA 31 standard.
   h. Acceptable Make: Preferred Utilities Catalog No. 13362 (½" in size) Catalog No. 13081 (¾" in size) and Catalog No. 13082 (1" in size).

O. Self-Regulated Flow Control Valves:
1. Miniature threaded iron valves shall consist of ductile iron (A445-70, Class 60-40-18) body and stainless steel flow control cartridge assembly; shall be rated at 450 PSI/250°F; shall have female NPT end connections; shall be supplied with dual pressure or pressure/temperature test valves for verifying accuracy of flow performance for all sizes; shall be permanently marked to show direction of flow; shall have body tag to indicate flow rate, model number and PSIG control range; shall be available in ½", ¾", 1", 1-1/4" and 1-1/2" sizes, with flow rates from 0.33 GPM to 34.0 GPM.

2. Threaded flange valves shall consist of grey iron (ASTM A126-61T, Class 30) body and stainless steel flow control cartridge assembly; shall be rated at 300 PSI/275°F; shall have female NPT threaded flange end connections; shall be supplied with plated steel studs and nuts; shall be supplied with dual pressure or pressure/temperature test valves for verifying accuracy of flow performance for all sizes; shall be permanently marked to show direction of flow; shall have body tag to indicate model number, flow rate and PSID control range; shall be available in 1-1/2", 2" and 2-1/2" sizes, with flow rates from 14.0 GPM to 150.0 GPM. Valves shall be based on pressure rating of 2-32 psig at 20 GPM.
3. Upstream of each flow control valve, provide a Y-type strainer. Unit shall have threaded configuration shall be made of bronze (ASTM B584) with a brass cap; shall be rated at 300 PSI; shall be available in sizes ranging from ½" through 2". Strainer screen shall be stainless steel, ported with 0.055" diameter, 1400 micron holes and easily accessible for cleaning; shall be provided with blowdown option.
4. Acceptable Make: Griswold.

P. Balance Valve:
1. **BBV-01** - Ball Type Balancing Valves:
   a. Balancing and flow meter stations suitable for use on heating and cooling systems. Constructed for 125 psi at 250°F.
   b. Maximum Pressure Drop 5.0 Ft. or less.
   c. Quarter turn ball valve operation with calibrated scale for indication of balanced position.
   d. Calibrated balance valve with provisions for connecting a portable differential pressure meter suitable as a service valve. Meter connections to have built-in check valves. An integral pointer shall register degree of valve openings. Valve shall have internal seals. Install device in pipe line per manufacturer's instructions for upstream and downstream distances.
   e. Balance valve size shall be based upon gpm range rather than pipe size. Select flow balancers such that the range of pipe flow resides in the middle 50% of the manufacturer's recommended operating range for the device.
   f. Acceptable Makes: Bell & Gossett, Taco

2. **GBV-01** - Globe Type Balancing Valve:
   a. Balancing valve and flow meter stations suitable for use on heating and cooling systems. Constructed for 125 psi at 250°F.
   b. Maximum Pressure Drop 5.0 Ft. or less.
   c. Calibrated balance valve with provisions for connecting a portable differential pressure meter. Meter connections to have built-in check valves.
   d. Multi-turn handle for precision adjustment.

e. Balance valve size shall be based upon gpm range rather than pipe size. Select flow balancers such that the range of pipe flow resides in the middle 50% of the manufacturer's recommended operating range for the device.
f. Operating temperature range -4 – 300°F. Suitable for 300psi at 150°F.
g. Brass: Solder or threaded body to match piping system up to 2".
h. Cast Iron: Grooved or flanged bodies to match piping system 2 ½ - 12".
i. Acceptable Makes: Armstrong CBV, Tour & Anderson 780 Series

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:
1. Provide valves of type called for and where required to service equipment.
2. Provide at major building and system sections.
3. Provide chain wheels, guides, and chain loops for valves, where called for or in Mechanical Rooms where valves are mounted higher than 8'-0" AFF.
4. Isolating valves for individual fan convectors, room units, terminal units, or other similar apparatus may be inside cabinet or at connection to branch main where accessible.
5. Locate valves with stems at or above horizontal positions and swing check valves in horizontal position only.
6. Provide hose threaded drain valves at all piping system low points, strainers, equipment, and as called for heating hot water systems, chilled water systems, glycol heating systems and glycol cooling systems operating at or below 125 psi and 200°F. Drain or blowdown valves for water and glycol systems operating above 125 psi and 200°F, and steam systems shall be provided with valves specified in Exhibit 'A'. Provide Cap or plug at valve discharge.

B. Install self-regulating flow control valves as recommended by manufacturer. All flow control valves shall have strainer upstream of valve. Strainer shall be as specified in part 2 – Self Regulating Flow Control Valves.

C. Balance Valves:
1. Provide on zone or riser returns, on each hydronic unit and where called for. Meter connection points shall not point downward.
2. On details where a shut-off valve is shown in conjunction with the flow balancer (3" and smaller), if the Armstrong "CBV" or Tour & Anderson "ST" type is used, the additional shut-off valve may be deleted.
3. Install device in pipe line per manufacturer's instructions for upstream and downstream distances.

3.2 VALVE SELECTION

A. Provide valve types for the specific services as specified in Exhibit 'A'. Valve changes shall be made only as reviewed by Owner's Representative.

EXHIBIT - 'A' - VALVE TYPE (HVAC)
Notes are at the end of Exhibit 'A'

Service	Gate	Globe	Check	Ball	Butterfly	Plug	Balancing	Special Purpose, Drains and Manual Air Vents	Notes
Hot water heating, glycol heating operating at 125 psi or below			CV-01 Class 125 and CV-03 Class 125	BV-03,	BFV-01		GBV-01,	DBV-01	Note 1, 3 and 4
Domestic water				BV-01					
Make-up water and soft water			CV-01 Class 125	BV-01					
Water treatment (max. 100 psi wp)				BV-11 or BV-07					Note 6

NOTES FOR EXHIBIT "A":

NOTE 1: Hose threaded drain and vent valves DBV-01 shall only be used on heating hot water, chilled water, glycol heating and glycol cooling systems operating pressure at or below 125 psi and temperature at or below 200°F. Systems operating pressure above 125 psi and operating temperature above 200°F, or sizes above ¾" shall be provided with the listed service valve with the open end of the valve provided with a threaded plug or cap.

NOTE 2: The use of butterfly valves is not allowed.

NOTE 3: Where options are indicated for the valve connection types (threaded, soldered or welded) in this specification section, refer to Specification Section 232000 for the specific requirement for the connection type for the intended service.

NOTE 4: Silent check valves SCV-01 or SCV-02 shall be used at pump discharges.

NOTE 5: If Butterfly valves are being utilized on steam systems, all sizes shall be provided with gear operators.

NOTE 6: Provide valve of the same material as adjoining piping. Refer to Specification Section 232000. PVC and CPVC valves must have flame spread rating of 25 or less and a smoke developed rating of 50 or less.

NOTE 8: The non-return/stop check valve shall be the first isolation valve on a steam boiler operating above 15 psi. The second isolation valve shall be a gate valve with rising stem. Provide a minimum 1" blowoff valve between the non-return/stop check valve and second isolation valve.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

B. This Contractor shall reference the entirety of Divisions 22 and 23 as they apply to this work.

C. Refer to specification Section 019113 for commissioning requirements related to this project.

1.2 SUMMARY

A. Provide labor, materials, equipment and services to perform operations required for testing, adjusting, and balancing HVAC systems to produce design objectives, including, but not limited to the following:
   1. Pre-demolition testing of existing systems.
   2. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
   3. Adjusting total HVAC systems to provide indicated quantities.
   4. Measuring electrical performance of HVAC equipment.
   5. Setting quantitative performance of HVAC equipment.
   6. Verifying that automatic control devices are functioning properly.
   7. Calibration of flow (air and water) sensors provided by the 230923 contractor
   8. Additional balancing procedures described within the 230993 sequences of operation.
   9. Reporting results of the activities and procedures specified in this Section.

1.3 SUBMITTALS

A. Quality-Assurance Submittals: Submit copies of evidence that the Testing, Adjusting, and Balancing contractor and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" article below.

B. Sample Report Forms: Submit required number of sets of sample testing, adjusting, and balancing report forms.

C. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in "Preparation" article below. Include a complete set of report forms intended for use on this Project with each copy. Included in this plan shall be a thorough description of means and methods pertaining to maintenance of systems balance in detailed coordination with all phasing requirements for this project

D. Certified Testing, Adjusting, and Balancing Reports: Submit required number of copies of reports prepared, as specified in the Submission of Certified Balance Reports Section, on approved forms certified by the registered contractor; include registration number.

E. Warranty: Submit required number of copies of the warranty specified in the "Warranty" Article below.

1.4 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing contractor certified/registered by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Contractor shall have performed as a member in good standing with recognized procedures for no less than five (5) years including projects of the magnitude and design of this project. Balancing Contractor must be approved by the Engineer. See Section 1.3.

B. Testing, Adjusting, and Balancing Conference: Meet with the Engineer's representatives after approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation in the conference of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls contractor, and other support personnel. Provide 30 days advance notice of scheduled meeting time and location.
   1. Agenda Items shall include at least the following:
      a. Submittal distribution requirements.
      b. Contract Documents examination report.
      c. Testing, adjusting, and balancing plan, including pre-demo work.
      d. Work schedule and Project site access requirements.
      e. Coordination and cooperation of trades and subcontractors.
      f. Coordination of documentation and communication flow
      g. Integration of commissioning functions into TAB Plan.

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.

2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC or NEBB's Standards for Testing, Adjusting, and Balancing, or approved equal.

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC or NEBB national standards.

F. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.5 PROJECT CONDITIONS

A. The Owner may occupy all or part of the site and existing building during the entire testing, adjusting, and balancing period as required. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations. It is the intent to have all possible balancing procedures complete prior to any Owner occupancy. Contractor shall perform the necessary work in an expedient and accurate manner which best serves the need of verifying proper installation and operation of the installed systems and allowing prompt Owner occupancy.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls contractor, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Coordinate TAB activities with temperature control system setup and calibration

1.7 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by this Contractor under requirements of the Contract Documents.

B. NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing contractor fails to comply with the Contract Documents. Guarantee shall include the following provisions:
1. The certified contractor has tested and balanced systems according to the Contract Documents.

2. Systems are balanced to optimum performance capabilities within design and installation limits.
3. Copy of the performance guarantee shall be included in each final certified air balance report.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide all required instrumentation and tools, including, but not limited to ladders, recording meters, gauges, thermometers, voltmeters, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers and tachometers. Instruments used shall be accurately calibrated as per AABC or NEBB requirements

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are located as required in the Contract Documents and installed per manufacturer's requirements. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operations. All deficiencies shall be reported to the Engineer in writing within 60 days from award of contract. Failure to provide notice within this time period may require that any devices required for proper balance of these systems be installed at the cost of this contractor.

B. Examine approved submittal data of all HVAC systems and equipment.

C. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions and/or cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. 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 this data with the design data and installed conditions.

D. Examine system and equipment installations to verify that they are complete and ready for testing.

E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing. Any noted deficiencies should be reported immediately to the Engineer for further action.

G. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

H. Examine strainers for clean screens, removal of startup screens and proper perforations.

I. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

K. Examine equipment for installation and for properly operating safety interlocks and controls.

L. Examine automatic temperature control system components to verify the following:
   1. Dampers, valves, and other controlled devices operate by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multi-zone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves are properly connected.
   5. Temperature sensors are located to avoid adverse effects of sunlight, drafts, and cold walls. Sensors are located to sense only the intended conditions.
   6. Sequence of operation for control modes is according to the Contract Documents.
   7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
   8. Interlocked systems are operating.
   9. Changeover from heating to cooling mode occurs according to design values.

M. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures immediately to the Engineer for further action.

3.2 PREPARATION

A. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete. Equipment rotation has been checked.
   2. Hydronic systems are filled, clean, strainers cleaned, startup screens removed and system free of air.
   3. Automatic temperature control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices has been provided.
   8. Filters are clean and in place, including pre-filters and final filters where applicable.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

A. All systems shall be tested and verified to be in compliance with the performance characteristics contained in the contract documents. All testing shall be performed in compliance with the requirements of NEBB or AABC Standards for Testing and Balancing, or within the standards described in this section. The more stringent standard shall apply.

B. Adjusting and balancing shall be accomplished as soon as the systems are completed to the extent required to allow the work to proceed, and before the Owner takes possession. Verify that the system is properly vented, cleaned, and strainers are cleared with startup mesh removed prior to balance.

C. Cut insulation, ducts, and pipes for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the Insulation Specifications for this Project.

D. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan speed control levers, and similar controls and devices, indicating final settings.

E. Adjusting and balancing shall be accomplished under appropriate outdoor temperature conditions. All outdoor conditions (Db, Wb, and a description of the weather conditions) at the time of testing shall be documented in the report.

F. Identify flow balancers and dampers in systems which cannot be manipulated to satisfy balancing requirements. Return to site after remedial actions are performed to adjust corrected systems.

G. Traverse duct mains to determine total air system delivery quantities after all outlets have been set and, if necessary prior to final adjustment if the system does not meet design requirements. A sum of room CFM's is not acceptable.

H. Balance all existing outlets marked with air quantities on the remodel plans and rebalance any relocated existing equipment or any equipment so noted on the remodel plans or under the remodel work.

3.4 FUNDAMENTAL AIR SYSTEM BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan total volume.
   1. Determine system diversity factors. Prepare plan to simulate system diversity
   2. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
   3. Check the airflow patterns from the outside air louvers and dampers and the return and exhaust air dampers, through the supply fan discharge and mixing dampers.
   4. Locate start-stop and disconnect switches, electric interlocks, and motor starters.
   5. Verify that motor starters are equipped with properly sized thermal protection.
   6. Check dampers for proper position to achieve desired airflow path.
   7. Check for airflow blockages.
   8. Check condensate drains for proper connections and function.
   9. Check for proper sealing of air-handling unit components

B. Air System Balancing Procedures:
   1. The procedures in this article apply to all supply, return, and exhaust air systems. Additional procedures are required for variable air volume systems; these additional procedures are specified in the following articles in this specification.
   2. Adjust fans to deliver total design air flows within the maximum allowable speed (rpm) listed by the fan manufacturer.
   3. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable 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 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.

4. Measure static pressure across each air-handling unit component.
5. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions in the event that adverse resulting conditions occur which make the system unable to achieve design performance levels.
6. Adjust fan speed higher or lower as required to meet as installed conditions. Provide new sheaves as required. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan speed changes.
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 no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.
8. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design air flows within specified tolerances.
    a. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved. Where sufficient space in submains and branch ducts is unavailable for pitot tube traverse measurements, measure air flow at terminal outlets and inlets and calculate the total air flow for that zone.
    b. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design air flows within specified tolerances.
9. Measure terminal outlets and inlets without making adjustments. Measure terminal outlets using a direct reading hood or the outlet manufacturer's written instructions and calculating factors.
10. Adjust terminal outlets and inlets for each space to within +/- 10% of design airflow. Make adjustments using volume dampers rather than the dampers at the air terminals, where available.
    a. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
    b. Adjust patterns of adjustable outlets for proper distribution without drafts.
    c. Where pressure gradients are required between spaces, provide adjustment of supply and return / exhaust air such that the supply vs return / exhaust rate shown on the plan is maintained.
    d. Record final air volume and air flow pattern for each inlet and outlet.

C. Variable Air Volume System Additional Procedures
   1. Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
   2. If fans are direct drive – verify that the maximum Hz on both supply and return ASD's matches the selection point for the fans (for example, 2120rpm with a 1760 rpm motor would be 72 Hz.)
   3. Pressure-Independent, Variable Air Volume Systems – Supply Air: After the fan systems have been adjusted, adjust the variable air volume systems as follows:
      a. Set outside air dampers at minimum; return and relief air dampers at a position that simulates full cooling load.
      b. Perform air terminal TAB per NEBB / AABC procedures. Lock final terminal controller "K factor" into the operating programs for all air terminals.
      c. Select the terminal unit that is most critical to the supply fan airflow and static pressure. Adjust the total system air flow compensating for diversity and determine the necessary duct pressure and enter to the control system. This will be the design or peak static pressure requirement.
      d. For variable volume systems specified to operate with variable pressure control (VVP) – set all air terminals to control to minimum air delivery. Reduce the duct pressure setpoint until at least one terminal damper position is in excess of 80% open. Record and enter this value to the building management system as the minimum reset level for the VVP control strategy.
      e. Using diversity compensation, measure total system airflow by traverse for both supply and return air streams. Adjust to within 5% of design airflow. Compare to the sum of the diffusers / registers and report apparent duct leakage in percentage. Record supply fan apparatus data under peak performance conditions.
      f. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return air ducts and inlets as described for Air Systems.
      g. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply air sensing station to ensure adequate static pressure is maintained at the most critical unit.

3.5 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5%.

B. Verify that systems are prepared for hydronic systems testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open all manual valves for maximum flow.
   2. Check flow control valves for specified sequence of operation and set at design flow.

C. Hydronic System Balancing Procedures:
   1. Set calibrated balancing valves, if installed, at calculated pre-settings.
   2. Measure flow at all stations and adjust, where necessary, to obtain first balance.
      a. System components that have C_V rating or an accurately cataloged flow pressure drop relationship may be used as a flow indicating device.
   3. Measure flow at main balancing station and set main balancing device to achieve flow that is 5% greater than design flow. Where pump selection provides a firm operating point, pump flow may be derived from the pump curve in lieu of the balancing device.
   4. Adjust balancing stations to within specified tolerances of design flow rate as follows:
      a. Determine the balancing station with the highest percentage over design flow.
      b. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
      c. Record settings and mark balancing devices.

3.6 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data as it applies.
   1. Manufacturer, model, frame and serial numbers.
   2. Complete nameplate data.
   3. Efficiency rating if high efficiency motor.
   4. Measured voltage and amperage, each phase
   5. Starter thermal protection element rating.

3.7 HEAT TRANSFER COILS

A. Hydronic: Measure the following data for each coil.
   1. System identification.
   2. Location.
   3. Coil Type and nameplate data
   4. Dry-bulb temperatures of entering and leaving air.
   5. For cooling coils – record entering %RH or wet bulb data.
   6. For primary coils (Air Handlers, etc.) – Record face velocity and air pressure drop.
   7. Record airflow rate

8. Adjust water flow rate as scheduled
9. Adjust bypass water flow on three-way circuits for 50% of total coil water flow scheduled.

3.8 TEMPERATURE CONTROL VERIFICATION

A. Verify that all control devices are calibrated and fully operational.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify free travel and proper operation of control devices such as damper and valve operators.

3.9 TOLERANCES

A. Unless noted to the contrary in other portions of the contract documents, set HVAC system airflow and waterflow rates within the following tolerances.
1. Supply, Return, and Exhaust, Air Inlets and Outlets: +/- 10%, maintaining required pressure balance between adjacent spaces / zones.
2. Fans at +/- 5% of delivery requirements.
3. Water-Flow Rates: +/- 5%.

3.10 FINAL REPORT

A. General: Computer printout in letter quality font, on standard bond paper. Provide 1 hard copy in 3-ring binder, tabulated and divided into sections by tested and balanced systems. Provide PDF copy for project record.

B. A certification sheet in front of binder signed and sealed by the certified testing and balancing agent. All reports shall bear the seal of the certifying agent for the balancing contractor. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: Final report shall consolidate data from all segments of phased project. In addition to the certified field report data, include the following:
1. Fan curves.
2. Pump Curves
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
   1. Title page including:
      a. Name and address of testing, adjusting, and balancing contractor.
      b. Project name.
      c. Project location.
      d. Architect's name and address.
      e. Engineer's name and address.
      f. Contractor's name and address.
      g. Report date

   2. Signature of testing, adjusting, and balancing agent who certifies the report.
   3. Summary of contents, including the following:
      a. Design versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.

   4. Nomenclature sheets for each item of equipment.
   5. Data for terminal units, including manufacturer, type, size, and fittings.
   6. Report shall document all information items requested within this specification section.

E. System Diagrams: On complete set of reproducible contract drawings provide single line sketch of system (designer – one or the other) marked up with terminal unit numbers, room numbers, test locations, register, grill, and diffuser numbers to correlate with test sheet. Include the following:
   1. Quantities of outside, supply, return, and relief/exhaust airflow.
   2. Water flow rates.
   3. Pipe and valve sizes and locations.
   4. Terminal units.
   5. Balancing stations.

F. Fan Test Reports: In addition to other requirements for supply, return, and exhaust fans, include the following:
   1. Fan Data: Include the following:
      a. System identification.
      b. Location.
      c. Make and type.
      d. Model number and size.
      e. Manufacturer's serial number.
      f. Arrangements and class.
      g. Fan and motor sheave make, size in inches, bore, and key size.
      h. Fan and motor sheave dimensions, center-to-center and amount of adjustment in inches.
      i. Number of belts, manufacturer, and size

2. Test Data: Include design and actual values for the following:
   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.
   f. Motor data.

G. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record and report the following data as a minimum:
   1. System and air handling unit number.
   2. Location and zone.
   3. Traverse air temperature in °F.
   4. Duct static pressure in inches wg.
   5. Duct size in inches.
   6. Duct area in sq. ft.
   7. Design airflow rate in cfm.
   8. Design velocity in fpm.
   9. Actual airflow rate in cfm.
   10. Actual average velocity in fpm.

H. Air Terminal Unit Reports: In addition to other requirements for terminal units, include the following:
   1. Unit Data: Include the following:
      a. System and air handling unit identification.
      b. Location and zone.
      c. Test apparatus used.
      d. Area served.
      e. Air terminal make.
      f. Air terminal number from system diagram.
      g. Air terminal type and model number.
      h. Air terminal size.

   2. Test Data: Include design and actual values for the following:
      a. Airflow rate in cfm (minimum and maximum).
      b. Preliminary airflow rate as needed in cfm.
      c. Final airflow rate in cfm.
      d. Space temperature in °F.
      e. Duct Supply Air Temperature in °F.

I. Instrument Calibration Reports: For instrument calibration, include the following data in report, as a minimum:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Date of calibration.

3.11 ADDITIONAL TESTS

A. Balance Contractor shall be prepared to verify the balance of select devices in the presence of the Engineer and / or Commissioning Authority at their discretion. This typically will require only a few hours to a day of labor, depending on the project scope. If, in the opinion of the Engineer or Commissioning Authority these verifications contain adequate discrepancies to provide doubt to the accuracy of the balance procedures performed, the Engineer or Commissioning Authority may order additional re-balancing or re-verification until such time as these discrepancies are eliminated throughout the systems; this verification shall be at the Contractor's expense.

3.12 SUBMISSION OF CERTIFIED BALANCE REPORTS

A. Time is of the essence in the completion of this portion of the contract. It is expected that the certified balance reports will be submitted in a timely manner, within thirty (30) days of the work performed. At the completion of the project, it shall be the responsibility of this Contractor to assemble a single certified report and submit 1 printed copy to the Engineer as closeout documentation, along with electronic copy in PDF format.

END OF SECTION

SECTION 230700 - INSULATION

PART 1 – GENERAL

1.1 WORK INCLUDED

A. All work shall comply with the requirements of the 2020 Energy Construction Conservation Code of New York State, manufacturer's requirements for installation and these specifications. In the event of conflicts between these documents, the more stringent requirements shall govern.

B. Provide labor, materials, equipment and services to perform operations required for the complete installation and related work as required in the Contract Documents. The extent of insulation work is indicated on the drawings and by the requirements of this section.

C. Repair all insulation at points of piping and ductwork system tie in to existing and at locations where existing systems are cut, patched or capped.

D. Insulate all existing piping systems, ductwork systems and equipment after removal of existing insulation whether by this contractor or another, including but not limited to removal of asbestos products.

E. Remove existing insulation where indicated on the drawings or specified here-in.

1.2 SUBMITTALS

A. Manufacturers' Data. Submit manufacturer's data and installation instructions.

B. Schedule of insulation applications.

C. Certification: Provide certifications as necessary to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 232000 **–** Piping Systems and Accessories.

B. Section 232133 – Water Systems Specialties.

C. Section 233000 – Sheet Metal and Ductwork Accessories.

PART 2 – PRODUCTS

2.1 GENERAL

A. Insulation, Jackets, Adhesives, and Coatings, shall comply with the following:
1. Treatment of jackets or facings for flame and smoke safety must be permanent. Water soluble treatments are not permitted.
2. Insulation, including finishes and adhesives on the exterior surfaces of ducts, pipes, and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, as tested by ASTM E84 (NFPA 255) and UL 723 methods, using the specimen preparation and mounting procedures of ASTM E2231.
3. Insulation within plenums, duct coverings and duct linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F. Pipe and duct insulation shall be listed and labeled.
4. All adhesives, coatings and sealants used for the insulation shall comply with the maximum Volatile Organic Compound (VOM) limits as called for in the current version of U.S. Green Building Council LEED Credits.
5. Provide materials which are standard insulation products of manufacturers for piping, ductwork and equipment systems.
6. Provide insulation in accordance of MICA and NAIMA standards.
7. Asbestos or asbestos bearing materials are prohibited.
8. Ducts operating at temperatures above 120 degrees shall have sufficient thermal insulation to limit the exposed surface temperature to 75 degrees.
9. The insulation shall be clearly labelled by the manufacturer with the installed thermal “R” values in accordance to the Energy Conservation Code.
10. UL GREENGUARD Gold Certification – all insulation materials shall be GREENGUARD certified, documentation for which shall be contained in the paragraph 1.2.c submittal information.

2.2 ACCEPTABLE MANUFACTURERS

A. Fiberglass and Mineral Wool: Knauf, Manville, Owen-Corning, Certainteed.

B. Polyisocyanurate: Dow Trymer 2000XP, HyTherm.

C. Flexible Elastomeric: Armstrong, Rubatex International, Armacell

D. Calcium Silicate: Industrial Insulation Group (IIG), Johns Manville, Owens-Corning.

E. Removable Thermal Blanket: Insultech, Shannon, Irwin.

F. Adhesives, Coatings, Mastics, Sealants: Childers, Foster, Armacell.

G. Aluminum and Stainless Steel Jacket Material: GIC, GLT, RPR.

H. Laminated Rubberized Bitumen Jacket: Alumaguard, VentureClad, Flex Clad.

I. Pre-Molded PVC Fitting Covers: Zeston, Proto System

2.3 PIPE INSULATION (RIGID FIBERGLASS TYPE)

A. Glass Fiber insulation meeting ASTM C 552, Type II, Class 2, ASTM C 585, ASTM C 795 and ASTM C 1138; rigid, molded, noncombustible.

B. Minimum 'K' Value: ASTM C 335, 0.23 at 75°F mean temperature installed value. Maximum Service Temperature: 1000°F.

C. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C 1136 Type I, secured with self-sealing longitudinal laps and butt strips.

D. Field-Applied PVC 30 mil Fitting Covers with Flexible Fiberglass Insulation complying with ASTM C 450 and ASTM C 585: Proto Corporation LoSmoke, UV-resistant fittings and accessories, white or colored. Fitting cover system consists of pre-molded, high-impact PVC materials with blanket type fiberglass wrap inserts. Blanket fiberglass wrap inserts shall have a thermal conductivity ('K') of 0.26 at 75°F mean temperature. Closures to be stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

2.4 PIPE INSULATION (RIGID POLYISOCYANURATE TYPE)

A. Preformed Rigid Polyisocyanurate Insulation: Cellular foam complying with ASTM C591, Type I and Type IV, rigid molded, non-combustible. 2 lb./ft^3 nominal density. Maximum thermal conductivity (k) shall be 0.19 BTU-in/ft^2 hr. °F at 75°F mean temperature. Maximum Service Temperature; 300°F.

B. Vapor Retarder Jacket; Dow Saran Vapor Retarder Film and Tape

C. Covering Jacket; White Kraft outer surface bonded to aluminum foil and reinforced with fiberglass yarn.

2.5 PIPE INSULATION (RIGID MINERAL WOOL TYPE)

A. Mineral wool 1200°F Degree Pipe Insulation. Inorganic fibers bonded with a thermosetting resin, complying to ASTM C547, Type II, Grade A, ASTM C585, ASTM C 795 and ASTM C 1138.

B. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C 1136 Type I, secured with self-sealing longitudinal laps and butt strips.

C. Minimum 'K' Value: ASTM C 335, 0.24 at 75°F mean temperature installed value.

D. Field-Applied PVC Fitting Covers 30 mil with Flexible Fiberglass Insulation complying with ASTM C 450 and ASTM C 585: Proto Corporation LoSmoke, UV-resistant fittings, jacketing and accessories, white or colored. Fitting cover system consists of pre-molded, high-impact PVC materials with blanket type fiberglass wrap inserts. Mineral wool wrap inserts shall have a thermal conductivity ('K') of 0.29 at 100°F mean temperature. Closures to be stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

2.6 PIPE INSULATION (FLEXIBLE ELASTOMERIC FOAM)

A. Flexible, elastomeric thermal insulation, with expanded closed-cell foam structure, antimicrobial protection and free of CFC's, HFC's, HCFC's, formaldehyde, fibers and dust, with low VOC's. Maximum water vapor transmission of 0.10 perm-inch based on ASTM E96, Procedure A. Maximum thermal conductivity (k) shall be 0.27 Btu/ft²•hr.• F/in. at 75ºF mean temperature. Fire spread/smoke developed rating of 25/50 or less based on ASTM E84 for up to 2" material thickness. Furnish with self-sealing reinforced lap seal.

B. Pipe Insulation: ASTM C534, Type I.

C. Sheet Insulation for Ductwork and Equipment: ASTM C534, Type II, smooth skin one side.

2.7 PIPE INSULATION TAPES

A. ASJ Tape: White vapor retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 4 inches.
2. Thickness Total: 14.3 mil.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.

B. FSK Tape: Foil face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 4 inches.
2. Thickness Total: 13.3 mil.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.

2.8 DUCT INSULATION

A. Duct Liner – Refer to Specification Section 233000.

B. Flexible Fiber Glass Blanket:
1. Insulation Blanket meeting ASTM C 553, Type II, ASTM C 1290, Type III, and ASTM C 1138.
2. 'K' Value of 0.27 at 75°F mean temperature. Maximum Service Temperature (Faced): 250°F.
3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, II, III, IV, VIII or FSK conforming to ASTM C 1136 Type II, IV. Provide ASJ jacket for ductwork to be painted.
4. Installation: Maximum allowable compression is 25%.
5. Density: Minimum 1.0 PCF.
6. For duct wrap, the installed thickness shall be assumed to be 75 percent (25% compression) of nominal thickness.

C. Rigid Fiber Glass Board
1. Insulation Board meeting ASTM C 612 Type IA, IB and II, ASTM C 795 and ASTM C 1138.
2. 'K' Value of 0.23 at 75°F mean temperature. Maximum Service Temperature: 450º F.
3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or conforming to ASTM C 1136 Type II, IV. Provide ASJ jacket for ductwork to be painted.
4. Concealed Areas: Minimum 3 lb./ft.^{3}.
5. Exposed Areas: 6 lb./ft.^{3} minimum density for duct less than 8 ft. - 0 in. above finished floor or where indicated in these specifications or on the drawings.

D. Flexible Mineral Wool Blanket:
1. Mineral Wool bonded comply with ASTM C 553, Types I, II and III, and ASTM C 1290 and ASTM C 1138
2. 'K' Value of 0.27 at 75°F mean temperature. Maximum Service Temperature (Faced): 250°F.
3. Vapor Retarder Jacket: FSK conforming to ASTM C 1136 Type II. Provide ASJ jacket for ductwork to be painted.
4. Installation: Maximum allowable compression is 25%.
5. Density: Minimum 1.0 PCF.

E. Rigid Mineral Wool Board:
1. Mineral Wool complying to UL/ULC Classified per UL 723. Comply with ASTM C 612, Type IA or Type IB and ASTM C 1138.
2. 'K' Value of 0.23 at 75°F mean temperature. Maximum Service Temperature: 450º F.
3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, II, III, IV, VIII or FSK conforming to ASTM C 1136 Type II, IV. Provide ASJ jacket for ductwork to be painted.
4. Concealed Areas: Minimum 3 lb./ft.^{3}.
5. Exposed Areas: 6 lb./ft.^{3} minimum density for duct less than 8 ft. - 0 in. above finished floor or where indicated in these specifications or on the drawings.

F. Rigid Polyisocyanurate Insulation:
1. Cellular foam complying with ASTM C591, rigid molded, non-combustible. 2 lb./ft^3 nominal density. Maximum thermal conductivity (k) shall be 0.19 BTU-in/ft^2 hr. °F at 75°F mean temperature. Maximum Service Temperature; 300°F.

G. Flexible Elastimeric Foam:
1. Flexible, elastomeric thermal insulation, with expanded closed-cell foam structure, antimicrobial protection and free of CFC's, HFC's, HCFC's, formaldehyde, fibers and dust, with low VOC's. Maximum water vapor transmission of 0.10 perm-inch based on ASTM E96, Procedure A. Maximum thermal conductivity (k) shall be 0.27 Btu/ft²•hr.• F/in. at 75ºF mean temperature. Fire spread/smoke developed rating of 25/50 or less based on ASTM E84 for up to 2" material thickness.
2. Sheet Insulation for ductwork: ASTM C534, Type II, smooth skin one side.

H. Duct Insulation Tapes:
1. ASJ Tape:
a. White vapor retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
b. Width 4 inches.
c. Thickness 11.5 mil
d. Adhesion: 90 ounces force/inch in width.
e. Elongation: 2 percent.
f. Tensile Strength: 40 lbf/inch in width.

2. FSK Tape:
a. Foil face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
b. Width 4 inches.
c. Thickness 13.3 mil.
d. Adhesion: 90 ounces force/inch in width.
e. Elongation: 2 percent.
f. Tensile Strength: 40 lbf/inch in width.

2.9 EQUIPMENT INSULATION

A. Segmented board, sheets, blocks, size, shape, and material as called for.

B. Rigid Fiber Glass Board
1. Insulation Board meeting ASTM C 1393, Type I, II, IIIA, III B and Category 2, ASTM C 795 ASTM and C 1138.
2. 'K' Value of 0.27 at 75°F mean temperature. Maximum Service Temperature: 650º F.
3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, II, III, IV or FSK conforming to ASTM C 1136 Type II. Provide ASJ jacket for ductwork to be painted.
4. Concealed Areas: Minimum 3 lb./ft.^{3}.

5. Exposed Areas: 6 lb./ft.^{3} minimum density for equipment less than 8 ft. - 0 in. above finished floor or where indicated in these specifications or on the drawings.

C. Rigid Mineral Wool Board:
1. Glass Mineral Wool complying with ASTM C 612, ASTM C 1393Catagory 1 and ASTM C 1138.
2. 'K' Value of 0.23 at 75°F mean temperature. Maximum Service Temperature: 850º F.
3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, II, III, IV or FSK conforming to ASTM C 1136 Type II, IV. Provide ASJ jacket for ductwork to be painted.
4. Density: Minimum 6 lb./ft.^{3} for equipment less than 8 ft. - 0 in. above finished floor or where indicated in these specifications or on the drawings.

D. Flexible Elastimeric Foam:
1. Flexible, elastomeric thermal insulation, with expanded closed-cell foam structure, antimicrobial protection and free of CFC's, HFC's, HCFC's, formaldehyde, fibers and dust, with low VOC's. Maximum water vapor transmission of 0.10 perm-inch based on ASTM E96, Procedure A. Maximum thermal conductivity (k) shall be 0.27 Btu/ft²•hr.• F/in. at 75ºF mean temperature. Fire spread/smoke developed rating of 25/50 or less based on ASTM E84 for up to 2" material thickness.
2. Pipe Insulation: ASTM C534, Type I.
3. Sheet Insulation for equipment: ASTM C534, Type II, smooth skin one side.

2.10 PIPE, DUCT AND EQUIPMENT JACKETING

A. Metal Jacketing Material:
1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, , Temper H-14. Sheet and roll stock ready for shop or field sizing. Stucco Embossed: 0.024 inch thickness
   a. Moisture Barrier for Indoor Applications: Minimum 1mil thick, heat bonded polyethylene and kraft paper.
   b. Moisture Barrier for Outdoor Applications:Minimum 2.5 mil thick polysurlyn.

2. Factory-Fabricated Fitting Covers:
   a. Same material, finish, and thickness as jacket.
   b. Preformed 2 piece or gore, 45 and 90 degree, short and long radius elbows covers.
   c. Flange and union covers.
   d. Tee end caps.
   e. Beveled collars.
   f. Valve covers.
   g. Field-fabricate fitting covers only if factory-fabricated fitting covers are not available. Valve covers.

3. Banding: Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316 equal to the jacketing material, ½ and ¾ inch wide with wing seal. Banding. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14, 0.020 inch thick, ½ and ¾ inch wide with wing seal.

B. PVC 30 mil Jacket: High impact resistant, UV resistant PVC complying with ASTM D 1784, Class 16354-C. Roll stock ready for shop or field cutting and forming.
1. Color: White

C. Self-Adhesive, Laminated Rubberized Jacket:
1. Multi-ply laminated rubberized bitumen compound system. UV-resistant aluminum foil/polymer or polyester/foil system with acrylic adhesive.
2. 55-60 mil thickness with a low-pressure sensitive adhering system.
3. Stucco-embossed aluminum finish.

2.11 THERMAL BLANKET

A. Thermal Barrier with a maximum service temperature of 450°F.

B. Outer and Inner Jacket, 17 oz./sq. yd. Silicone impregnated Fiberglass cloth.

C. Insulation Material, 11 PCF Fiberglass Needled Mat-Type "E" Fiber.

D. Mat encapsulated by the silicone impregnated Fiberglass cloth and sewn together, producing a self-contained blanket system.

E. Blanket system fasteners for easy install and removal.

F. The insulation cover shall be 2 in. thickness with a K factor of 0.26 at 100°F.

G. Blanket construction shall be double sewn lock stitch with a minimum 7 stitches per inch. All raw jacket edges shall have a tri-fold Silicone Cloth binding. No raw cut jacket edge shall be exposed. Stitching shall be done with PTFE coated fiberglass thread or PTFE Teflon coated Nomex thread.

H. The blanket shall extend beyond mating flanges unto existing insulation for a minimum of 2 in. Where blanket cannot fit over existing oversized insulation, blanket shall butt up to existing insulation with a friction fit closing seam. All sections of pipes shall be insulated, and open gaps are not acceptable. Blanket diameters which are 2 in. or larger than existing insulation must be end capped to eliminate open air void.

I. The blankets shall have a low point stainless steel drain grommet or incorporate a mating seam at the lowest point of the blanket.

J. For large equipment where a multi-piece construction is necessary, the total number of pieces shall be minimized. Any one piece shall not exceed 40 lbs. in weight.

K. Provide an aluminum or 304 type stainless steel nameplate tag riveted to each blanket piece. 1/8 in. embossed lettering shall identify the equipment it is serving, size and pressure rating of the system. Each blanket requires an I.D. Plate.

L. 14-gauge type 304 stainless steel quilting pins shall be placed at random locations no greater than 18 in. apart to prevent shifting of the insulation, 14 gauge type 304 Stainless Steel speed washers shall secure the quilting pin stem in place.

M. Equipment and equipment heads shall be a multi-piece design installed in tag number sequence. Heat exchanger heads, large vessel flanges and pump housings will be designed in two half sections. Blanket design shall conform to the equipment with minimized air void. All valve covers shall be a two-piece design with a separate body and bonnet.

N. A 21-gauge type 304 stainless steel wire shall be doubled up and twisted in a spiral fashion, with a minimum of 4 to 5 twists per inch. Wire twist length shall be 16 in. or longer. The wire twist shall be secured to the lacing pin at the pin stem. Lacing pin stems shall be 14-gauge type 304 stainless steel. Pins shall be held in place with 1 in. diameter type 304 stainless steel speed washers. Wire twists shall be spaced 6 in. on center along closing seams with matching lacing pins to lace and secure to.

O. Alternate fastening systems such as Metal "D" ring strap with Velcro tab, or side release buckles may be utilized.

2.12 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass Fiber Fabric: Approximately 6 oz. /sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts and equipment. Childers CHIL-GLAS #5 or equal.

2.13 COATINGS, MASTICS, ADHESIVES AND SEALANTS

A. Vapor Barrier Coatings: Used in conjunction with reinforcing mesh to coat insulation on below ambient services temperatures. Permeance shall be no greater than 0.08 perms at 37 mils dry as tested by ASTM D5590 meeting zero growth rate for mold. Foster 30-80 or approved equal, or approved equal.

B. Lagging Adhesives: Used in conjunction with canvas or glass lagging cloth to protect equipment/piping indoors. Foster 30-36 AF meeting ASTM D 5590 with zero mold growth rating, or approved equal.

C. Weather Barrier Mastic: Used outdoors to protect above ambient insulation from weather. Foster 46-50 Weatherite; Childers CP-10 Vi Cryl, or approved equal.

D. Fiberglass Adhesive: Used bond low density fibrous insulation to metal surfaces. Shall meet ASTM C916 Type II. Foster 85-60; Childers CP-127, or approved equal.

E. Elastomeric Insulation Adhesive: Used to bond elastomeric insulation. Foster 85-75; Childers CP-82, or approved equal.

F. Elastomeric Insulation Coating: Water based coating used to protect outside of elastomeric insulation. Foster 30-65, Armacell WB Coating or approved equal.

G. Insulation Joint Sealant: Vapor sealant for below ambient piping with polyisocyanurate and cellular glass insulation. Foster 95-50; Childers CP-76, or approved equal.

H. Metal Jacketing Sealant: Used as a sealant on metal jacketing seams to prevent water entry. Foster 95-44; Childers CP-76, or approved equal.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

A. Provide Thermal Insulation:
1. Insulation is required on ductwork, piping and equipment in compliance with these specifications and referenced codes and standards.
2. Continuous through openings, sleeves and hangers.
3. Install only on clean, dry surfaces and after ductwork has been tested.
4. On cold surfaces provide continuous unbroken vapor seal. Exceptions - Do not cover inspection stampings, nameplate data, openings, petcocks, hand-holes, manholes, access doors, plugged outlets, air vents, plugged openings or petcocks. Provide continuity of insulation system and vapor barrier though partitions, floors, casings, plenums, etc.
5. Piping insulation exposed to the weather shall be protected from damage, including that due to sunlight, moister, equipment maintenance and wind, and shall be provided with a jacketing material as specified in these specifications.

3.2 PIPE INSULATION

A. Insulate piping systems including fittings, valves, flanges, unions, strainers, and other attachments installed in piping system, whether exposed or concealed, with the following exceptions:
1. Factory-installed piping within the HVAC equipment tested and rated in accordance with the 2020 ECCCNYS

2. Factory installed piping within room fan coil Units and unit ventilators tested and rated according to AHRI 440 and AHRI 840, respectively.
3. Piping that conveys fluids that have a design operating temperature range between 60 and 105 degrees.
4. Piping that conveys fluids that have not been heated or cooled through use of fossil fuels or electric power, the surface temperature of which does not risk condensation or occupant / service hazard (between 60°F and 105°F).
5. Strainers, control valves and balance valves associated with piping 1 inch or less in diameter and conveying fluids over 60 degrees.

B. Piping in exterior walls, spaces, overhangs, attics, or where subject to freezing, double the thickness of the insulation. Piping in wall chases adjacent to an exterior wall shall be packed with type glass fiber batting type insulation.

C. Hanger Shields: Refer to Section "Piping Systems and Accessories."
1. Pre-insulated type: Butt insulation to hanger shields and apply a wet coat of vapor barrier cement to the joints and seal with 3 in. wide vapor barrier tape.
2. Field insulated type: Provide 1-1/2" calcium silicate insulation between pipe and shield.

D. Joints in sections of pipe insulation shall be made as follows:
1. Standard: Longitudinal laps and butt joint shall be fully sealed. Factory applied pressure sensitive adhesive lap seal is acceptable.
2. Vapor barrier: For cold services, all service jacket (ASJ) longitudinal laps and 4 in. vapor barrier strip at butt joints shall be sealed with vapor barrier coating. Seal ends of pipe insulation at valves, flanges, and fittings with vapor barrier coating and reinforcing mesh.

E. Fittings, Valves and Flanges:
1. Hot services: Pre-molded fitting insulation of the same material and insulation value as the adjacent pipe insulation.
2. Hot water shall be coated with weather barrier mastic and reinforcing mesh.
3. Provide PVC fitting covers on all fittings.

F. Flexible Elastomeric Foam Pipe Insulation:
1. Split longitudinal joint and seal with contact adhesive. Carefully mate and seal with adhesive all contact surfaces to maintain the integrity of the vapor barrier of the system.
2. Fittings made from miter-cut pieces properly sealed with adhesive, or ells may be continuous. Use templates provided by the manufacturer and assemble the cut section in accordance with the manufacturer’s printed instructions.
3. Where exposed outdoors, apply water-based UV resistant coating and/or reinforcing membrane as recommended by manufacturer. Follow manufacturer’s installation instructions.

3.3 JACKETING ON PIPING

A. Secure jacketing to insulated piping with preformed aluminum band straps or stainless-steel band straps.

B. Jacket exposed insulated fittings, valves and flanges with mitered sections of aluminum or stainless-steel jacketing or factory fabricated, preformed, sectional aluminum or stainless-steel fitting covers shall be fully sealed water tight

C. Provide PVC, aluminum or stainless-steel jacket and fitting covers on exposed insulated piping installed in finished rooms including Mechanical Equipment Rooms, Penthouses, and Machine Rooms within eight feet of the finished floor.

D. Lap all joints a minimum of 2 inches.

E. Secure jacketing in place with a continuous longitudinal friction type joint to provide a positive weatherproof seal. Circumferential joints shall be weatherproof sealed with 2 inch x 0.016 inch thick aluminum straps lined with metal jacketing sealant.

F. Install jacketing to avoid trapping condensation and precipitation.

3.4 DUCTWORK INSULATION

A. External thermal insulation for duct. Not required where ducts have internal acoustical insulation, are located inside the conditioned space and lining meets the insulation value of these specifications and the 2020 ECCCNYS. Make special provisions at dampers, damper motors, thermometers, instruments, and access doors. Apply as Follows:

1. Rigid board type: Impale board over mechanical fasteners, welded pins or adhered clips, 12 in. to 18 in. centers; minimum of two rows per side. Secure insulation with washers on clips. Seal breaks and joints in vapor barrier with 4 in. wide matching tape or 4 in. reinforcing mesh applied with Foster 30-65 vapor barrier coating. Apply tape over corner beading where exposed. Flexible blanket type: Joints and seams made with 2 in. lap of vapor barrier. Round ducts: Apply Foster 85-20 adhesive to ducts in 6 in. brush widths at 1 ft. intervals and at each facing edge. Square ducts: Over 18” duct face width, fasten by impaling insulation on adhered or welded clips. Secure insulation with washers on clips. Seal joints and breaks with 4 in. wide matching tape or 4 in. reinforcing mesh applied with Foster 30-65 vapor barrier coating. Cooling ducts shall be covered with a vapor retarder having a maximum permeance of 0.05perm or an aluminum foil jacket with a minimum thickness of 2 mils. All joints and seams shall be sealed to maintain the continuity of the vapor retarder.

2. Flexible blanket type: Joints and seams made with 2 in. lap of vapor barrier. Round ducts: Apply Foster 85-20 adhesive to ducts in 6 in. brush widths at 1 ft. intervals and at each facing edge. Square ducts: Over 18" duct face width, fasten by impaling insulation on adhered or welded clips. Secure insulation with washers on clips. Seal joints and breaks with 4 in. wide matching tape or 4 in. reinforcing mesh applied with Foster 30-65 vapor barrier coating.
3. Kitchen Hood Exhaust Duct Board: Impale over welded pins, 12 in. to 18 in. centers, minimum of 2 rows per side. Secure insulation with washers on clips. Seal joints with matching pressure sensitive tape.
4. Expanded polystyrene: Impale over glued pins, 12 in. to 18 in. centers, minimum of 2 rows per side. Secure insulation with washers on clips. All insulation shall be covered with 0.016" embossed aluminum jacket. Corners shall be protected with aluminum corner bead, screwed to jacketing. All seams and breaks to be weatherproofed and caulked. All joints to be cleanly finished.
5. Flexible Elastomeric Foam Insulation: Apply foam sheet insulation to ductwork with adhesive. Insulate duct seams, angle bracing and reinforcing with same thickness as ductwork. Where exposed outdoors, apply UV resistant coating as recommended by manufacturer. Follow manufacturer's installation instructions.
6. Insulate the tube bends and all exposed surfaces of duct coils operating in excess of 10 degrees differential from ambient conditions.
7. Ductwork installed outdoors, exposed to weather.
    a. All duct insulation on ductwork installed outdoors shall be adhered 100 percent using Approved Contact Adhesive.
    b. Apply self-adhesive, laminated rubberized jacket per manufacturer's requirements. Apply to each side, starting with the bottom surface, then the sides, and finally the top. Provide minimum 3" overlap of material at each joint.
    c. Application:
        1) Flat ducts in a horizontal plane must be sloped to shed water. There must be no areas of ponding water.
        2) Install system over only clean, dry insulation base. Any insulation which becomes damp or damaged shall be removed and replaced prior to installation.

B. Service and access openings shall not be concealed by duct coverings unless the exact location of the opening is properly identified.

C. Continuous vapor barriers shall be provided on all ductwork subject to condensation. No gaps or methods for air to permeate the insulation materials below the vapor barrier shall be permitted.

3.5 EQUIPMENT INSULATION

A. Equipment insulation surfaces shall be a hard, smooth, uniform finish. Install Work ready for painting.

3.6 RECOVERING

A. Field apply glass cloth and applied over standard insulation jacket with lagging adhesive. Properly cut at fittings to avoid wrinkles and coat with lagging adhesive. Leave ready for painting.

3.7 EXISTING INSULATION

A. Patch existing insulation damaged during the course of the work.

B. Report any deficiencies in existing insulation systems to the Owner's Representative for further action.

3.8 EXISTING WORK

A. Insulate existing piping, ductwork and equipment where called for.

EXHIBIT "I" - PIPE INSULATION MATERIALS

SERVICE	**INSULATION MATERIAL**	**THICKNESS**	**REMARKS**
Hot water and glycol/hot water (200°F and lower)	Glass fiber, **[Mineral Wool] (k=.25-.29)**	1-1/2 in. and Larger: 2 in. 1-1/4 in. and Smaller: 1-1/2 in.	

EXHIBIT "II" - DUCT INSULATION MATERIALS

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
HVAC Supply Note – use duct liner only where specified or called for on drawings to R values to right. Where 1" is called for as acoustic measure, provide external insulation to balance of specified R value.	Exposed: Rigid fiberglass, **[Mineral Wool]** Concealed: Flexible fiberglass, **[Mineral Wool]**	1-1/2 in. 2 in.	Min. installed R value of 6 Min. installed R value of 6
Return-air ducts within heated building envelope		NOT INSULATED	

END OF SECTION

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SECTION 230800 – MECHANICAL SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The purpose of this section is to specify Division 23 responsibilities in the commissioning process.

B. The systems to be commissioned are listed within this section.
   1. Radiant Ceiling Panels
   2. Reheat Coils
   3. All temperature controls as shown on design drawings
   4. Fire, Smoke, and Combination Fire/Smoke Dampers

C. Commissioning requires the participation of Division 23 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 019113. Division 23 shall be familiar with all parts of Section 019113 and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.2 RESPONSIBILITIES

A. Mechanical, Controls and TAB Contractors. The commissioning responsibilities applicable to each of the Mechanical (MC), Controls (CC), and TAB Contractors of Division 23 are as follows in paragraphs below (all references apply to commissioned equipment only).

B. Construction and Acceptance Phases:
   1. Attend a commissioning scoping meeting and other meetings necessary to facilitate the Cx process.
   2. Contractors shall provide the commissioning authority (CA) with complete submittal data as specified elsewhere in the contract documents for each piece of commissioned equipment (concurrent with submittals to Engineer).
   3. Provide additional requested documentation, prior to normal O&M Manual submittals, to the CA for final development of functional testing procedures.
      a. Typically, this will include:
         1) detailed manufacturer installation/start-up, operating, troubleshooting, and maintenance procedures;
         2) full details of any owner-contracted tests;
         3) fan and pump curves;
         4) factory testing reports, if any; and
         5) Warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified.

b. In addition, the installation, start-up and checkout materials that are actually shipped inside / with the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CA.
c. The CA may request further documentation necessary for the commissioning process.

4. Provide a copy of the O&M Manuals and submittals of commissioned equipment, through normal channels, to the CA for review and approval.
5. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the Specifications, control drawings or equipment documentation are insufficient for writing detailed testing procedures. This is to include safety concerns or parameters which may result in damage to systems.
6. Provide limited assistance to the CA in preparing the specific functional performance test procedures as specified in Section 230813. Contractors shall review test procedures to ensure feasibility, safety, and equipment protection. Provide in writing the values of any necessary alarm limits to be used during the tests.
7. Develop a full Start-up and Initial Checkout Plan using manufacturer's start-up procedures and the Temperature Controls Testing and Commissioning report, refer to 230900. Refer also to Section 019113 for further details.
8. During the startup and initial checkout process, provide the mechanical-related portions of the Temperature Controls Testing and Commissioning report.
9. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.
10. Address all A/E punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
11. Provide skilled technicians to execute functional performance tests under the direction of the CA, who designs and documents the functional tests. The functional testing forms will be delivered to the commissioning team members at the initial meeting. The Contractor technicians must be available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments, and problem-solving.
12. Perform functional performance testing under the direction of the CA for specified equipment listed in this Section.
13. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA.
14. Prepare O&M Manuals according to the Contract Documents; update and clarify original sequences of operation to as-built conditions.
15. Provide training of the Owner's operating staff as specified.
16. Coordinate with equipment manufacturers to determine specific requirements to maintain the warranty.

C. Warranty Period:
   1. Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the Specifications.
   2. Correct deficiencies and make necessary adjustments to O&M Manuals and as-built drawings for applicable issues identified in any seasonal testing.

D. Mechanical (HVAC) Contractor. The responsibilities of the HVAC Mechanical Contractor, during construction and acceptance phases in addition to those listed in (A) are:
   1. Provide startup for all HVAC equipment, except for the building automation control system.
   2. Assist and cooperate with the TAB Contractor and CA by placing all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
   3. List and clearly identify on the as-built drawings the locations of all air-flow stations.
   4. Prepare a preliminary schedule for Division 23 equipment start-up; and TAB start and completion for use by the CA. Update the schedule as appropriate.
   5. Be proactive in ensuring that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.

E. Controls Contractor. The commissioning responsibilities of the Controls Contractor, during construction and acceptance phases in addition to those listed in (A) are:
   1. Submittals. The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. Provide submittal data in compliance with section 230972 of these specifications. The Controls contractor shall keep the CA informed of all changes to this list during programming and setup.
   2. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.
   3. Assist and cooperate with the TAB Contractor in the following manner:
      a. Meet with the TAB Contractor prior to beginning TAB and review the TAB Plan to determine the capabilities of the control system toward completing TAB. Provide the TAB Contractor any needed unique instruments for setting terminal unit boxes and instruct TAB Contractor in their use (handheld control system interface for use around the building during TAB, etc.).
      b. For a given area, have all required temperature control testing and commissioning, calibrations, startup and selected functional tests of the system completed and approved by the CA prior to TAB.
      c. Provide a qualified technician to operate the controls to assist the TAB Contractor in performing TAB, or provide sufficient training for the TAB Contractor to operate the system without assistance.

4. Assist and cooperate with the CA in the following manner:
   a. Using a skilled technician who is familiar with this building, execute the functional testing of the controls system. Assist in the functional testing of all equipment.
   b. Execute all control system trend data logs as indicated by the CA.

5. Upon completion of the temperature control testing and commissioning sequence of each controlled device, equipment, and system provide a signed and dated certification to the CA that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
6. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water, and building pressure).

F. TAB Contractor. The duties of the TAB Contractor, in addition to those listed in (A) are:
   1. Prior to starting TAB, provide all specified submittals, including contractor qualifications, TAB plan and approach, and qualifications of the firm and technicians to perform the work. All submittals are to be reviewed and approved no less than six weeks prior to starting TAB activities.
   2. In addition to items described in section 230593, the submitted TAB Plan shall include:
      a. Certification that the TAB Contractor has reviewed the construction documents and the systems with the design engineers and Contractors to sufficiently understand the design intent for each system.
      b. An explanation of the intended use of the building control system. The Controls Contractor will comment on feasibility of the TAB Plan.
      c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted, and balanced with the data cells to be gathered for each.
      d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      e. Final test report forms to be used.
      f. Detailed step-by-step procedures for TAB work for each system and issue.
      g. Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
      h. The identification and types of measurement instruments to be used and their most recent calibration date.
      i. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
      j. Details of how building static and exhaust fan/relief damper capacity will be checked.

k. Details regarding specified deferred or seasonal TAB work.
l. Plan for formal deficiency reports (scope, frequency and distribution).

3. Communicate in writing to the Controls Contractor all setpoint and parameter changes made and problems or discrepancies identified during TAB which affect the control system setup and operation.
4. Provide a draft TAB report to the GC, and A/E within two weeks of completion. A copy will be provided to the CA. The report will contain a full explanation any assumptions, and provide results in a clear format with explanations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.
5. Provide the CA with any requested data gathered but not shown on the draft reports.
6. Provide a final TAB report to the Engineer with details, as in the draft.
7. Conduct functional performance tests and checks on the original TAB as specified for the TAB Contractor.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Division 23 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Division 23 shall provide submittal documentation relative to commissioning as required in Part 1 of this Section and Section 019113.

3.2 STARTUP

A. The HVAC Mechanical Contractor and Controls Contractor shall follow the Start-up and Initial Checkout Plan discussed in Part 1.2 of this Section and in Section 019113. 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 CA or Owner.

B. Functional testing is intended to begin upon completion of the entire system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA. Beginning system testing before full completion does not relieve the Contractor from fully completing the system.

C. TAB: Refer to the TAB responsibilities in Part 1.2 above.

3.3 FUNCTIONAL PERFORMANCE TESTS:

A. Part 1.1 of this section. The functional performance testing forms will be distributed at the initial commissioning team meeting.

3.4 DEFERRED TESTING

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other reason, execution of checklists and Functional testing may be delayed upon approval of the CM. These tests shall be conducted in the same manner as the seasonal tests as soon as practicable.

B. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design conditions) specified in Section 230810 shall be completed as part of this contract. The CA shall coordinate this activity through the CM. Appropriate Contractors shall perform functional testing under the direction of the CA, who shall also document the testing procedures and results. Any final adjustments to the O&M Manuals and as-built drawings due to the testing shall be made by the appropriate Contractors and given to the Owner.

3.5 WRITTEN WORK PRODUCTS

A. Written work products of Contractors will consist of the TAB Report (TAB), Controls Testing and Commissioning documentation (CC), the filled-out start-up, initial checkout forms from manufactures. The CA shall be responsible for documenting functional test results.

END OF SECTION

SECTION 230923 – TEMPERATURE CONTROL SYSTEMS

PART 1 – GENERAL

1.1 FUNCTIONAL INTENT

A. Accessibility: As much as practical, design the system to keep the BACS equipment out of, and above user areas. The maintenance staff must have quick and ready access with sufficient room for operation and maintenance.

B. Reliability: Controls are integral to maintaining reliable conditions throughout the building and as such need to be designed and installed with an appropriate degree of robustness and reliability.

C. Digital Terminal Unit Control - This intent of this standard is to require digital electronic control down to the terminal level. Terminal level controls will typically be cost-effective controllers designed for the specific application. Stand-alone local controls may only be used when specifically approved by the Engineer.

D. Expandability - When configuring the BACS equipment, provision must be made for expansion that may be required in the future. Hardware and software required to implement expansion must be provided via system sizing, configuration, and appropriate license agreements

E. When a portion of an existing building is to be renovated, the new control system shall match or integrate seamlessly with the existing control system.

F. Unless stated to the contrary, all hardware points (AI, AO, BI and BO) shall be hardwired to controllers. Data points / BACNet Objects are only to be accessed through equipment integration where specifically called for.

1.2 RELATED SECTIONS

A. This Contractor shall reference the entirety of Divisions 22, 23 and 26 as they apply to this work, with specific attention to the following sections:
   1. Section 230593 – Testing and Balancing
   2. Section 019113 – Commissioning Requirements
   3. Section 230514 – Electric Wiring

1.3 DEFINITIONS

Binary Input (BI)	An on/off indication that has a maximum cycle rate of 1 Hz. This is typically sensing a contact closure
Binary Output (BO)	A contact closure on the controller that will cause inaction in the system

Binary Value (BV)	A network-visible binary point whose value is determined by a controller computation
Analog Input (AI)	A continuously varying voltage or amperage signal that is varied by a sensor in relation to a sensed variable. This signal is processed in the controller after an analog-to-digital converter on the controller that converts the analog signal to a digital value
Analog Output (AO)	A continuously varying voltage or amperage signal that is generated from the controller after digital-to-analog conversion. The voltage or amperage signal will be used, for instance, to drive a modulating actuator or reset a hardwired set point on a packaged device. 6. Analog Value (AV): A network-visible analog point whose value is determined by a controller computation
Analog Variable / Value (AV)	A network-visible analog point such as a setpoint or calculation result whose value is determined by a controller computation or user input
Building Management System (BMS)	Integrated DDC Temperature control system used both for system operation and troubleshooting meeting the requirements of this specification.

1.4 WORK INCLUDED

A. Provide labor, materials, equipment, services and warranty for a complete installation, startup and commissioning of motor control wiring and temperature control wiring as required in Contract Documents.

B. Provide wiring and conduit required to connect devices furnished as a part of, or integral to the automatic temperature control system, and for motor control and interlocks regardless of the source of supply.
   1. Control wiring includes, as required, 120 volt and lower voltage wiring for control signals directing equipment operation. Control circuits shall be 24VAC in general, and no more than120 VAC where required.
   2. Provide wiring in accordance with the requirements specified in Division 26, "Electrical", Section 230514 and the National Electrical Code.
   3. Provide all devices required for proper system operation including electrical switches, transformers, disconnect switches, relays, device controllers and control modules, hubs, routers, temporary servers, actuators, transducers, sensors, safety devices, power supplies, mode selecting switches, enclosures, and circuit breakers.
   4. Provide complete wiring and terminations. Provide all assembly, programming and test of all items as necessary to create a coherent system, encompassing all combined intents of design, drawings, specifications, addenda, and professional quality of work.
   5. Assembly of all damper linkages and shafts, including extension through duct walls where applicable and mounting of actuators shall be by the Temperature Controls Contractor.

6. Mounting of all actuators and sensing devices shall be by the Temperature Controls Contractor.

C. The temperature controls contractor shall be responsible for extending 120vac power from designated power panels / circuit breakers to all temperature control panels.

D. Provide support requirements for Commissioning as described in Section 019113. The DDC temperature control system is a primary tool for HVAC Commissioning.

E. Coordinate all work with factory provided equipment controllers.

F. Coordination: Work with the Engineer, Commissioning Agent, air-balancing contractor, ventilation contractor, piping contractor and electrical contractor to provide proper and obstruction free component location, and system commissioning.

1.5 WORK NOT INCLUDED

A. Power wiring for motors, motor starters, adjustable speed drives, as well as the motors, motor starters, and adjustable speed drives (except in the case of equipment specified to have packaged controls/starters) are included in Division 26, "Electrical," unless otherwise called for.

B. Electrical wiring, interlocks or components specifically called out in the electrical specifications or drawings shall be included in the Division 26 scope of work.

1.6 ACCEPTABLE MANUFACTURERS

A. Noyes Memorial Hospital Building Management System is a Johnson Controls system. The project is designed and based upon the extension of this system.

B. All control systems in each building shall seamlessly integrate with the existing system without the use of integrator panels, routers, or any other hardware or software. The control system manufacturer shall guarantee that all new controls operate with the existing Johnson Controls System.

C. Basis of Design – Johnson Controls (JCI)

D. Acceptable Manufacturers - Automate Logic, Johnson Controls, Day Automation, Siemens

1.7 WORK INCIDENTAL TO TEMPERATURE CONTROL CONTRACTOR

A. The temperature control contractor shall furnish the following materials, for installation by the contractor responsible for HVAC piping and sheet metal (Sections 232000 and 233000) scope of work.

B. For piping work - Section 232000 Contractor shall install:
   1. Control valves in piping.
   2. Immersion sensing wells in piping systems.
   3. Valved pressure taps (typically for pressure switches or sensors)

C. For sheet metal work - Section 233000 Contractor shall install:
   1. Automatic Control Dampers:
      a. Control dampers, at the direction of the Temperature Controls Contractor.
   2. The Mechanical Contractor shall provide access doors or other means of access through ducts or ceilings and walls for service and adjustment of controllers, valves, and dampers.

D. Control system manufacturer or their authorized representative shall furnish written details, instructions and supervision for the above trades to ensure proper installation, size, and location of any equipment furnished for installation by others.

1.8 QUALITY ASSURANCE

A. Acceptable Products: All products shall be proven to be functional and suitable in accordance with this specification for a period of warranty commencing on the day of transfer of completed project to the Owner. Demonstration of such warranty may be required prior to the submittal approval.

B. Contractor Qualifications: The Temperature Controls Contractor shall be factory-authorized by the respective manufacturer to provide pertinent installation and service.

C. Any subcontractors in employ of the Temperature Controls Contractor on this project must receive prior approval to be permitted work on this project.

D. Field Representation: The Temperature Controls Contractor shall staff the project with a field representative that has been factory-trained in the installation, programming and commissioning of the equipment specified. This representative must be in the direct employ of the Temperature Controls Contractor.

E. Coordination of Work During Construction – this contractor shall:
   1. Protect work installed by other trades
   2. Coordinate its work with other trades
   3. Repair any damage caused by his work
   4. Promptly correct all work that Engineer finds as defective or failing to conform to Contract Documents

5. Bear all cost of correcting of work found defective as described above.

1.9 SHOP DRAWINGS AND SUBMITTALS

A. Product Data: Submit for approval the manufacturer's technical product data for each component furnished as part of the control system. Data shall include dimensions, capacities, performance characteristics, electrical requirements, and material finishes. Data shall also include installation and start-up requirements.

B. Shop Drawings: Submit for approval control drawings detailing the following:
   1. Network Block Diagrams and System Riser Diagrams: These diagrams shall depict all DDC components that make up the network. They shall provide specific detail on network terminations, and panel power requirements, including breaker allocation. Each DDC panel within the diagram shall list the equipment that it is controlling.
   2. Point-to-point Termination Detail: These drawings shall be created for each unique control application type. Drawings that are typical for similar application shall state the application and quantity of that they represent, and the specifics for each. All wiring and piping required to install and operate the system shall be represented in these details. For terminations that are unknown at the time of submittal, or introduced over the course of project, properly designate these as “Field determined terminations,” and include in the As-built Drawings after completion. All wiring and piping shall be number coded on the drawings. These tag numbers shall be used during the installation, and shall appear at both ends of all conductors, including within any junction boxes.
   3. Provide individual details for each control type, as described in the Sequence of Operation.
   4. Provide spreadsheets of schedules for dampers, valves, wiring, fans and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.
   5. For prefabricated control panels, provide panel’s interior and exterior layout details. These details shall depict the equipment layout and shall detail the panel wiring and piping.

C. Product Data: The BACS vendor shall submit manufacturer’s technical product data for each control device, panel, controller, and accessory furnished indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also, include installation, start-up, calibration, and maintenance instructions as well as all cable and tubing requirements.

D. Database Information: The submittal package shall contain detailed information on the point naming convention that is to be used.

E. Provide documentation for all sequences of operation that cannot be performed by stand-alone controllers and require non-controller-resident programs, or programs requiring retransmission to be effective on the controller’s output. Wherever possible, sequences of operation and associated inputs and outputs shall be contained on a single controller.

F. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface. All controllers and operator interface shall fully conform to ANSI/ASHRAE 135-2016: Data Communication Protocol for Building Automation and Control Systems (BACNET). Designer Note – remove if system is an extension of an existing non-BACnet system.

1.10 OPERATION AND MAINTENANCE MANUALS FOR COMPLETE PROJECT

A. Upon completion of installation and prior to the training, provide manuals containing the following information:
   1. Installation and Service Manuals for all products and components
   2. Calibration and Troubleshooting Procedures for all installed equipment and components.
   3. List of location of all enclosures, controllers, sensors, transformers and other components as specified above
   4. As-built Control Drawings with all modifications, changes and wiring details that depict actual installation. These shall include all final controller and device names, locations for concealed components (pressure sensors, etc.),wire tags, etc.
   5. Sequence of operation – Describing in detail the operation of every piece of equipment subject to control by the DDC system. Each section of the sequence should contain the following:
      a. Overview – describes what the intent is, what components are involved and provides a concise description of the piece of equipment to be described.
      b. Occupied Mode – Describes the operation of this system during occupied periods.
      c. Unoccupied Mode – Describes the operation of this system during unoccupied periods.
      d. Alarm Mode - Describes operation of the system in the event of alarm condition and steps to restore system to normal operation. List all anticipated alarm conditions.
      e. Each Component's individual Sequence - Describes the detailed operation of each component and how it interacts with the entire system.
   6. Listing of the entire DDC controllers with database, software and programs and program locations.
   7. Provide spreadsheets of schedules for enclosures, control modules, dampers, valves, wiring, fans, well, tap and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.

B. Provide laminated control diagrams in each control panel for each piece of major controlled equipment or system.

C. Backup database information in electronic format (other than resident on computer hard drive) to be left on-site that will allow the Owner to fully download the entire DDC System software, including programming point database, configuration, graphic screens and all library of typically composed objects, and details supporting navigation, screens and graphics.

D. Within five working days from the time of the final system commissioning, one (1) hard copy and one (1) electronic copy in PDF format of Operation and Maintenance Manuals shall be turned directly to the Engineer.

E. A Programmers Manual shall be provided with graphic and text descriptions of all functions required for software modifications and developments. The use and installation of high-level programming language shall be included in this manual. The manual shall include ASCII text (or block diagram printouts for graphical programming language based systems) of all DDC programs with the spreadsheet inventorying the name and location of each program. Each file shall be accompanied by a "plain English" description of the program operation by subroutine to assure that future programmers can easily modify the existing database. The manual shall contain computerized printouts of all data file construction including all point information, physical terminal relationships, scales and offsets, alarm limits, messages, schedules, etc. The manual should also contain:
1. System overview
2. Networking concepts
3. Launching browsers from log in
4. Schedule manipulation
5. Software upload and download instruction, including field devices
6. Trend and alarm creation and maintenance
7. Report generation
8. Backup procedure for entire system and modular controllers
9. Sequence of Operation

F. Section for each Major Piece of equipment – Contains the cutsheets for the controllers, custom programs, and relevant information pertaining to that piece of equipment. (IE: schedules for AHUs showing Equipment Tag, Controller address, serial #, airflow, and pertinent engineering units like MBH, GPM, etc…).

G. Wiring Details – Contains 8-1/2" x 11" drawings of all the wiring details shown throughout the set of drawings.

H. Instrumentation Cut sheets – Contains the Manufacturer's original cut sheets for all the instrumentation used on the job. (IE: Well sensor, transformers, enclosures, pressure sensors, etc.).

I. AutoCAD Drawings – All drawings shall be provided in Auto CAD format (i.e. each file format should have the ".dwg" extension), made as set of both, a set 11"x17" black and white and a set of 24"x36" (1 color set and 3 black and white sets). Drawing Sets consists of the following:
   1. System Description Drawing – Shows the overview of the job and what is being controlled.
   2. Network Riser Drawings – Shows how the network is connected between all the devices on the job
   3. Detail drawing(s) – Shows all the wiring and piping details for the entire job – all other drawings refer to these drawings.
   4. Individual Control panel drawings & Schematics (1 or 2 drawings per piece of equipment) Shows the EXACT wiring and layout of each control panel. Also shows the schematic representation of the system that is being controlled. (IE: AHU, HW Plant, Fan Coil, Etc.)
   5. Controls Floor plans (at least 1 for each floor) – Shows the approximate location of the control panels, thermostats, equipment, network wiring, thermostat wiring and any specific controls required for the job. All this information is overlaid on top of the mechanical floor plan showing the architectural layout (Wall and room #'s).

J. All above shall be copied to a CD (or another approved electronic format) and released to the Owner.

1.11 SYSTEM PRE-COMMISSIONING

A. In addition to responsibilities described within section 019113, and prior to formal project commissioning contractor shall complete the following Pre-Commissioning requirements to assure operational readiness of equipment prior to conducting commissioning.

B. Equipment Start-up: Upon completion of installation, all equipment being controlled shall be initially started and tested on site using a workstation configured identically to that to be presented for permanent use by the Owner, including graphical user interface. Upon completion of all system pre-commissioning (and 019113 commissioning) the entire contents of the workstation, including all changes and corrections performed during these phases, shall be re-loaded to the permanent operator workstation.

C. System Pre-Commissioning shall document the following:
   1. Measure, calibrate and adjust all analog inputs. This is to be performed in a manner that verifies that sensors meet the accuracy requirements as specified for the device. All measurements shall be taken using an instrument certified for accuracy within a 12 month period.
      a. Where multiple sensors are "in line" within an air handling system – such as VAV leaving air temperature sensors vs an AHU leaving air temperature, or return / mixed / coil discharge sensors (with economizer correctly positioned) within an air handler, only one of the sensors need be directly measured, and the balance may be validated against the reference sensor.

b. Where multiple sensors are “in line” within a piping system, the system may be manipulated such that only one sensor need be directly measured, and the balance may be validated against the reference sensor.

2. Stroke all analog outputs from 0% to 100%
   a. Visually verify that all linkage adjustments are set properly.
   b. Verify and record range of operation for ASD commands
   c. Verify and calibrate ASD feedback signals to correspond with command signal and actual operating speed in either RPM or HZ.

3. Valves and Dampers shall fully close and provide tight shut-off.
   a. Hydronic coils – verify that no temperature rise / drop occurs with the valve commanded fully closed
   b. Economizers – Verify return air temperature =mixed air temperature at 100% return air position, mixed air temperature = outdoor air temperature at 100% outdoor air position

4. Verify that all binary outputs are properly energizing the controlled device.
5. Verify that all binary inputs are properly calibrated to accurately reflect status of monitored equipment
6. Adjust setpoints so that equipment operates properly. Tune all PID control loops to avoid unnecessary cycling of control equipment, overheating, sub-cooling, tripping of freezestats or other limit switches and safeties. Create trends for review by the Engineer and Commissioning Agent.
7. Provide control and operational assistance to the balancing personnel during testing and balancing procedures.

D. Communication Network Start-up: Verify from a host computer that all configured controllers are engaged in proper communication passing all configured points to viewing stations. Verify communication speed and level of transactions until it is acceptable and meets the requirements of this specification.

E. Software Verification: All programs and software functions shall be verified to be in compliance with the contract documents for proper sequence of operation.

F. Pre-Commissioning Report: A report shall be provided to the Engineer detailing the dates, times and person(s) performing each phase of the specified system pre-commissioning. This report shall detail when and who performed the individual processes described in this section, and documents the results of all testing procedures. Coordinate phasing of work such that this can be completed PRIOR to formal system commissioning.

G. Project commissioning is considered complete only once the following are completed:
   1. Pre-commissioning as described under this paragraph 1.11 is performed, the associated report submitted and approved. All points connected to the BMS shall operate in full compliance with this specification before project substantial completion is acknowledged.
   2. The project formal commissioning as outlined under section 019113 is performed, including completion of all remedial work to correct Issues log items,
   3. A physical walk-though of the project, conducted by the Engineer or Commissioning Agent and attended by the Temperature Controls Contractor and Owner or their authorized representative is concluded
   4. The complete set of required closeout documentation is provided by the contractors. The Owner has no right to refuse or delay a reasonably scheduled walk through. The Owner and Engineer shall determine the level of detail required for the walk-through, and may take this to a component level inspection, at their discretion.

1.12 TRAINING

A. Provide BMS training for up to four (4) Owner selected personnel.

B. After Section 019113 Commissioning is complete as specified, the Temperature Controls Contractor shall provide an on-site session detailing the layout of the BMS. This shall include network wiring routes, control panel locations, transformer locations, etc.

C. The Temperature Controls Contractor shall then provide an on-site session to review the entire Operations and Maintenance manual(s) with the Owner. This session shall also include but not be limited to:
   1. Fundamental operation of the system
   2. Training on setpoint adjustment and scheduling modifications
   3. Operation and sequencing of control loops for all mechanical equipment being controlled

D. Provide telephone support and answer system relevant questions throughout the warranty period.

1.13 WARRANTY

A. Warranty for the entire control system shall commence upon completion and acceptance by the Engineer of the system commissioning as specified. The warranty includes fine-tuning of all dynamic elements of control system to achieve reasonable, efficient end equipment protective mode of operation.

B. Provide a one-year warranty on all DDC controllers.

C. Provide a one-year warranty on all other components.

D. Disclose to Owner and accommodate longer warranty periods if provided by components manufactured at the time of purchasing.

E. The Contractor shall provide all OEM recommended preventative maintenance of the installed work as described in the operating and maintenance manuals during the warranty period. In addition, the Contractor shall provide two (2) semi-annual service visits (i.e., one visit during the peak cooling season and one visit during the peak heating season) to test and evaluate the performance of the installed work. The Contractor shall provide a written report of the test and evaluation results. The service visits shall include, but not be limited to:
   1. Checking and, if necessary, correcting the calibration of the sensors, transducers, and transmitters for airflow, liquid flow, pressure, and temperature.
   2. Checking and, if necessary, correcting the operation of the dampers and damper actuators.
   3. Checking and, if necessary, correcting the operation (i.e., monitoring and command) of the system points, graphics, and display functions.

F. Software and Hardware Updates: At the end of the first six months after acceptance, and during the subsequent six-month period, the BACS contractor shall update the equipment and any controllers, servers, workstations and HMI web servers with the latest modification and improvements in software, firmware, and hardware that the manufacturer may have incorporated in the furnished equipment.

G. Contractor shall, during the ensuing four seasons (one year), conduct periodic inspections and fine-tune all dynamic elements of the system with all costs of testing to be included in this scope of work.

PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION

A. General Requirements
   a. A distributed logic control system, complete with Direct Digital Control (DDC) software shall be provided. This system is to control all mechanical equipment, as described on the project drawings and these specifications.
   b. All controllers for terminal units, air handlers, central mechanical equipment and the Microsoft Windows-based operator's terminal(s) shall communicate and share data.
   c. All controllers shall be fully programmable.

d. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.

e. DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device.

f. All control points associated with a single piece of equipment (air handler, VAV air terminal, heat exchanger, pump control, etc.,) shall be wired to the local controller. Network sharing of data via the network, for example, remote monitoring of a temperature sensor to control a valve or other devices, shall not be permitted without advance permission from the Engineer.

g. The Temperature Controls Contractor shall assume complete responsibility for the entire controls system as a single source, providing installation, program debugging and service of all portions of logic control system. This shall include designated server, operator's terminal, global controllers, routers, terminal unit controllers, sensors and all other sections of the system.

h. During construction, at least one operator's terminal shall be equipped to act as a system server / operator interface. This system server shall store copies of all installed software for all field components and shall be capable of automatic or manual reloading of such software into the field components as required. The system server shall also gather and archive system-operating data, such as trends, energy logs, and other historical operating data. Complete energy management firmware, including self-adjusting optimum start, demand limiting, global control strategies and logging routines for use with total control systems shall be supplied. All energy management firmware shall be resident in field hardware and shall not be dependent on the operator's terminal for operation. Operator's terminal software is to be used for access to field-based energy management control firmware only. All schedules shall be module resident and shall not be affected in case of interruption network transport between the module and the host station.

i. Upon completion of the project, the Contractor shall transfer and install to all software, graphics, etc., associated with the scope of this project to the existing operator workstations

B. Basic System Features

a. Direct digital logic control of temperature, scheduling, optimum start, equipment alarm reporting and override devices for unoccupied mode of operation.

b. Operator's terminal software (Graphical User Interface or GUI) shall run under Microsoft Windows operating system. Software shall be multi-tasking, capable of executing and displaying multiple instances in individual windows while running concurrently with other Windows programs such as word processors or database programs. Operation of the terminal software shall be simple and intuitive.
c. Operator's terminal software shall contain graphical user interface software, allowing configuration of system-wide controllers.
d. Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for network communications and interface to the internet as required to allow for remote access to system operations.
e. The system shall meet peer-to-peer communication services such that the connection of any operator interface to any one controller shall allow the operator to interface with all other controllers. The software shall provide transparent viewing and editing of all data, control programs, schedules, trends, alarms from any one controller through connection to any other controller on the internet work, regardless of subnetwork routers.
f. Priority password security systems shall prevent unauthorized use. Each user shall have an individual password. The user shall only be given access to the system functions required for individual job performance.
g. Equipment monitoring and alarm functions, including information for diagnosing equipment problems shall be included with the system.
h. The complete system, including, but not limited to terminal unit controllers, higher level controllers and operator's terminals shall auto-restart, without operator intervention, on resumption of power after a power failure. Database stored in any controller's memory shall reside error free for a minimum of 30 days. Logic controllers for all air handlers and all unitary equipment shall utilize EEPROM or battery backup for all variable data storage.
i. System design shall be modular.
j. All software and/or firmware interface equipment for connection to remote monitoring station from field hardware or the operator's terminal shall be provided.
k. System shall be capable of equipment runtime totalization of fans, heaters, boilers, etc. And capable of alarm generation and alarm dial out.
l. All hardware shall be listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the UL Standard for Safety 916 in both the US and Canada, with integral labels showing rating.
m. All hardware shall be in compliance with FCC Part 15, Subpart J, Class A.

2.2 SYSTEM PERFORMANCE

A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation.
   a. Graphic Display. A graphic with a minimum of 20 dynamic points shall display with current data within 10 sec.
   b. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec.
   c. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
   d. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
   e. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.
   f. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 1 sec. Select execution times consistent with the mechanical process under control.
   g. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
   h. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.
   i. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 1.

[Designer note – Edit or add to table for other or critical applications.]

Table 1 - Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Water Flow	±2% of full scale	
Dew Point (note 1)	±1.5ºF	
Water Temperature	±1.2 ºF	
Air Pressure (note 2)	±0.05 in. w.g.	1-6 in. w.g.
Air Pressure (note 2)	±0.03 in. w.g.	±0.25-1 in. w.g.
Air Pressure (note 2)	±0.005 in. w.g.	±0-0.25 in. w.g.
Airflow	±5% of full scale	
Space Temperature	±1.0ºF	
Duct Temperature	±1.2ºF	
Fluid Pressure (note 2)	±0.5 psi	
CO2 Sensors	50ppm	400-2000ppm

NOTE 1: Accuracy applies to 10% - 90% of scale
NOTE 2: For both absolute and differential pressure

GENERAL NOTE - Sensors to be selected such that measured media is near middle third of sensor range

2.3 TEMPERATURE SENSORS

A. General
   a. Sensors shall have a limited lifetime warranty.
   b. All devices shall use precision thermistors unless stated to the contrary in this section.
   c. Provide NEMA 1 termination box unless otherwise specified

B. Sensor Specifications
   a. Space Sensors:
      a) Standard Space sensor shall be available in an off-white enclosure for mounting in a standard electrical box. Mount at 48" height.
      b) Sensors in public areas shall be provided without local temperature indication, setpoint adjustment or setback override.
      c) Sensors in private / staff only areas shall be provided with local temperature indication, setpoint adjustment and setback override functions.
      d) Where potentially subject to damage (stairwells, gyms, corridors) or as directed by the Owner or Engineer, provide bushed stainless steel blank wall plate type sensors.
      e) Where determined cost effective and approved by the Owner and Engineer, the use of wireless room temperature sensors shall be permitted. Siemens QAA2391.FWTC (with temperature display) override and setpoint adjustment) or QAA2301.DWTC (temperature display only) or approved equal. [Contractor shall be responsible for components and requirements necessary to eliminate operational conflicts between these components and other systems within the facility.
      f) Where space sensors are connected to dedicated terminal unit controllers, they shall be equipped with local communication interface for troubleshooting and balancing purposes. Provide all required wiring from the terminal controller to the space sensor to allow for interface to a local laptop interface device.
      g) Wall Plate Sensors - Blank wall plate style sensors, Kele KTP Stainless Steel Flush Mounted Thermistor and RTD Sensors or approved equal. Provide only where specified or called out on project drawings

   b. Duct Sensors:
      a) Single point duct mounted sensors shall have a minimum 8" rigid probe and be used when the duct size is less than 24"or where duct stratification is not present, such as downstream of fans.

b) Averaging duct-mounted sensors shall have a minimum 8’ long averaging element and be used when the duct size is greater than 24". All averaging sensors shall use true averaging elements such as platinum (or equivalent) or balco. Averaging bridges [multi-point sensors] are specifically not permitted. Provide averaging sensors in all locations where specified or where temperature stratification can occur. Minimum element to be provided, 1 ft. per 2. sq ft of area. Securely support all elements to avoid movement in air stream or long term damage at stress / mounting locations. Supports shall provide radius bend support and insulation to avoid thermal bridging.

c) Averaging duct-mounted sensors shall have a minimum 8’ long averaging element and be used when the duct size is greater than 24". Where multi-point thermistor averaging sensors are to be used, sensing element spacing not to exceed 16”. Provide averaging sensors in all locations where specified or where temperature stratification can occur. Minimum element to be provided, 1 ft. per 2. sq ft of area. Securely support all elements to avoid movement in air stream or long term damage at stress / mounting locations. Supports shall provide radius bend support and insulation to avoid thermal bridging.

c. Well Sensors:

a) Liquid immersion sensors shall have a stainless-steel probe and a stainless steel or brass well. Length of the sensor well shall be selected based on the diameter of the pipe to provide accurate, reliable sensing of the liquid temperature.

d. Outside Sensors:

a) The sensing element shall mounted inside a ventilated, treated, sun shield to minimize the radiant energy and wind effects. Sensor location shall be selected to minimize effects from sunlight, building heat, exhaust systems, etc. Temperature Controls Contractor shall be responsible for selection of an appropriate location. Where sensor location is determined to be adversely affected by outdoor conditions, this contractor shall relocate the sensing devices to a more reliable position.

2.4 THERMOSTATS

A. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

B. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

2.5 HUMIDITY SENSORS

A. Duct and room sensors shall have a sensing range of 20%-80%, minimum accuracy of +/- 2% over this span.

B. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH, minimum accuracy of 2% this span, and shall be suitable for ambient conditions of 0°F-140°F.

C. Humidity sensors shall not drift more than 1% of full scale annually.

D. Temperature compensation of RH reading.

E. Two-year warranty from date of installation.

2.6 FLOW SWITCHES. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service). Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).

A. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.

B. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

2.7 RELAYS

A. Control Relays. Control relays shall be UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

B. Time Delay Relays. Time delay relays shall be solid-state, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

2.8 OVERRIDE TIMERS

A. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

2.9 CURRENT TRANSMITTERS

A. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500-ohm maximum burden.

B. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.

C. Unit shall be split-core type for clamp-on installation on existing wiring.

2.10 CURRENT TRANSFORMERS

A. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.

B. Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.

C. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

2.11 VOLTAGE TRANSMITTERS

A. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

B. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be ±1% full-scale at 500-ohm maximum burden.

C. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

2.12 VOLTAGE TRANSFORMERS

A. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.

B. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.

C. Windings (except for terminals) shall be completely enclosed with metal or plastic.

2.13 POWER MONITORS

A. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.

B. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

2.14 CURRENT TRANSDUCER / EQUIPMENT INTERFACE RELAY

A. Low voltage, single phase:
   a. Combined status sensor, command relay, and hand-off-auto switch.
   b. Sized for monitor and control of small motors.
   c. Field selectable relay output.
   d. High and low voltage isolation.
   e. Industrial grade load switching relay.
   f. Mountable on single or double gang boxes, flush on starter enclosures, or stand-alone.
   g. Approved for installation in the following environmental conditions:
      a) 0-95% RELATIVE HUMIDITY, NON-CONDENSING.
      b) –15° TO 60° C
   h. Design equipment: Veris Hawkeye H500.
   i. Alternative components combining the total functionality of the specified device may be submitted for approval.

2.15 PRESSURE TRANSMITTERS

A. Pressure transmitters shall be of 2-wire, 4-20 mA / 0-10vdc output type with a capacitance element having an accuracy of +/- 1% over the entire range. Transmitter shall include protection against reverse polarity and supply voltage transients. Accuracy and zero span adjustment shall be provided with each transmitter to allow for recalibration as necessary.
   a. Liquid Pressure
      a) The operating range shall be -40.0 to 176.0 F.
      b) Safe overpressure shall be a minimum of 150% of the rated pressure.
      c) Sensor range to be selected so anticipated control setpoint resides in the middle third of the sensor span.
      d) Use of two discrete pressure sensors and mathematical determination of system differential pressure is acceptable.

e) Differential pressure sensor shall use a five-valve manifold to allow proper service and removal of air from the sensing lines without damage. Locate such that the lines from the primary piping can be properly drained and vented. Provide isolation at the mains to allow service to the assembly.
f) Shall be contained in an aluminum NEMA-1 enclosure.

b. Air Pressure

a) The operating range shall be -40.0 to 176.0 F.
b) Safe overpressure shall be a minimum of 150% of the rated pressure.
c) Sensor range to be field selectable so anticipated control setpoint resides in the middle third of the sensor span.
d) Sensor shall have local readout.
e) Sensor shall be equipped with reverse polarity protection.
f) Sensor shall have ability for field zero of reading and output.
g) Shall be contained in an aluminum NEMA-1 enclosure.
h) Not to be provided when Space Pressure Monitor (SPM) / Room Pressure Monitor (RPM) is specified or called out on the drawings.
i) Sensor warranty shall be 3 years.
j) Design Make – BAPI ZPS series

2.16 DIFFERENTIAL PRESSURE SWITCHES

A. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

2.17 PRESSURE-ELECTRIC (PE) SWITCHES. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-175 kPa (0-25 psig), with calibrated scale minimum setpoint range of 14-125 kPa (2-18 psig).

A. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.

B. Switches shall be open type (panel-mounted). Exception: switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.

C. Each pneumatic signal line to PE switches shall have permanent indicating gauge.

2.18 ENCLOSURES

A. Enclosures shall be NEMA-1 rated steel, finished to control oxidation in a highly humid atmosphere.

B. Each enclosure shall have a hinged door with handle and keyed lock

C. Shall provide 40% of free space for future expansion of the system.

2.19 DAMPER MOTORS

A. Electronic:
   a. Electronic actuators shall be driven directly by 0-10 VDC, supply power: 24 VAC or 30VDC, as acceptable to its controller, and provide adequate torque to meet the application.
   b. Where actuators over 30vdc requirement are supplied, coordinate with furnishing contractor for all wiring requirements in compliance with NEC and these specifications.
   c. Electronic actuators shall be direct-coupled type.
   d. For all actuators, assure execution of the fail-safe position in case of the Freezestat trip or power loss.
   e. Actuators to be sized for smooth operation over entire range and a minimum of 150% of required torque for connected components.
   f. Design Make: Belimo, Neptronic.

2.20 CONTROL DAMPERS

A. Blades are extruded aluminum profiles. Aluminum end caps are press fitted to blade ends in order to seal hollow interior and reduce air leakage rates.

B. Blade and frame seals are extruded silicone and are secured in an integral slot within the aluminum extrusions.

C. Bearings are composed of a Celcon inner bearing fixed to a 7/16" (11.11mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.

D. Linkage hardware is installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.

E. Dampers are designed for operation in temperatures ranging between -40°F (-40°C) and 212°F (100°C).

F. Dampers are available with either opposed blade action or parallel blade action.

G. Leakage class 1A at 1” w.g. Static pressure differential. Standard air leakage data is certified under the AMCA Certified Ratings Program.

H. Two position dampers - Pressure drop not to exceed 0.2”wc as installed. If frame is fully within the duct, the pressure drop calculations shall account for this installation method.

I. Modulating Control Dampers shall be sized by the temperature control manufacturer. Maximum velocity shall be 1500 fpm and maximum pressure drop shall be 0.15 in w.g, not to exceed 0.2”wc. Dampers shall be of adequate authority and sized and positioned to allow for smooth modulation of controlled air streams.

J. Damper pressure drops shall take into account the as-installed position and be certified for pressure drop per AMCA standard 500-d.

K. Dampers are available in two mounting types: i.e., "Installed in Duct" or "Flanged to Duct".

L. Provide thermally broken frame design where use of standard frame could cause condensation or operational issues.

M. Installation of dampers shall be in accordance with current manufacturer’s installation instructions.

N. Dampers over 48 in. In length and height shall be made into multiple sections.

O. Automatic dampers are required at all exterior walls and roof openings. Dampers to open when respective fan starts. Dampers at exterior walls and roof openings shall be insulated blade, thermal break design.

P. Design make: Tamco 1500 series (standard), Tamco 9000 series (outdoor air intake and exhaust / relief locations)

2.21 CONTROL VALVES

A. General:
   a. Valves shall be applicable for the rated pressure and temperature service. Close off pressures must be determined in concert with the actuators and valves shall be provided to close off against extreme anticipated conditions. Valves shall be selected such that they are not, as a practice, “oversized.”
   b. Modulating valves shall be carefully selected to control in a smooth and stable fashion across the range of anticipated conditions. “Split ranging” of heating and cooling valves controlled by the BMS is not acceptable. A separate output from the BMS shall be provided for all control valves. When the selection criteria indicated below are not met, flow characteristic analyses shall be submitted to demonstrate reasonable correlation between stroke and flow.

c. Modulating actuators for Primary Equipment (air handlers, etc.) shall be selected for smooth actuation over the entire operating range, use a 24vac power supply, and respond to an electronic input of: 4-20 mA or 0-10 VDC.
d. Actuators using “floating point” (bi-directional) for positioning shall be permitted on VAV box dampers and VAV reheat valves. Additional applications may be permitted with advance permission by the Engineer.
e. Pulse Width Modulation (PWM) actuators will not be permitted.

B. Provide factory fabricated control valves with operators as required by this specification. Provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with specified maximum pressure drop across control valve. Equipment control valves with heavy duty actuators, with proper shut off rating for each individual application.

C. Valves shall be selected to perform as specified taking into account inlet and outlet piping geometry correction factors. Temperature control contractor shall instruct mechanical contractor on correct installation technique and verify that installation matches manufacturer’s requirements for proper performance.

D. Design Pressure Drop –
a. Water Service Valves - Unless specified to the contrary, valves shall be selected for a pressure drop approximately equal to that of the connected equipment, but less than 3 psi at design water flow.
b. Steam Service Valves: Linear characteristics for 90% of closing stroke and equal percentage for final 10 percent with range of 30 to 1, and maximum full flow pressure drop of 50% of inlet pressure for low pressure systems, and 42% for high pressure systems. Two-position valves shall be line size.

E. Single Seated Valves:
a. Cage type trim, providing seating and guiding surfaces for plug on “top and bottom” guided plugs.
b. Valve Trim and Stems: Polished stainless steel.
c. Packing: Dual O-Ring up to 1 ½”, Spring-loaded Teflon, self-adjusting 2” and up.
d. Bodies, 2" and Smaller: Bronze with screwed end connections, replaceable brass seat. 125 psig rated, minimum
e. Bodies, 2 1/2" and Larger: Cast iron with flanged end connections, replaceable brass seat. 125 psig rated, minimum.

F. Ball Valves:
a. Modulating water valves shall be ball valves with an equal percentage characteristic.
b. Type: Two or three-way as called for, V-port ball valve with characterizing disk, 1/4 turn.
c. Packing: EPDM O-rings, lubricated.
d. Ball & Stem: Stainless steel.
e. Seat: Fiberglass reinforced Teflon.

f. Actuator: Electric, one motor only; valves 4 inches and larger shall have single operator.
g. Flow Characteristic: Equal percentage.

G. Actuator: Electric, one motor only
a. Failure positions shall generally be as follows, contact owner for special circumstances requiring deviation from these requirements:
a) Terminal hot water radiation: fail last
b) Fan Coil Unit cooling coils: normally closed spring return
c) Pre-Heat coils in air handling units: normally open spring return

b. Input signal: 0-10 VDC, equipped with spring failure position return all heating applications. “Floating point” actuation allowed only where specifically noted elsewhere in the contract documents.
c. The Back-to-back electronic actuations, i.e., where two identical actuators are engaged in operating the rising or rotation of valve stem are not permitted.
d. Valve Closeoff:
a) Water – 120% of total system (pump) head.
b) Steam – 200% of system operating (inlet) pressure.
c) Valves to be used on this project shall be suitable for complete closeoff to the levels stated under modulating duty. In the event that manufacturer’s data provides a separate maximum differential pressure under modulating duty, both criteria shall exceed the above requirements.

2.22 SAFTEY/STATUS DEVICES

A. Low Limit Detector (“freezestat”): Electric type, with manual reset and auxiliary contacts to the DDC, set for 37°F for "freeze" protection and 55°F for fan discharge application. Provide a 20' long element for every 25 sq. Ft. Of coil face area or fraction thereof. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

B. High Limit Detector (“firestat”): Electric type, with manual reset and auxiliary contacts to the DDC, UL Listed for fire, set for 180°F.

C. Pump status through adjustable range current sensing element on pump motor. Calibrate to actual conditions.

D. Fan status through adjustable range current sensing element on the fan motor. Calibrate to actual conditions.

2.23 COMMUNICATIONS

A. Install new wiring and network devices as required to provide a complete and workable control network.

B. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

C. Internet operator interface and value passing shall be transparent to network architecture.
   a. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
   b. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

D. System shall automatically synchronize system clocks daily from an operator-designated controller via the network. If applicable, system shall automatically adjust for daylight saving and standard time.

E. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.24 OPERATOR INTERFACE

A. All operator workstation functions shall be updated on the existing operator workstation(s) to reflect the new equipment and systems installed under this project.

B. Provide an operator workstation, location to be coordinated with Owner requirements. Workstation to be “Web Based” using a standardized web browser for interface to the BMS for all functions described herein.

C. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
   a. Log In and Log Out. System shall require user name and password to log in to operator interface.
   b. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
   c. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, pid gains, on and off controls, and sensor calibration.

d. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.

e. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.

f. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.

g. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.

h. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.

I. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

D. System Software

a. Operating System. Workstation server shall operate on Microsoft Windows 10.

b. System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

a) Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.

b) Animation. Graphics shall be able to animate by displaying different image files for changed object status.

c) Alarm indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

d) Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

e) Provide a link from each piece of graphically represented equipment to the associated wiring diagram and sequence of operation.

E. System tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.

a. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.

b. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.

c. System Configuration. Operators shall be able to configure the system.

d. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.

e. Security. System shall require a user name and password to view, edit, add, or delete data.

a) Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.

b) Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.

c) Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.

f. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).

g. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object.

h. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.

i. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.

j. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.

k. Trend Configuration. Operator shall be able to configure trend sample or change of value interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk.

l. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.

m. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.

n. Standard Reports. Furnish the following standard system reports:
   a) Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
   b) Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
   c) Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
      (1) Alarm History.
      (2) Trend Data. Operator shall be able to select trends to be logged.
      (3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

o. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.

p. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

q. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language (or block language equivalent) shall have the following features:
   a) Language. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.
   b) Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
   c) Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
   d) Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
   e) Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.
      (1) Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
      (2) System Variables. Operator shall be able to use predefined variables to represent status and results of controller software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

2.25 CONTROLLER SOFTWARE

A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

B. Scheduling. System shall provide the following schedule options as a minimum:
   a. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
   b. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule, has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
   c. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

C. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

D. Alarm Reporting.

E. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms.

F. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits.

G. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

H. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

I. Startup Optimization – All equipment noted in the sequences of operation to have scheduled operation shall be started on an optimized basis which attempts to reach occupied conditions just prior to the scheduled occupancy time.

J. Pressure control optimization – All equipment noted in the sequences of operation (fans and pumps) shall have reset of pressure control setpoint initiated in the sequence. Typically, for pumps this would cause the software to examine all connected control valves for position, determine the critical valve (defined as the valve at the highest demand position), and reset the pressure setpoint up or down to maintain the critical valve between 80 and 90% open. For fans serving zone air valves / VAV boxes, this would similarly reset the duct pressure setpoint to maintain the critical zone damper between 80 and 90% open.

K. Heating Water Pump Control – Whenever heating demand reaches a minimum controllable threshold; the heating pumps shall be disabled and the heating water system shut down until demand for heating / reheat reaches a controllable level. This shall apply only in non-critical environment, exclusions apply to medical and laboratory application.

L. Energy Calculations.
   a. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
   b. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

M. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

N. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

O. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified.

2.26 CONTROLLERS

A. General. Provide controllers and accessory devices as required to achieve performance specified.

B. Communication
   a. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
   b. Signal Management – Master or Global Controller operating systems shall manage input and output communication signals to allow distributed controllers (lower level networks) to share real and virtual object information and to allow for central monitoring and alarms.
   c. Data Sharing. Each Master or Global Controller shall share data as required to allow the specified performance and sequence of operation.
   d. Stand-Alone Operation. Each piece of equipment specified shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

C. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
   a. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
   b. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

D. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

E. Serviceability
   a. Controllers shall have diagnostic LEDs for power, communication, and processor.
   b. Wires shall be connected to a field-removable modular terminal strip or to a termination card to allow service without rewiring the controller.
   c. Each controller shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

F. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 hz and from keyed radios up to 5 W at 1 m (3 ft).

G. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.27 INPUT AND OUTPUT INTERFACE

A. General. Hard-wire input and output points to all controller hardware.

B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

C. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

E. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

G. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.

I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.28 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
   a. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
      a) Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
      b) Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering
   a. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
      a) Dielectric strength of 1000 V minimum
      b) Response time of 10 nanoseconds or less
      c) Transverse mode noise attenuation of 65 dB or greater
      d) Common mode noise attenuation of 150 dB or greater at 40-100 Hz

PART 3 - EXECUTION

3.1 WIRING

A. All wiring shall comply with these specifications, Specification Section 230514, and the NEC. Deviations are only permitted where manufacturer's requirements specifically conflict with gauge and wiring type specified within this section.

B. Communication wiring shall be installed using the particular system recommended, plenum rated, jacket shielded cable. The communication network wiring shall be clearly marked with a specific color code. Communication wiring shall not be installed near noise producing equipment, such as ballasts, magnetic starters, etc. Communication wiring shall comply with the optimum requirements necessary to assure communication integrity and speed.

C. All analog inputs and analog outputs shall be wired using 18 gauge stranded shielded cable. All Analog inputs and analog outputs wiring shall not be installed near noise producing equipment, such as ballasts, magnetic starters, etc.

D. All digital outputs shall be wired using 18 gauge stranded wire.

E. All wiring in mechanical rooms, walls shall be installed in EMT conduit. Concealed conduit and wiring is required in all finished spaces.

F. Power Supplies

1. Transformers – Each w/ low voltage fuse holder/disconnect
2. Actuators and relays shall use separate transformers from those powering microprocessor control panels.
3. Transformers shall be sized for a minimum of 150% of the connected load.
4. Convenience Outlet –
   a. 110vac combination outlet w/ switch to kill 110vac to panel
5. Switched 110vac to panel is fused before transformers (after outlet).
6. Provide at all control panels excepting those for terminal equipment (exclude reheats, cabinet heaters, fan coils, etc.)
7. Wiring Panduit
   a. Wire ducts around exterior of panel for cables entering panel
   b. Wire ducts as necessary to route hookup wires from terminals to controllers and other devices
8. Panel Construction (sized to provide 25% future expansion w/ removable back panel)
   a. Indoors – Johnson M8100 series
   b. Outdoors – Hoffman fiberglass Nema 4x
9. Wire Labeling
   a. All DDC system wiring shall be individually labeled and permanently tagged at both ends of the conductors, including within all junction boxes between panels.

b. All submittal and as-built drawings shall reflect the field installed wire tag numbers.
c. All wire numbers shall be unique throughout the system installation.

3.2 DDC EQUIPMENT

A. All components shall be installed in protective enclosures. All wiring within the DDC enclosure shall be number coded. Both the enclosure and the controller shall be properly grounded in accordance with manufacturer's recommendation. Documentation shall be firmly attached to the enclosure within a plastic envelope. Documentation shall state point-to-point termination detail, description of each individual point, location of power source for the controller and ID number or address within the network.

B. All DDC Controllers shall be mounted on walls within equipment rooms, custodial closets or electrical rooms. Only application-specific controllers for rooftop units or package units may be mounted on the equipment.

3.3 EXAMINATION

A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.

B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.

C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate work of others. Temperature Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.4 PROTECTION

A. Temperature Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.

B. Temperature Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.5 COORDINATION

A. Site.
1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Test and Balance.
1. Furnish Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing for the duration of TAB activity
2. Train Test and Balance Contractor to use control system interface tools.
3. Provide a qualified technician to assist with testing and balancing of all air handling equipment and terminal units.
4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

C. Life Safety.
1. Duct smoke detectors required for air handler shutdown are furnished and installed by others. Interlock smoke detectors to air handlers for shutdown as specified Sequence of Operations for HVAC Controls.
2. Smoke dampers and actuators required for duct smoke isolation are furnished and installed by others. Interlock smoke dampers to air handlers as specified in Sequence of Operations for HVAC Controls.

D. Coordination with Other Controls. Integrate with and coordinate controls and control devices furnished or installed by others as follows.
1. Each supplier of a controls product shall configure, program, start up, and test that product to meet the required sequences of operation regardless of where within the contract documents those products are described.
2. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
3. Temperature Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

3.6 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

B. Independently support all temperature control wiring from other systems. Do NOT support from conduits, piping or hangers for equipment.

C. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

D. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

E. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

F. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.7 FIELD QUALITY CONTROL

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances.

B. Continually monitor field installation for code compliance and workmanship quality.

C. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.8 COMMUNICATION WIRING

A. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

B. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

C. Verify entire network's integrity following cable installation using appropriate tests for each cable.

D. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

E. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

F. Label communication wiring to indicate origination and destination.

3.9 INSTALLATION OF SENSORS

A. Install sensors according to manufacturer's recommendations.

B. Mount sensors rigidly and adequately for operating environment.

C. Install room temperature sensors on concealed junction boxes properly supported by wall framing. Where sensor locations can be effected by wall surface temperature, pack junction box with insulation and provide insulated back plate for sensor. Install all space sensors so they are not affected by direct sunlight, appliances / equipment, or air currents. Consult with the Engineer prior to installing device if the location shown on the project drawings does not meet these criteria.

D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas. Use of Silicon or similar sealant is prohibited. Use Fiberglass or poly fill in the junction boxes.

E. Use averaging sensors in mixing plenums and hot and cold decks, and all duct locations which may be subject to stratification. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a mechanically fastened capillary clip. “Stick on” type fasteners are specifically prohibited.

F. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a mechanically fastened capillary clip. “Stick on” type fasteners are specifically prohibited.

G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells. Sensors and wells shall be installed to assure that the entire sensing element is completely immersed in the measured media with minimal pressure drop. Provide oversized pipe section, oversized elbow, or other recognized method to achieve this result in compliance with this specification and manufacturer’s recommendations.

H. Install outdoor air temperature sensors on north wall with sun shield. Sensor to be located where thermal characteristics of the building and solar load do not effect readings.

I. All sensors to be mounted on externally insulated ductwork or plenums shall be provided with standoff brackets. Insulation and vapor barriers shall be carried continuously beneath the sensor enclosure. Coordinate installation with mechanical and insulation contractors.

J. Differential Air Static Pressure.
   1. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
   2. Air pressure transducers shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
   3. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.

K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status. Interlock shall be provided such that the unit cannot be restarted in either hand or auto modes without manual reset of the safety device.

3.10 FLOW SWITCH INSTALLATION

A. Use correct paddle for pipe diameter.

B. Adjust flow switch according to manufacturer's instructions.

3.11 FLOW TRANSMITTER INSTALLATION

A. Airflow and Liquid Flow
1. Provide meter probe size, type and arrangement per manufacturers recommendations to obtain accuracy and performance specified.
2. Verify calibration of Remote Readout Unit (where specified to be provided) over operating range in conjunction with TAB contractor. Perform all necessary field calibration to obtain readout accuracy within specified limits.
3. Provide specified interface to DDC system.
4. Verify accuracy of DDC system reading against Remote Readout Unit (where specified) and balancer readings over operating range of device.
5. Provide installation in strict compliance with manufacturer’s requirements.

3.12 ACTUATORS

A. General. Mount actuators and adapters according to manufacturer's recommendations.

B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.
1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.
3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
4. Provide necessary mounting hardware and linkages for actuator installation.

C. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.

D. Where actuators are mounted to the side of insulated ductwork or equipment, provide insulation standoffs and repair insulation and vapor barrier.

3.13 WARNING LABELS

A. Affix permanent warning labels to equipment that can be automatically started by the control system.
   1. Labels shall use white lettering (12-point type or larger) on a red background.
   2. Warning labels shall read as follows.

C A U T I O N
This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
   1. Labels shall use white lettering (12-point type or larger) on a red background.
   2. Warning labels shall read as follows.

C A U T I O N
This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.14 IDENTIFICATION OF HARDWARE AND WIRING

A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 2 in. of termination.

B. Permanently label or code each point of field terminal strips to show instrument or item served.

C. Label control panels with minimum ½ in. letters on laminated plastic nameplates.

D. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.

E. Label room sensors related to terminal boxes or valves with nameplates.

F. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

G. Label identifiers shall match record documents.

H. Provide laminated control diagrams in each control panel for each piece of major controlled equipment or system.

3.15 OPERATOR INTERFACE

A. Standard Graphics. Provide graphics as specified. Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List / diagram. Point information on graphics shall dynamically update.

B. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation).

C. Provide logical descriptions and engineering units on all data displays. Example: percentage position shall be easily discernable as percent open or closed.

D. Provide logical linking between graphics. For example, direct penetration from building to floor to air handler to air terminal and back is to be provided without need to resort to a menu tree to navigate the building.

E. Graphical user interface shall be reviewed by the Owner and / or Engineer. If in their sole opinion the graphics are inaccurate, incomplete, or improperly represent the systems, the graphics shall be updated as no additional cost to the project.

3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Prior to demonstration and acceptance, the contractor shall:
   1. Complete all Pre-Commissioning requirements as described in paragraph 1.11 of this section.
   2. Complete system commissioning requirements per section 019113.
   3. Correct all deficiencies in control system hardware and software noted in engineer's punchlists, field observations, and commissioning issues logs / reports.

B. Demonstration. Prior to acceptance, perform the following to demonstrate system operation and compliance.
   1. Engineer and / or Owner's representative will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.
   2. Demonstrate actual field operation of sequence of operation. Provide at least two persons equipped with two-way communication (if required). Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation. Engineer may, at their discretion, perform these tests on a "spot check" basis.

3. Demonstrate complete operation of operator interface.
4. Demonstrate each of the following.
   a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.
   b. Demand limiting (where applicable). Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.
   c. Building fire alarm system interface.
   d. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation.. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs.
5. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

C. Acceptance.
1. After tests described in these specifications are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control, such as seasonal requirements or construction progress issues. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

3.17 CLEANING

A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.

B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.

C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

END OF SECTION

SECTION 232000 - PIPING SYSTEMS AND ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

B. Provide all chemical treatment required for piping systems each time an individual system is drained and then refilled as a result of work performed under this contract.

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

1.3 SUBMITTALS

A. Submit a schedule of pipe materials, fittings and connections by piping system.

B. Submit grooved mechanical connection system.

C. Submit oil piping diagram.

D. Submit refrigerant piping diagram.

E. Submit anchors, sleeves, hanger shields, and guides.

1.4 QUALITY ASSURANCE

A. Manufacturer: Provide domestically manufactured pipe, fittings and accessories.

B. All pipe, tubing and fittings shall be either tested by an approved third party testing agency or certified by an approved third party certification agency.

C. All grooved couplings and fittings shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. All casting used for the couplings and fittings shall be date stamped quality assurance and traceability.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver products in factory-fabricated containers. Deliver pipe and tube with factory-applied plastic end-caps on each length.

B. Store products in original wrapping and protect from dirt and damage. Store piping and tube inside. Where necessary to store outside, evaluate well above grade and enclose with waterproof wrapping.

C. Handle products carefully to avoid damage. Do not install damaged products.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each length of pipe and each pipe fitting shall be new and marked with manufacturer's name; complying with the following Standards where applicable:

- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- American Society of Mechanical Engineers (ASME)
- American Society of Testing and Materials (ASTM)
- American National Standards Institute (ANSI)
- American Water Works Association (AWWA)
- American Petroleum Institute (API)
- American Standards Association (ASA)

B. Refer to the MCNYS section 1202 for additional compliance standards for piping and fittings.

2.2 STEEL PIPING AND FITTINGS

A. Pipe: ASTM A53, ASTM A106, Schedule 40 or Schedule 80 weight as specified as Exhibit “A”; black or galvanized finish as specified in Exhibit ‘A’ or as noted on drawings; ends chamfered for welding or roll grooved for grooved mechanical connections. Galvanizing on piping shall be in compliance with ASTM A123.

B. Fittings: Same material and pressure class as adjoining pipe.
1. Welded fittings: Same weight as adjoining piping, factory forged, seamless construction, butt weld type, chamfered ends, in compliance with ASTM A105, ANSI/ASME B16.9 and MSS SP-43. Socket weld, Class 3000, forged in compliance with ASTM A105 and ASME B16.11. Where branch connections are two or more sizes smaller than main size, "Weldolets", Class 3000, forged, in compliance with ASTM A105, ANSI/ASME B16.9 and MSS SP-97, "Threadolets", Class 3000, forged, in compliance with ASTM A105, ASME B16.11, ANSI/ASME B1.20.1 and MSS SP-97. Sockolet weld type, Class 3000, forged in compliance with ASTM A105, ASME B16.11 and MSS SP-97 where specified in Exhibit ‘A’.

2. Screwed fittings: Malleable iron, black or galvanized, as called for in Exhibit ‘A’ or as noted on the Drawings. Fittings shall be in compliance with ASTM A197, ANSI/ASME B1.20.1 and ASME B16.3. Galvanizing of fittings sha1l be in compliance with ASME A153.
3. Malleable iron fitting shall be Standard Class 150 unless otherwise specified in Exhibit ‘A’ to be Extra Heavy Class 300.
4. Mitered elbows, "shaped" nipples, and job fabricated reductions are not acceptable unless specifically called for.

C. Flanges, Unions and Couplings:
1. Unions: For sizes 2 in. and smaller - Malleable iron, bronze to iron seat, Class 300 in compliance with ASTM A197, ANSI/ASME B1.20.1 and ASME B16.39, or Class 3000 forged steel, steel to steel ground joint to ASTM A181, ANSI/ASME and B1.20.1. MSS SP-83 as called for in Exhibit ‘A’. Galvanizing on the unions sha1l be in compliance with ASME A153.
2. Flanges: For sizes 2-1/2 in. and larger pipe sizes - Welding neck type, forged, in compliance with ASTM A105 and ASME B16.5. Class 150 or Class 300 as called for in Exhibit ‘A’.
3. Flange Gaskets: All flange gaskets shall be Flexitallic Thermculite Type 835 Spiral Wound.

D. Cleanouts, gauge and instrument connections, nipples and plugs, for adapting gauges and instruments to piping system shall be IPS brass.

E. Base Elbows:
1. Cast iron or steel type, flange connections; Crane 500 or equivalent. Made from welding elbows, with welded pipe support and steel base. Reducing elbows where necessary.

Elbow Size	Support Size	Base Plate
To 3 in.	1-1/4 in.	6 in. x 6 in. x 1/4 in.
4 in. to 6 in.	2-1/2 in.	8 in. x 8 in. x 1/4 in.
6 in. and larger	6 in.	14 in. x 14 in. x 5/16 in.

2. Anchor bolt holes in each corner of base for securely bolting to floor or concrete base; minimum 3/4 in. bolts.

2.3 COPPER PIPE, SOLDER FITTINGS

A. Tubing (Type K, L or M “pipe”): Hard temper meeting in compliance with ASTM B75 and ASTM B88; Type K, L, M. as called for in Exhibit ‘A’ or as noted on the Drawings. Soft temper only as called for in Exhibit ‘A’ or as noted on the Drawings. Plans show copper tube sizes.

B. Tubing (DWV): Hard tempered, seamless copper, in compliance with ASTM B306.

C. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper or cast bronze as called for in Exhibit ‘A’ or as noted on the Drawings; solder end connections; shall meet applicable and applicable ASME B16.22 or ASME B16.18.

D. Fittings (Tees, Elbows, Reducers, etc.): Cast bronze, threaded end connections, in compliance with ASME B16.15 and ANSI/ASME B1.20.1.

E. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper or cast copper alloy drainage fitting (DWV), solder end connections, in compliance with ASME B16.29 or ASTM B23.

F. Unions and Flanges: 2 in. and smaller use unions, solder type, cast copper alloy or wrought copper alloy, metal to metal meeting surface, 150 lb. swp, in compliance with ASME B16.18 or ASME B16.22, ANSI/ASME B1.20.1. For piping 2-1/2 in. and over use flanges, cast copper alloy, companion type, Class 150, in compliance with ASME B16.24.

G. Solder Materials: No-lead solder, using alloys made from tin, copper, silver and nickel.
1. Make: Harris "Stay-Safe 50" and "Bright", Englehart "Silverbright 100", Willard Industries "Solder Safe (silver bearing), Canfield "Watersafe".

2.4 COPPER PIPE AND BRAZED FITTINGS

A. Tubing (Type K, L): Hard temper in compliance with ASTM B75 and ASTM B88. As called for in Exhibit ‘A’ or as noted on the Drawings.

B. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper or cast bronze as called for in Exhibit ‘A’ or as noted on the Drawings; solder end connections; shall meet applicable and applicable ASME B16.22 or ASME B16.18.

C. Unions and Flanges: 2 in. and smaller use unions, solder type, cast copper alloy or wrought copper alloy, metal to metal meeting surface, 150 lb. swp, in compliance with ASME B16.18 or ASME B16.22, ANSI/ASME B1.20.1. For piping 2-1/2 in. and over use flanges, cast copper alloy, companion type, Class 150, in compliance with ASME B16.24.

D. Brazing Materials: Silver Alloy, Airco Sil-4S or Sil-Fos as called for in Exhibit ‘A’ or as noted on the Drawings.

2.5 DIELECTRIC PIPE FITTINGS

A. Tensile strength, ASME B16.8 union 250 psi, or flange design, 175 psi, pressure rating, threaded or solder joint, constructed to prevent gasket from squeezing into internal opening.

B. Make: Capitol Manufacturing, Epco, Watts, Victaulic.

2.6 HANGERS, INSERTS AND SUPPORTS

A. Hangers, Inserts, Clamps: Carpenter and Patterson, Central Iron, Fee and Mason, ITT Gruvlok.

B. Hangers:
1. Adjustable, wrought malleable iron or steel. Copper plated or PVC coated where in contact with copper piping. Cadmium plated or galvanized for exterior.
2. Adjustable ring type where piping is installed directly on hanger for piping 3 in. and smaller.
3. Adjustable steel clevis type for piping 4 in. and larger, and where insulation passes through hanger.
4. Steam (over 50 psi) piping, adjustable yoke pipe roller equivalent Gruvlok.
5. Hangers sized to permit passage of continuous insulation through the hanger.
6. Nuts and rods with electroplated zinc or cadmium (0.005 in. minimum) finish.

C. Hanger Shields:
1. Pre-insulated type:
a. Insulated pipes shall be protected at point of support by a 360° insert of high density, 100 psi waterproofed calcium silicate, encased in a 360° sheet metal shield. Insulation insert to be same thickness as adjoining pipe insulation and extend 1 in. beyond sheet metal shield.

2. Field-insulated type:

a. #18 USSG, galvanized steel shields, minimum 120° arc. Provide temporary blocking between pipe and hanger to maintain proper spacing for insulation. Provide at all support points.

3. Shield Sizing:

Pipe Size	Shield ID (1 ½" insulation)	Shield Length	Minimum Gauge
Up to 3-1/2"	Up to 6.5"	12 in.	18
4"	7"	12 in.	16
5" and 6"	8" and 9"	12 in.	14
8" to 14"	11" to 17"	24 in.	12
16" to 24"	19" to 27"	24 in.	10

a. Hanger shield gauges listed are for use with band type hangers only. For point loading (roller support), increase shield thickness by one gauge, and length by 50%.

D. Spacing Schedule: Hanger spacing shall be per the following tables. For alternate materials and sizes not listed herein, refer to the MCNYS, Section 305

Pipe Size	Steel	Copper	PVC Plastic	Rod Size
½ to 1 in.	8 ft.	6 ft.	3 ft.	3/8 in.
1 ¼ to 2 in.	10 ft.	6 ft.	3 ft.	3/8 in.
2 ½ to 4 in.	12 ft.	10 ft.	4 ft.	1/2 in.
5 and 6 in.	12 ft.	10 ft.	4 ft.	5/8 in.
8 in.	12 ft.	10 ft.	4 ft.	3/4 in.
Over 8 in.	To suit loading conditions			

E. Inserts: ITT Gruvlok, maximum loading 1000 lbs., galvanized finish, and Fig. #285, maximum loading 400 lbs. Make: Globestrut, Gruvlok, Unistrut.

F. Supports:
1. For weights under 1000 lbs.: "Drill-In" inserts equivalent to Phillips "Red Head," "U-Channel," "Unistrut," beam clamps or other structurally reviewed support. The factor of safety shall be at least four. Follow manufacturer's recommendations.
2. For weights above 1000 lbs.: Drill through floor slabs and provide flat flush plate welded to top of rod or provide additional "Drill-In" inserts and hangers to reduce load per hanger below 1000 lbs. The factor of safety shall be at least four.
3. For metal decks: Drill hole through for hanger rods and imbed a welded plate in concrete or use Phillips "Red Head" devices designed for this application, with a safety factor of four.

2.7 PIPING ACCESSORIES

A. Escutcheon Plates: Steel or cast iron polished chrome, split hinge type with setscrew, high plates where required for extended sleeves.

B. Pipe Guides: Cylindrical steel guide sleeve, proper length for travel, integral bottom base anchor; top half removable. Split steel spider to bolt to pipe, copper plated spider for copper pipe. Space between sleeve and spider to allow for insulation where required. Make: Anaconda, Flexonics, Pipe Shields, Keflex, or equal.

C. Anchors: Same material as pipe. Make: Keflex, Flexonics, Pipe Shields, or field constructed.

D. Pipe Roll Stand: Cast iron roll stand. Make: Advanced Thermal Systems, Carpenter and Patterson, ITT Gruvlok, Pipe Shields.

2.8 SLEEVES

A. Standard Type:
1. Schedule 40 black steel pipe sleeves, two pipe sizes larger than the pipe, for structural surfaces (bearing walls, structural slabs, beams and other structural surfaces) and where called for.
2. Sheet metal sleeves for nonstructural surfaces and existing construction. Sheet metal sleeves shall be 18 gauge minimum and braced to prevent collapsing.

B. Pre-Insulated Type:
1. Adjustable or fixed length metal cans, 24 gauge minimum, sized for 1 in. spacing between insulation and can. Insulation shall consist of a 360° waterproofed calcium silicate insert sized to extend 1 in. beyond wall or floor penetration. Calcium silicate insert shall be same thickness as adjoining pipe insulation. Spacing between shield and can packed at each end with double neoprene coated rope positively fastened.

2.9 SEALING ELEMENTS

A. Waterproof Type:
1. Exterior walls, below grade, above floor: Synthetic rubber material with zinc plated bolts.
2. Acceptable Make: "Link-Seal" Series 200, 300 or 400, Pyropac, Calipco.

2.10 FIRESTOP SYSTEM FOR OPENINGS THROUGH FIRE RATED WALL FLOOR ASSEMBLIES

A. Materials for firestopping seals shall be listed by an approved independent testing laboratory for "Through-Penetration Firestop Systems". The system shall meet the standard fire test for Through-Penetration Firestop Systems designated ASTM E814. Firestop system seals shall be provided at locations where piping passes through fire rated wall, floor/ceiling, or ceiling/roof assembly. Minimum required fire resistant ratings of the assembly shall be maintained by the Firestop System. Installation shall conform to the manufacturer's recommendations and other requirements necessary to meet the testing laboratory's listing for the specific installation.

2.11 PIPING MATERIALS AND SCHEDULE

A. See Exhibit "A," "Schedule of Piping Materials" at end of this Section for (HVAC) piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leak proof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate accessible unions and flanges for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, with 1/16" misalignment tolerance.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as indicated or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 1.0" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Wherever possible, in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Space pipe supports, arrange reducers, and pitch piping to allow air to be vented to system high points and to allow the system to be drained at the low points, and wherever required to permit complete draining of all lines.

D. Make all changes in size and direction of piping with fittings, except for soft copper tubing, use tubing bender.

E. Install piping to valves, strainers, pumps and other equipment at full line size. Where reduction or increase in size is required, make it with a fitting at the equipment connection.

F. Air Vents: Provide manual air vents at high points in piping system and where indicated on the drawings.

G. Drain Valves: Provide manual drain valves at low points in piping system and where indicated on the drawings.

H. All piping located in chases, soffits or other elements of construction which is not accessible by access doors or ceiling tile removal shall be welded, brazed or soldered. Mechanical coupling or pressure seal fittings are not permitted.

I. Grooved joints shall be installed in accordance with the manufacturer's latest published instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

3.2 EQUIPMENT AND SYSTEMS

A. Equipment and systems in accordance with laws, codes, and provisions of each applicable section of these specifications. Accurately establish grade and elevation of piping before setting sleeves. Install piping without springing or forcing (except where specifically called for), making proper allowance for expansion and anchoring. Arrange piping at equipment with necessary offsets, unions, flanges, valves, to allow for easy part removal and maintenance. Offset piping and change elevation as required for coordination with other work. Avoid contact with other mechanical or electrical systems. Provide adequate means of draining and venting units, risers, circuits and systems. Conceal piping unless otherwise called for. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction. Install piping parallel with lines of building, properly spaced to provide clearance for insulation. Make changes in direction and branch connections with fittings. Do not install valves, unions and flanges in inaccessible locations. Provide trap seal of adequate depth on drain pans.

3.3 WATER AND GLYCOL SYSTEMS

A. Top connection for upfeed, bottom or side connection for downfeed. Grade off-level; up in direction of flow and down toward drain.

3.4 HANGERS, INSERTS AND SUPPORTS

A. Piping shall not be supported by wires, band iron, chains, vertical expansion bolts or from other piping. Support each pipe with individual hangers from concrete inserts, welded supports, or beam clamps of proper configuration and loading design requirements for each location. Trapeze hangers are acceptable for racking of multiple pipes of 1-1/2" or less in size. Follow manufacturer's safe loading recommendations. Suspend with rods of sufficient length for swing and of size as called for, using four nuts per rod. Provide additional rust proofed structural steel members, where required for proper support. Provide oversized hangers where insulation/supports must pass between pipe and hanger. Hangers, when attached to joists, shall only be placed at the top or bottom chord

panel point. Only concentric type hangers are permissible on joists; "C" type not permitted on joists. Provide riser clamps for each riser at each floor.

3.5 PIPE CONNECTIONS

A. Solder Connections: Utilize non-acid flux and clean off excess flux and solder. Flux conforming to ASTM B813 shall be used in conjunction with solder conforming to ASTM B32.

B. Brazed Connections: Make joints with silver brazing alloy in accordance with manufacturer's instructions. Remove working parts of valves before applying heat. "Walseal" fittings may be used; if insufficient alloy is showing, face braze such joints. Filler material shall conform to AWS A5.8

C. Threaded Connections: Clean out tapering threads, made up with pipe dope; screwed until tight connection. Pipe dope must be specific for each application. Threads shall conform to ASTM B.1.20.1.

D. Dielectric Pipe Fittings: Provide dielectric unions at all equipment connections where dissimilar metals meet. In addition, provide dielectric unions in all open type piping systems (condensing water, domestic water, etc.) where dissimilar metals are to be joined.

E. FRP Pipe Joints: Bonded with resin catalyst adhesive.

F. Grooved Mechanical Joints: Pipe shall be prepared in accordance with the latest Victaulic Grooving Specifications (ref. Victaulic PB137), using Victaulic Vic-Easy Grooving tools. Pipe shall be checked to be sure it is free of indentations, projections, weld seams or roll marks on the exterior of the pipe over the entire gasket seating area. Pipe ends are to be square cut. Victaulic lubricant shall be applied to gasket and/or pipe ends and housing interiors to eliminate pinching the gasket. Grooved Joints shall conform to the requirements of ASTM F 1476.

3.6 HANGER SHIELDS

A. Pre-insulated type or field-insulated type at Contractor's option.

B. Provide for all chilled water and all "non-direct" connection supports.

3.7 SLEEVES

A. Provide for pipes passing through floors, roofs/decks, walls or ceilings.

B. Pre-insulated type: Required for chilled water, refrigerant and steam piping.

C. Standard type: Provide for piping as noted above. Extend 1/8 in. above finished floor in finished areas. In above grade mechanical rooms and other areas with floor drains; use steel pipe sleeves projecting 2 in. above floor. Sleeves shall be as small as practical, consistent with insulation, to preserve fire rating. Fill abandoned sleeves with concrete. Where necessary for pipes to pass through ducts, air chambers or built-up housings and approved by Engineer, provide rubber grommet seals.

D. Roof/deck penetrations: Provide sleeve and deck sealing for watertight installation per detail on Contract Documents.

E. Provide a 0.16 inch thick smooth aluminum jacket over insulated pipes where they pass through sleeves.

3.8 ANCHORS AND GUIDES

A. Provide piping system anchors and guides as shown on the plans, and as recommended by the expansion joint/loop manufacturer. Where an anchor is shown at a change in piping direction, it shall fully control movement in all three axes. In lieu of a single anchor fabricated for two directional pipes, two (2) individual anchors may be provided.

3.9 SLEEVE PACKING

A. Seal Void Space at Sleeves As Follows:

B. Interior locations: Firmly pack with fiberglass and caulk.

C. Exterior walls and below grade cored holes: Use sealing element.

D. Fire rated, partitions and floor slabs: Use fire rated sealing elements, materials and methods. Provide per manufacturer's instructions to maintain firestop.

E. Vapor Barriers – provide continuity of vapor barriers through sleeves.

F. Waterproofed floors: Use waterproof sealing element, device, or compound.

3.10 ESCUTCHEON PLATES

A. Provide polished chrome escutcheon plates for exposed piping passing through floors, walls or ceilings, except in Boiler, Fan and Mechanical Rooms.

3.11 TESTS

A. Test piping and accessories before insulation, connecting to existing piping, and concealment. Repeat as many times as necessary to prove tight system. Notify Owner's Representative at least seven days in advance of each test. Isolate valves and equipment not capable of withstanding test pressures. Make leaks tight; no caulking permitted. Remove and replace defective fittings, pipe or connections. Furnish necessary pumps, gauges, equipment, piping, valving, power and labor for testing. Certify that test have been successfully completed.

B. Schedule of Test Requirements:
   1. Hot, chilled, glycol water: Hydrostatic, 100 psig at high point of system; two hours duration.
   2. Vent, drain, overflow and condensate drain: Hydrostatic, maintain 10 feet head of water above highest point of section being tested for six hours.
   3. Steam (50 psi and lower), drip and condensate piping: 125 psig hydrostatic pressure; two hours duration.
   4. Steam (over 50 psi), drip, and condensate piping: Hydrostatic test, 1-1/2 times working pressure; two hours duration.
   5. Oil piping:
      a. Isolate from tank and pumps and test at 125 psi air pressure for not less than six hours.
      b. In addition, test suction piping under 20 in. of mercury vacuum for three hours. Test storage tank at 5 psi air pressure for three hours.
   6. Refrigeration: Refer to section for Refrigerant Piping and Testing.
   7. Gas piping: 100 psi air pressure, for not less than six hours with a maximum loss 1/2 psi or as required by local utility company.
   8. Bottled gas piping: As required by supplier; but for not less than six hours at 15 psi.
   9. Compressed air piping (other than temperature controls): 100 psi air pressure; hold for six hours with maximum loss 2 psi.
   10. Tests: No change in pressure under stable temperature conditions.
   11. Equipment: Test at working pressures.

3.12 PIPE LINE SIZING

A. Pipe sizes called for shall be maintained. Pipe size changes shall be made only as reviewed by Owner's Representative. Where discrepancy in size occurs, the larger size shall be provided.

Exhibit 'A' – Piping Materials (HVAC)
Notes are at the end of Exhibit 'A'

Service	Pipe Materials	Fittings	Connections
Hot water heating	Schedule 40, black steel	Malleable iron and butt weld	2 in. and smaller screwed 2-1/2 in. and larger welded
Hot water heating (Optional)	Type L copper	Wrought copper or cast bronze, solder end	2 in. and smaller: No-lead solder

END OF SECTION

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SECTION 232133 - WATER SYSTEMS SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

1.3 SUBMITTALS

A. Submit shop drawings on all water system specialties.

1.4 GENERAL REQUIREMENTS

A. Equipment and accessories shall be rated for a minimum of 125 psi wwp, and 250°F temperatures. Manufacturer's written installation procedures shall become a part of these specifications.

B. Provide equipment, piping, valves, fittings, switches, and miscellaneous equipment necessary and required for the complete installation.

PART 2 – PRODUCTS

2.1 STRAINERS – HVAC WATER AND GLYCOL SYSTEMS (NON-POTABLE WATER SYSTEMS):

A. Wye Type Strainer:
   1. Bronze 2” and Under (Threaded End or Soldered Connections):
      a. Strainer shall be suitable for 400 psi @ 150°F WOG (threaded) and 400 psi @ 100 °F WOG (soldered).
      b. Body: Bronze ASTM B62 or ASTM B584.
      c. Cap: Bronze ASTM B62 or ASTM B584 or Brass ASTM B16.
      d. Screen: Type 304 stainless steel, 20 mesh.
      e. Gasket: Metal filled graphite, PTFE or copper.
      f. Threaded blowdown connection.

g. Makes: Mueller Model 352M (threaded) or Model 352MS (soldered), Keckley Style F-300 (threaded) or Style E-300 (soldered), Apollo Model 59000 (threaded) or Model 59300 (soldered).

2. Cast Iron 2 ½" and Larger (Flanged End Connection):
   a. Strainer shall be suitable for Class 125, 200 psi @ 150°F WOG (2½" to 12") and 150 psi @ 150 °F WOG (14" and larger) or Class 250, 500 psi @ 150°F WOG (2½" to 12") and 300 psi @ 150 °F WOG (14" and larger).
   b. Body and Cover: Cast iron ASTM A126, Class B.
   c. Screen: Type 304 stainless steel, 0,062 perforation (2½" to 4") and 0.125 perforations (5" and larger").
   d. Gasket: composition.
   e. Threaded blowdown connection.
   f. Makes: Mueller Model 758 (Class 125) or Model 752 (Class 250), Keckley Style A-7 (Class 125 and 250).

3. Cast Steel 2 ½" and Larger (Flanged End Connection):
   a. Strainer shall be suitable for Class 150, 285 psi @ 100°F WOG (2½" to 12") and 150 psi @ 150 °F WOG (14" and larger) or Class 300, 500 psi @ 150°F WOG (2½" to 12") and 300 psi @ 150 °F WOG (14" and larger).
   b. Body and Cover: Cast steel ASTM A216, Grade WCB.
   c. Screen: Type 304 stainless steel, 0,062 perforation (2½" to 4") and 0.125 perforations (5" and larger").
   d. Gasket: Spiral wound Type 304 stainless steel with graphite filler.
   e. Threaded blowdown connection.
   f. Makes: Mueller Model 781 (Class 150) or Model 782 (Class 300), Keckley Style SA-7 (Class 150 and Class 300).

2.12 PUMP AND COIL FLEXIBLE CONNECTORS

B. Bronze Braid and Hose 2" and Under (Soldered End Connection):
   1. Hose and Braid Bands: Bronze.
   2. End Connections: Copper female soldered ends.
   3. Minimum operating pressure of 150 psi at operating temperature of 200°F.
   4. Design Equipment: Metraflex Model BBSC.
   5. Makes: Metraflex, Mason Industries, Inc., Flex-Hose Co. Inc.

C. Stainless Steel Braid and Hose 2" and Under (Threaded) and 2½ and Larger (Flanged and Grooved Connections):
   1. Hose and Braid Bands: Series 300 stainless-steel.
   2. End Connections: Carbon steel Class 150 flanged, Sch. 40 carbon steel male threaded or Sch. 40 carbon steel grooved.
   3. Minimum operating pressure of 125 psi at operating temperature of 200°F.

4. Design Equipment: Metraflex Model MLPC and RMF (flange to flange), Model GFC (flange to groove), Model GGC (groove to groove), Metraflex Model SSTC (male thread to male thread).
5. Makes: Metraflex, Mason Industries, Inc., Flex-Hose Co. Inc.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Obtain detailed instructions from each manufacturer for proper method of installation.

B. Equipment and systems shall be installed in accordance with manufacturer's installation requirements.

3.2 STRAINERS

A. Provide where called for. Provide blowdown connection for strainers with valves. Provide valve type as specified in Specification Section 230523. All blowdown valves shall be provided with cap or plug. Open ended valves are not allowed.

3.3 PUMP AND COIL FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in accordance with manufacturer's installation requirements.

B. Where pump discharge or suction size is smaller than system pipe size, provide concentric type reducing flexible connector.

C. Install flexible connectors within manufacturer's parallel offset tolerances. Flexible connectors shall not be subjected to the weight of equipment or piping causing deformation of connector.

END OF SECTION

SECTION 233000 - SHEETMETAL AND DUCTWORK ACCESSORIES

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services required for the complete installation designed in Contract Documents.

1.2 QUALITY ASSURANCE

A. Ductwork shall be fabricated and installed in compliance with latest edition of the following standards:
   1. SMACNA Duct Construction Standards - Metal and Flexible Ductwork.
   2. SMACNA Duct Liner Application Standard.
   3. NFPA Standards, Bulletin 90A, 96, 101.
   4. 2020 New York State Mechanical Code
   5. Plans and Specifications which exceed the requirements in any of the referenced standards.

B. All sheet metal shall be fabricated and installed by an experienced Contractor specializing in this type of Work.

C. All ductwork shall be maintained to the following cleanliness standards throughout the project:
   1. All ductwork is to be shipped to the job site with ends covered in plastic or capped, and fully shrink or poly sheet plastic wrapped. On arrival to the project site, all ductwork shall be manually inspected and anywhere protective plastic or caps that have been damaged shall be cleaned inside and out and re-wrapped prior to storage.
   2. Ductwork protective coverings shall be removed only immediately prior to installation.
   3. All small fittings and parts shall be bagged.
   4. All adhesive labels or part identification markings shall be on the exterior of the ductwork only.
   5. Ductwork shall be stored in an area specifically maintained for that purpose which shall remain clean, dry and have minimum exposure to dust.
   6. Internal surfaces of ductwork and all ductwork accessories to be installed within ductwork shall be wiped immediately prior to installation to remove excess dust, machining oil and debris.
   7. All open ends are to be maintained covered through the progress of construction with self-adhesive poly sheeting.
   8. Duct contaminated due to failure to maintain these standards shall be cleaned to the satisfaction of the Owner and Engineer at the cost of this contractor.

1.3 SUBMITTALS

A. Provide a complete shop standard construction manual including construction details for all shop fabricated materials, fittings, and accessories.

B. Provide coordinated sheetmetal shop drawings. Refer to DUCTWORK SHOP DRAWINGS in this specification section for further requirements.

C. Ductwork detail drawings.

D. Exhaust and kitchen hood details.

1.4 DUCTWORK CLASSIFICATION

A. Duct systems are classified and constructed per the SMACNA pressure classification as follows:
   1. All ductwork shall be constructed for a minimum pressure class of 2 in. w.g. unless stated otherwise.

1.5 DUCTWORK SHOP DRAWINGS

A. Prepare minimum 1/4 in. scale drawings:
   1. Constructed from actual field inspections and measurements so as to assure a complete job.
   2. Incorporating dimensions of actual equipment proposed for use on the project.
   3. Showing adequate sections, elevations, and plan views and indicating the bottom of ductwork elevations from the finished floor.
   4. Indicating all volume dampers, damper access doors, air balance test plugs, and other accessories required for a complete project.

B. Immediately call to the attention of the Engineers any major deviations from the Contract Drawings which must be made. All deviations shall be documented in writing.

C. Submit roof, wall and floor opening dimensions and locations shown on shop drawings.

D. Submit prints to each Contractor of other trades for review for interferences and coordination with their work.

E. Refer to 230010.3.2 for further information related to Sheet Metal Shop and Coordination Drawings

PART 2 – PRODUCTS

2.1 DUCTWORK MATERIALS

A. Unless otherwise called for, provide materials in accordance with Exhibit I.

2.2 SQUARE AND RECTANGULAR DUCTWORK

A. Transverse and longitudinal duct seams reinforcement shall conform to appropriate tables and figures per SMACNA Pressure Classification for duct construction.
   1. “Ductmate" or "Nexus" 4-bolt corner connection systems may be used in lieu of standard construction. Provide all corner brackets, corner bolts, transverse clips, and seals between flange to flange connections

B. Corner closures shall be required as described and illustrated by SMACNA Duct Construction Standards.

C. Throat radius on all elbows shall not be less than dimension of duct in plane of radius. Where this cannot be maintained, use shorter radius with internal guide / splitter vanes per SMACNA guidelines, or square elbow with turning vanes.

D. Bracing and hanging of ductwork shall be per SMACNA Standards for size and pressure class of ductwork being used.

E. Any transformations shall not reduce the ductwork cross-sectional area. Maximum angle in straight duct, 20° for diverging flow and 30° for contraction flow. Transformation from square to round or flat oval seams welded or brazed.

F. Provide 45 degree shoe-taps or 45 degree laterals for square and rectangular branch ductwork. Unless noted otherwise or shown on the contract drawings, 90 degree straight taps or “A” collars are prohibited.

2.3 ROUND AND FLAT-OVAL DUCTWORK

A. Round Ductwork:
   1. Manufactured of galvanized steel ASTM A527, gauges per SMACNA Duct Construction Standards, spiral lock-seam or longitudinal fusion-welded, as called for in Exhibit I.
   2. All spiral duct shall have locked seams so made as to eliminate leakage under pressure for which this system has been designed. Longitudinal seams duct shall have fusion-welded butt seams.
   3. No longitudinal seam duct (“stovepipe”) will be allowed.
   4. Round ductwork fittings:
      a. All fittings fabricated Per SMACNA Standards for round and flat-oval ductwork.
      b. Fittings shall have continuous, welded seams.

c. 90º tees shall be conical type. 90º tees and 45º laterals up to and including 12 in. diameter tap size shall have a radiused entrance into the tap, produced by machine or press forming. The entrance shall be free of any restrictions.
d. Round taps off the bottom of rectangular ducts down to diffusers shall be made with a 45º square to round shoe-tap.
e. Spin-in, dovetail, and adjustable take-offs are prohibited unless noted otherwise.

5. Elbows:
   a. Diameters 3" through 12": Two-section stamped and continuously welded elbows.
   b. Over 12": Gored construction with seams continuous welded. Less than 35º - two gores, 36º to 71º - three gores, over 71º - five gores.
   c. Fabricated to a centerline radius of 1.5 times the cross-section diameter.
   d. Adjustable elbows, minimum 26 gauge, maybe used for round duct up to 12" diameter in Velocity-Pressure Classes 2" w.g. and below. Secure and seal adjustable joints air tight after installation.
   e. Use of adjustable Elbows is prohibited.

6. Joints:
   a. Pipe-to-pipe joints in diameters up to 60" shall be by the use of sleeve couplings, reinforced by rolled beads.
   b. Insertion length of sleeve coupling and fitting collar shall be 2" up to 36" diameter and 4" above 36" diameter.

B. Flat-Oval Ductwork:
1. Manufactured of galvanized steel ASTM A527. Within the available sizes, flat-oval duct shall all be spiral wound type ductwork. Gauges per SMACNA Duct Construction Standards.
2. Flat-oval duct shall be adequately reinforced by the installing Contractor to limit the amplitude of wall vibration to ± .008" and the maximum wall deflection to 1/4".
3. Elbows:
   a. Gored construction with seams continuously welded. Less than 35º - two gores, 36º to 71º - three gores, over 71º - five gores.
   b. Fabricated to a centerline radius of 1.5 times the cross section diameter.

4. Joints:
   a. Pipe-to-pipe joints in oval ducts up to 42" the major axis shall be made using sleeve couplings, reinforced by rolled beads.
   b. Pipe-to-fitting joints in oval ducts up to 42" major axis shall be made using slip-fit of projecting collar fitting into the pipe.
   c. The insertion length of sleeve coupling and fitting collar shall be 2" up to 42" major axis, and 4" above 42" major axis.

d. Pipe-to-pipe and pipe-to-fitting connections for ducts above 42" major axis shall be made by angle ring flanges. Flanges on ducts shall be 1-1/2" x 1-1/2" x 3/16" up to 25" minor axis and 2" x 2" x 3/16" above 25" minor axis.
e. If longitudinal seam duct greater than 42" major axis is supplied in lengths greater than 4 ft., one angle ring must be welded to duct on 4 ft. centers. Welding can be an intermittent weld of 1". in 12".
f. Bolt hole spacing for angle rings shall be 6 in. center.

5. Flat-Oval fittings:
a. Matching flat-oval fittings shall be manufactured from galvanized steel with continuous -welded seams per SMACNA Duct Construction Standards.
b. 90° tees, shoe taps and laterals shall be conical type.

C. Make: Semco, United Sheet Metal.

2.4 DUCTWORK SEALING

A. Ductwork sealing shall comply with paragraphs 403.11 of the ECCCNYS.

B. SMACNA duct sealing classification shall be used for duct systems using the following criteria:
1. Seal Class A, shall include transverse and longitudinal joints and duct wall penetrations, grommets at damper shafts for all ductwork to be provided.

C. Approved ductwork sealing materials shall include the following Hardcast products or approved equivalents when and where applied per manufacturer's recommendations and requirements:
1. Water Based Sealants - Versa-grip 181

D. Tapes and mastics used to seal metallic and flexible air connectors shall comply with UL 181B and be marked 181 B-FX for pressure sensitive tape or 181-B-M for mastic.

2.5 ACOUSTIC-THERMAL DUCT LINING IN DUCTWORK

A. Duct Liner (Closed Cell Foam)
1. Lining shall be constructed of closed cell, engineered polymer foam insulation (EPFI). Air Stream coefficient of friction not to over 0.22"wg / 100 ft.
2. Material must have a maximum thermal conductivity of 0.25 Btu-in/hr-ft²-°F @ 75°F mean temperature.
3. Material must have a maximum Water Vapor Transmission rate of 0.0 Perm-in.
4. Lining shall meet UL No. 181, NFPA 90A, and shall have a flame spread classification of not more than 25 and a smoke developed rating of 50 maximum.
5. Make: Nomaco "Nomaply Whitech".

2.6 TURNING VANES

A. Standard Type:
1. Provided in square elbows as shown on contract drawings. Vanes for ducts with areas greater than 100 sq. in. shall be "double" type having dimensions and spacing as detailed.
2. Make: Elgen, or contractor fabricated.

2.7 PVS (Poly Vinyl Coated) DUCTWORK

A. General Description:
1. Constructed of same gauge sheet metal as called for square, rectangular, round, and flat-oval ductwork, 2 mil polyvinyl coating applied to inside and outside.
2. Where buried: Provide 2 mil polyvinyl coating on inside and 4 mil polyvinyl chloride coating on outside of ductwork.
3. For corrosive duty: 4 mil polyvinyl coating on inside and outside.

B. Fittings and Couplings:
1. Fabricated the same as called for square, rectangular, round, and flat-oval ductwork with polyvinyl coating.
2. Joints shall be riveted with stainless steel rivets and sealed on the inside with epoxy. Raw edges of couplings shall be sealed with epoxy.
3. Field connections shall be made with couplings, using stainless steel screws, sealed with epoxy and taped on exterior. Taping shall be done with PVS polyethylene tape and epoxy.

C. Joints:
1. Joints shall be performed using connectors and flange systems specifically designed for the application. Sheetmetal Connectors “EZ Flange” system or approved equal.

D. Continuity of PVS Coatings
1. Duct coating shall be patched to match original factory conditions at all locations where the ductwork is cut, joined or where the factory coating is in any manner damaged during the course of installation.

2.8 DAMPERS IN DUCTWORK

A. Provide single blade type volume dampers where duct sizes in either dimension are under 12”. Constructed per SMACNA standards, one gauge heavier than duct material. For round ducts, Rossi RD series blades securely fastened to 3/8 in. sq., cold rolled steel operator rod and B300/B330 end bushings. For rectangular ducts use Greenheck MBD-10M with 3/8 in. sq., cold rolled steel operator rod. Provide quadrant locking handle on standoff for ductwork to be externally insulated. Wing nut friction screw type are specifically prohibited. Shop fabricated or alternate damper manufacturers meeting these specifications are to be submitted for approval.

B. Provide volume dampers at all air outlets, diffusers, grilles. Dampers to be located at branch takeoff collar or as close as practical. Use of register dampers in return or exhaust inlets shall be strictly limited and approved by the Engineer in advance.

C. Provide multi-blade dampers above 12 in. duct dimension in width or depth. Where multi-blade dampers are required, they shall be equal to Ruskin Model CD35. Provide quadrant locking handle on air volume dampers, wing nut friction screw type are specifically prohibited. Provide quadrant locking handle on standoff for ductwork to be externally insulated.

D. Fire and Smoke Dampers: See "Fire and Smoke Dampers" Section 233316.

E. Automatic Air Dampers: Furnished as part of "Control Systems" Section 230923 installed by this Contractor.

2.9 FLEXIBLE DUCTWORK

A. Shall be constructed in compliance with NFPA Bulletin 90A, and UL Standard 181, Class I Air Duct:
   1. Consisting of corrosion resistant galvanized steel helix mechanically locked to fabric. Fabric to be a trilaminate of aluminum foil, fiberglass and aluminized polyester.
   2. Factory applied, fiberglass exterior insulation, sheathed in a seamless reinforced exterior vapor barrier jacket. Refer to Specification 230700 Insulation for required R-Value and insulation thickness.
   3. Flexible ductwork shall be rated for 20” w.g. positive pressure, 10” w.g. negative pressure thru 12” dia.; 5” w.g. negative pressure, 14-16” dia.; 1” w.g. negative pressure 18”-20” dia., 5500 fpm, operating temperature range -20^{o}F to 250^{o}F.

B. Design Equipment: Flexmaster Type 3B (insulated), Flexmaster Type N1-35 (uninsulated).

C. Make: Clevaflex, Flexmaster, Genflex, Thermaflex.

2.10 FLEXIBLE CONNECTIONS TO FANS AND EQUIPMENT

A. Materials for flexible connections shall be fire retardant, water and mildew resistant, and comply with UL Standard 214:
   1. Systems up to 2” w.g. s.p.: approximately 20 oz. of fabric per sq. yd. Ventfabrics, Inc., "Ventfab".
   2. Systems greater than 2” w.g. s.p., and watertight systems: Of heavy glass fabric, double neoprene coated, approximately 30 oz. per sq. yd. Ventfabrics Inc., "Ventglas".
   3. Flexible connections for grease duct system fans shall be listed and labeled for the application per NYSMC 506.3.2.4

2.11 ACCESS DOORS

A. In Ductwork: Shall be double panel construction, 1” rigid insulation when in insulated ducts; SMACNA construction, hinged type. Double cam type only acceptable where hinged type will not fit and if approved by engineer. Same metal as duct, or factory fabricated. Doors airtight to fit system static pressure, minimum size 16” x 12” or as practical based on the specified location.

B. When installed in intake or exhaust plenums, access doors will be sized to allow for full access to plenum.

C. Where plenums are greater than 4 feet wide or deep, the access door is to be at least 2 ft. wide by 4 ft. tall to allow for personnel entry.

D. Door Hardware:
1. Hinges: Minimum of two per door, at least 1-1/2” long by 1/8” thick, spaced no more than 2 ft. apart and no more than 1/4 of the door size from top to bottom of door. Maximum 4” length, 6 ft. door, for larger doors, length equal to 1/12 door height.
2. Latches: As manufactured by Ventfabrics, Inc. or equivalent. Metal window sash latch not acceptable.
   a. Access doors up to 2” w.g.: Ventlok #100/#102.
   b. Walk-in doors up to 2” w.g.: Ventlok #260.
   c. Access or walk-in above 2” w.g.: Ventlok #310.

E. Make: Air Balance, Ruskin, Ventlok, Elgen.

2.12 INSTRUMENT TEST HOLES

A. Suitable for insertion pitot tubes and other test instruments:

B. Fabricated with heavy screw cap and gasket.

C. With sufficient extension to accommodate exterior insulation where required.

D. Make: Ventlok #699.

PART 3 – EXECUTION

3.1 REQUIREMENTS

A. Equipment and systems shall be installed in accordance with local and state codes and regulations having jurisdiction.

B. Install all ductwork concealed and tight to the structure above unless noted otherwise on shop drawings. Fabricate only after the approval of shop drawings, and in locations to avoid interference. Ductwork installed without approved shop drawings, which requires removal/modification and/or reinstallation due to conflicts or improper installation shall be corrected at no cost to the Owner.

C. Sizes given on contract drawings are inside dimensions. Keep openings closed with protective caps or blanks during construction to prevent entrance of dirt and debris.

D. Extend access openings, damper rods and levers, to outside of external insulation make systems airtight.

E. No piping, conduit or other obstruction to airflow is permitted in ductwork. Where shown on the drawings or permitted through approved shop drawings, provide with airtight streamlined sleeve, soldered or brazed joint between sleeve and ductwork. Increase size of ductwork to maintain proper cross-sectional area.

F. Provide necessary openings, sleeves, hanger inserts, framing, chases, and recesses, not provided by other trades.

G. Exposed exhaust or return registers and grilles shall be flush with face of duct; exposed supply registers and grilles shall be mounted outside airstream with 45^{o} shoe-tap extension collars.

H. Provide sleeves for ducts passing through walls or floors. Use 14 gauge sleeve with framing through structural surfaces; 18 gauge sheet metal for other cases. Set sleeves 4” above finished floor in Mechanical Rooms, seal watertight to floor.

3.2 FLEXIBLE CONNECTIONS

A. Provide flexible connections for the intake and discharge connections of duct connected to fans and air handling equipment:
   1. Round connections made with adhesive and metal drawbands with ends tightly bolted.
   2. Rectangular connections made with material securely held in grooved seam between flanges, tightly clipped or riveted on 6” centers.

B. Connections made with a minimum of 2” space between duct and equipment collars, installed in line, and with 1” excess material folded so as not to interfere with airflow through connection.

3.3 FLEXIBLE DUCTWORK

A. Install flexible duct systems, including connections and joints, in accordance with manufacturer’s installation instructions, ADC Flexible Duct Performance and Installation Standards Chapter 4 “Installation Requirements”, and with UL 181, Class 1 Air Duct.

B. Flexible ductwork shall not pass through any wall, floor or ceiling.

C. Duct slide on depth minimum of 2” and secured with ½” stainless steel worm gear clamp or non-metallic band clamp meeting UL 181B-C. Connections to conform with all manufacturer’s requirements. Maintain insulation value and vapor barrier without gaps from branch main to diffuser / grille / register connection.

D. For round-to-oval connections, provide round-oval flexible adapter.

E. Maximum length 48”, not to penetrate any wall, ceiling or floor.

F. Maximum one 90° angle wide radius bend from ductwork to outlet. Provide molded flexible elbow support secured to structure to support bend radius. Thermaflex flexflow or approved equal. Use of Panduit straps unapproved means of bend support are specifically prohibited. Where a wide radius cannot be maintained, provide hard duct elbow at outlet.

3.4 TURNING VANES

A. Install fixed turning vanes in square elbows of equal dimensions only.
   1. Use large size vanes, 2-1/4” spacing when ducts are 20” or wider.
   2. Secure vane runners to duct with spot welding, riveting or sheet metal screws.
   3. Seal all penetrations for attachment of vane runners.

B. For unequal dimension elbows:
   1. Provide Aero Dyne HEP turning vanes and rail assembly or approved equal
   2. Adjust vanes for angle of attack per manufacturer instructions
   3. Seal all penetrations for attachment of vane runners.

C. When installing in ductwork with internal insulation:
   1. Install runners in ductwork inside insulation and bolt through insulation and duct sides, welding bolts to insure rigid installation. Provide build-outs for duct Velocity-Pressure classes above 2” w.g.

3.5 INSTRUMENT TEST HOLES

A. Locate in the following locations:
   1. Downstream of fan discharge
   2. Downstream of exhaust duct
   3. Downstream of fan inlet.

3.6 CLEANING DUCTWORK AFTER INSTALLATION

A. Clean rubbish and dirt from system before fans are turned on.

B. Keep openings closed during this construction period.

C. Pay damages resulting from dirt blown on painted or other finished surfaces.

D. Repair or replace damaged fan wheels, dampers, or other system parts damaged as a result of dirt.

E. Clean system as many times as required until the entire system is dirt-free.

3.7 INSTALLATION ROUND AND FLAT-OVAL DUCTWORK

A. Use factory fabricated couplings for joints.

B. After the joint is slipped together, sheet metal screws are placed ½" from the joint bead for mechanical strength.

C. Sealer is applied to the outside of the joint and covering the screw heads.

D. Flanged joints shall be made with neoprene rubber gaskets.

3.8 DAMPERS AND AIR CONTROL DEVICES

A. Provide dampers necessary to permit proper balancing of air quantities. Comply with code requirements for smoke and fire control. Prevent introduction of uncontrolled outside air into building through roof and wall openings.

B. When dampers are installed in acoustically lined ductwork, install with insulated "build-outs" per SMACNA.

C. Install fire and smoke dampers in accordance with "Fire and Smoke Dampers" Section and applicable codes.

D. Install all dampers furnished as part of "Control Systems" Section.

3.9 ACCESS DOORS

A. Provide as required for maintenance and service access at:
   1. Control dampers
   2. Damper motors
   3. Fire dampers for replacement of fire damper link
   4. Smoke detectors
   5. Control instruments
   6. Fan bearings
   7. Both inlet and outlet of terminal heating and/or cooling coils
   8. Intake or exhaust plenums
   9. Any other equipment requiring periodic inspection or service, complete with angle iron frame.

3.10 DUCT SUPPORTS

A. Provide per SMACNA, same material as duct. Hanger bands to extend down sides and turn under bottom 2". Minimum two metal screws per hanger. Steel angle or "unistrut" on larger duct. Spaced per building structural system but not greater than 8 ft or the maximum allowable by SMACNA guidelines. Provide extra support angles as required.

B. Provide supports per manufacturers requirements for factory fabricated duct systems

C. Refer to section 230549 for Seismic Bracing requirements.

D. Refer to section 230550 for wind restraint of exterior ductwork systems.

3.11 SMOKE DETECTION

A. Smoke detectors shall be furnished by Division 26 "Electrical". This Contractor shall install detectors located in ductwork. Clearly indicate locations of smoke detectors on the sheet metal shop drawings.

B. Increase duct size at smoke detectors, where required for proper installation, per smoke detector manufacturer's recommendations. Coordinate minimum duct size required with Division 26 "Electrical".

3.12 ACOUSTIC-THERMAL DUCT LINING

A. Duct area on project drawings are clear areas. Increase metal duct dimensions to accommodate lining.

B. Adhere lining to interior side of duct; minimum 90% coverage of Benjamin Foster 85-20 fire retardant adhesive, UL approved. Stapling method of attaching will not be permitted. Mechanical fasteners shall not pierce the sheet metal. Installing fasteners with spacing as per SMACNA Standards. Multiple layers of liner to achieve indicated thickness is prohibited.

C. Butting edges of acoustic linings shall be sealed with a fire-resistant neoprene coating, and exposed edges of acoustic linings shall be installed with sheet metal nosing to prevent erosion.

D. Lining shall not impart odor to the air, delaminate or be loosened by the airstream under normal operating conditions. Lining which is damaged during fabrication or shipment shall not be installed.

E. Linings shall be interrupted at the area of operation of a fire damper and at not less than 6 inches upstream and downstream of electric-resistance and fuel burning heaters in duct systems.

F. Metal nosings or sleeves shall be installed over exposed duct liner edges that face the opposite direction of the air flow.

G. Where a duct liner has been interrupted, a duct covering of equal thermal performance shall be installed.

H. Thermal acoustic duct liner shall not be used to line ducts or plenums from the exit of a cooling coil to the downstream end of the drain pan.

EXHIBIT I - DUCTWORK MATERIALS
(Notes are at the end of Exhibit "I")

SERVICE	MATERIAL	SPECIAL REQUIREMENTS
Supply, return, vent, relief, and exhaust	Lock forming quality, galvanized steel ASTM 525	Joints and features as called for
Accessories, dampers and air turns	Same or better as parent duct	------
Field constructed apparatus casings	Galvanized steel ASTM 525	

NOTES FOR EXHIBIT I:

NOTE 1: Wall plenums that are likely to see moisture collection due to rain or snow are to be provided with a sloped floor and trapped drain to indirect waste connection.

NOTE 2: Wall plenums greater than 4 ft. wide are to have 16 gauge floor, reinforced to support maintenance or service personnel.

END OF SECTION

SECTION 233316 - FIRE AND SMOKE DAMPERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation as shown on the Contract Documents.

1.2 SUBMITTALS

A. Types, schedule of sizes, locations, and installation arrangements of all dampers.

B. Manufacturers UL listed installation details for each mounting arrangement.

C. Installation certification per paragraph 3.3 of this section.

D. Identification chart for dampers per paragraph 3.4 of this section.

E. Size, location and construction detail of all fire rated access doors.

1.3 QUALIFICATIONS

A. Provide work in accordance with latest requirements of the New York State Building Code, NFPA 90A, NFPA 101 and UL 555 (Seventh Edition), UL 555S (Fifth Edition). Fire dampers shall be Underwriter's Laboratories classified.

B. All Dampers shall be rated for protection at 350°F and shall be Leakage Class I.

C. Smoke dampers and operator assemblies shall be Underwriter's Laboratories classified as an assembly.

D. All fire rated access doors shall be in accordance with NFPA 80 and 104.

PART 2 – PRODUCTS

2.1 FIRE DAMPERS

A. Curtain type damper of galvanized steel (stainless steel for corrosive fume exhaust) construction with fusible link, roll formed frame and stainless steel closure spring. UL listed and labeled.

B. Maintain no less than 80% free area for velocities up to 2000 fpm; 100% free area with welded head for velocities above 2000 fpm. Provide necessary duct transitions, sleeves and supports to maintain assembly rating and these free area requirements.

C. Square, rectangular, round or oval duct connection as required by duct connections.

D. 1-1/2 hour rated dampers for assemblies with rating three hours or less. Three-hour rated dampers for assemblies with rating of 3 hours or greater.

E. Provide with “break away” duct connections which comply with rated assembly construction details.

F. Fusible link temperature rating of 165°F

G. Type A, B or C as called for on the contract drawings or as required to meet installation, free area and performance requirements.

H. Design Equipment:
1. Static, 1 ½ hour, Ruskin Model IBD2
2. Static, 3 hour, Ruskin Model IBD23
3. Dynamic, 1 ½ hour, up to 4000fpm and 4”wc, Ruskin DIBD2
4. Dynamic, 3 hour, up to 4000fpm and 4”wc, Ruskin DIBD23

I. Make: Air Balance, Greenheck, National Controlled Air, Prefco, Ruskin, Safe Air, Inc., Venco.

2.2 FIRE RATED ACCESS DOORS

A. Fire rated access doors shall be designed specifically for application rated wall openings and shall bear an Underwriters' Laboratories fire door label for a two or three-hour rating to match adjacent construction.

B. Design Equipment:
1. Two hour rated for walls – Activar FD Series
2. Three hour rated for walls – Activar FD3 Series

C. Make: Air Balance, Duro, Prefco, Cesco.

PART 3 – EXECUTION

3.1 LOCATIONS

A. Provide where called for on the contract drawings and as required per Section 607 of the New York State Mechanical Code.

3.2 INSTALLATION

A. Provide sleeves, angles, and access doors for installation in accordance requirements of NFPA, UL and damper manufacturer. Provide sheet metal access doors in ductwork for dampers and accessories. Provide ceiling or wall access doors for dampers and accessories. Provide rated access doors where required in shafts and other rated assemblies.

B. Provide access door or removable ductwork section for inspection and repair in compliance with NFPA 80 and NFPA 104 for all assemblies. Minimum allowable access door size shall be 12”x12”, minimum allowable length for removable duct section shall be 24 inches.

3.3 CERTIFICATION

A. Contractor shall certify that dampers are accessible for servicing, are installed properly, and are operational. Submit three copies of signed certification to the Owner's Representative for review.

3.4 IDENTIFICATION

A. Provide damper tags and chart. Fasten tag to ductwork adjacent to the dampers. Number each damper and make chart listing.
   1. Number
   2. Location
   3. Air system in which they are installed.

B. Submit three copies of chart to the Owner's Representative for review.

END OF SECTION

SECTION 238216 - COILS

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Submit shop drawing on coils

1.3 GENERAL REQUIREMENTS

A. Provide coils of proper size and rows to fit intended use and capacity as scheduled and specified. Location as shown on Plans. Designed for 150 psi. Same end or opposite end connections as required to fit installation shown on Plans. Vertical mounted coils shall have bottom drain headers. Duct mounted coils shall be equipped with flanges. Tag each coil at factory giving number and location. Coils completely drainable with auxiliary drain headers, if necessary. Minimum 1/2 in. drain and vent connections. Aluminum fins shall be a minimum of .0075 in. thick unless otherwise noted. Coils shall have brazed return “U” bends; bent tubes are not acceptable. Performance certified in accordance with ARI Standard 410.

PART 2 – PRODUCTS

2.1 REHEAT COIL

A. Non-ferrous heating coils, 125 psi working pressure, designed to relieve expansion and contraction strains. Minimum 16 gauge galvanised steel casing, non-ferrous header, with non-ferrous pipe connects (male NPT) pipe to exterior of casing, .025 in. thick copper tubes with .025 in. thick “U” bends, minimum 0.0075 thick aluminum fins. Coils tested at 300 psig then leak tested at 200 psig with air pressure under water.

B. Design Equipment: Heatcraft.

C. Make: Aerofin, Heatcraft, Marlo.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements. Provide supporting ironwork and sheet metal safing to assure proper installation without any bypass air around coil.

B. Provide ample space during installation to allow for the removal of the coil.

END OF SECTION

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SECTION 238231 - RADIANT CEILING PANEL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Submit shop drawings on radiant panel heating equipment with color selection chart. Clearly indicate which equipment is being submitted. Provide 12" long sample showing face pattern, tubing in place, cross channels and clips in place.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment shall be free from expansion, noises and strains. Exposed parts to be cleaned and phosphate coated before prime coating or baked enameling. Finish colors as selected from manufacturers standard colors during the submittal process. Factory-boxed and tagged by room numbers. Verify at site, the space available for each piece of equipment. Refer to Owner's representative at once, any correction, discrepancy or suggested change in size or location.

2.2 RADIANT PANELS

A. General Requirements:
   1. Provide complete system including all required accessories for installation without visible warp or deflection.
   2. Enclosures to run continuous unless otherwise called. Size to accommodate thermal movement of the radiant system.

B. Extruded Continuous Panels:
   1. Interlocked aluminum extrusions (0.10" thick minimum) with fluted face pattern, mechanical locking edges and integral tube channels.
   2. Copper tubing with .020" wall thickness. Provide heat conductive silicon paste between tube and tube channel.

3. Provide accessories for interconnecting continuous sections of panels including tubes.
4. Provide 3" thick unfaced fiberglass insulation on concealed face of panel.

C. Suspension System:
1. Conform to ASTM C635 for heavy duty systems.
2. Hanger wire: minimum 12 gauge galvanized, soft-annealed, steel wire.
3. For Modular Panels, panels shall be installed by ceiling grid. Provide panels as appropriate for regular or slimline grid systems.

D. Design Equipment: Sterling

E. Make: Sterling, Airtex, Aerotech.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each unit isolated with shut-off ball valves to permit servicing. Provide flow balancer for each unit as detailed. Contractor responsible for correct end connections and arrangements. Arrange piping accessories and valving fully accessible for servicing.

B. Connections to piping mains shall be made with soft copper to avoid imposing thermal expansion stress of piping onto radiant panel system.

C. Main hot water system shall be flushed completely prior to flowing water through panel systems.

END OF SECTION

JORDAN HEALTH CENTER - PHARMACY
DIVISION 26, 27, 28
ELECTRICAL SPECIFICATIONS
PAGE 1

SECTION 260010 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Section 019113 Commissioning Requirements, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 26, 27, & 28.

1.2 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state and local governmental agencies.

B. The following is a list of codes and standards that will apply to this project:
1. 2020 Building Code of New York State
2. 2020 Existing Building Code of New York State
3. 2020 Fire Code of New York State
4. 2020 Energy Conservation Construction Code of New York State
5. New York State Department of Labor Rules and Regulations
6. 2017 National Electrical Code, NFPA 70
7. Electrical Safety Requirements, NFPA 70E
8. 2016 National Fire Alarm Code, NFPA 72
9. New York State Department of Health
10. Standard for Healthcare Facilities, NFPA 99
11. 2018 Life Safety Code, NFPA 101
12. Local Codes and Ordinances for the City of Rochester, New York.
13. Federal Occupational Safety and Health Act - OSHA.
14. Factory Mutual or other Insurance Carrier.

1.3 LICENSING & PERMITS

A. Provide certificate of inspection from Commonwealth Electrical Inspection Services Inc. for all electrical work prior to acceptance of each phase.

B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid. Provide third party inspection of all electrical work by a certified inspection agency or approved professional.

C. Refer to General Conditions of the Contract for additional requirements.

1.4 GLOSSARY

ACI	American Concrete Institute
ADA	American Disabilities Act
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
FM	Factory Mutual Insurance Company
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Standards Organization
NYBFU	New York Board of Fire Underwriters
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
NYS/UFBC	New York State Uniform Fire Prevention and Building Code
OSHA	Occupational Safety and Health Administration
UFPO	Underground Facilities Protective Organization
UL	Underwriter's Laboratories, Inc.

1.5 DEFINITIONS

Approved / Approval	Written permission to use a material or system.
As Called For	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Equipment	Refer to the article, BASIS OF DESIGN.
Design Make	Refer to the article, BASIS OF DESIGN.
Equal or Equivalent	Equally acceptable as determined by Owner’s Representative
Exposed	Work not identified as concealed.
Final Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnish	Supply and deliver to installation location.
Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's site Representative.
Install	Mount and connect equipment and associated materials ready for use.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.

Or Approved Equal	Approved equal or equivalent as determined by Owner's Representative.
Owner's Representative	The Prime Professional
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Provide	Furnish, install and connect ready for use.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Rough-in	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.
Site Representative	Construction Manager or Owner's Inspector at the work site.

Refer to General Conditions of the Contract for additional definitions.

1.6 BASIS OF DESIGN

A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger electrical feeders, circuit breakers, equipment, additional control devices and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of rough-in and connections by other trades. Remove and replace door frames, access doors, walls ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.7 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, fixtures, panelboards, conduits, and wiring devices. Exact locations are subject to the approval of the Owner's Representative. The general run of electrical feeders, branch circuits, and conduits, indicated on the drawings, is not intended to be the exact routing. Circuit designations, in the form of "Home Runs" on branches, indicate the designation of the branch circuit, the size and the quantity of branch circuit conductors, and the panelboard or interconnection box from which the branch circuit is served.

1.8 QUALITY ASSURANCE

A. Manufactures of equipment shall be firms regularly engaged in the production of factory fabricated systems and equipment whose products have been in satisfactory use in similar service for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. The Materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.

B. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are not acceptable.

C. Refer to Division 1 specifications for additional information on Substitutions and associated procedures.

D. Proposed substitutions must be submitted to the Architect/Engineer a minimum of ten (10) days prior to the date for receipt of Bids. Each request shall include the name of the proposed material equipment being substituted, cut sheets, installation drawings, performance and test data and warranties. At that time the equipment or will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders.

2.2 MATERIALS

A. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.

B. The listing of a manufacturer as “acceptable” does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems conform to the Specifications.

2.3 U.L. LISTING

A. Equipment shall bear the Underwriter’s Laboratories (UL), or other approved agency listing label. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with the National Electric Code and listed by U.L.

2.4 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed.

B. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Refer to applicable Division 01 Section(s) for additional information and requirements.

C. All products specified in an individual Division 26, 27, and 28 specification sections shall be submitted at the same time and each Division Specification section shall have its own submittal. Number each submittal and do not combine multiple specification sections into a single submittal.

D. Shop Drawings Shall Be Dated and Contain:
1. Name of project
2. Name of prime professional;
3. Name of prime contractor;
4. Associated Specification Section, description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed.
5. Incomplete submittals will not be accepted.
6. Indicate deviations from contract requirements on Letter of Transmittal.

E. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications.

F. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

PART 3 - EXECUTION

3.1 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings in the form of reproducible transparencies drawn at not less than 3/8" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings As Follows:

1. HVAC Contract will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be sepias of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.
2. HVAC Contract will provide sepia transparencies and/or prints and submit the base plan to all major trades' Contractors.
3. Electrical, Plumbing and Fire Protection Contracts will draft location of piping, raceways, cable trays, light fixtures and equipment on the base plan, indicating areas of conflict and suggested resolutions.

3.2 ELECTRONIC CAD DRAWING FILES

A. The Engineer may provide the Contractor with AutoCAD .dwg or MicroStation .dgn format files for this project with the understanding that these CAD files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors' responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors' coordination shop drawings is to account for all trades and field conditions and identify any conflicts that shall be resolved prior to installation.

B. Any additional cost for changes due to conflicts as a result of the Contractors' failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

C. A request must be made in writing to the engineer with the requested individual files. The contractor will then be sent a CAD Release Form and must sign the form to obtain electronic drawings.

3.3 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough-in work. **DO NOT SCALE PLANS**. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the owners representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.
   1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.
   2. Before rough-in for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved rough-in drawings giving exact location for each piece of equipment. Do not "rough-in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owners representative or other contractor for any “rough-ins” that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the electrical contractor at no expense to the Owner.
   3. For equipment and connections provided in this contract, prepare rough-in drawings as follows:
      a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.
      b. New equipment: Obtain equipment rough-in drawings and dimensions, then prepare rough-in drawings.

c. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

3.4 EXISTING SYSTEMS AND CONDITIONS

A. Prior to beginning work inspect and test all existing electrical systems that will be affected by the work in this contract. Provide a report to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.

B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, that is determined to have been caused by the work in this contract.

3.5 ELECTRICAL INSTALLATIONS

A. All installations shall comply with the following requirements:
1. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.
2. The architect shall control the placement of all wall and ceiling mounted electrical equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.

3. Verify all dimensions with field measurements.
4. Arrange for all chases, slots and openings in other building components that are not indicated on drawings, to allow for electrical installations.
5. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
6. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.
7. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.
8. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.
9. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
10. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
11. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the owners representative.
12. All finished equipment surfaces damaged during construction shall be brought to “as new” condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.
13. Workmanship shall be as called for in the “Standard of Installation” published by the National Electrical Contractors Association (NECA).
14. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
15. No electrical equipment shall be hidden or covered up prior to inspection by the owners representative. All work that is determined to be unsatisfactory shall be corrected immediately.
16. All electrical work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
17. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

18. Install access panel or door where units are concealed behind finished surfaces.

3.6 PAINTING

A. This Contract Includes the following :
   1. Painting for all cut and patch work performed as part of Division 26, 27, and 28 contract.
   2. Painting required for touch-up of surfaces damaged due to the installation of electrical work.
   3. Painting as required to repair finish of equipment furnished.
   4. Painting of all surface mounted raceways in finished areas.

3.7 ELECTRICAL EQUIPMENT CONNECTIONS

A. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide a disconnect switch ahead of each piece of equipment receiving an electrical connection in accordance with the latest version of the National Electrical Code . Ground all equipment in accordance with the latest version of the National Electrical Code.

B. Provide all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts,

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to rough-in.

3.8 CLEANING

A. After all tests are made and installations completed satisfactorily:
   1. Thoroughly clean entire installation, both exposed surfaces and interiors.
   2. Remove all debris caused by work.
   3. Remove tools, surplus, materials, when work is finally accepted.

3.9 TEMPORARY FACILITIES

A. Refer to Division 0 and 1 specifications for temporary facility requirements of this contract.

3.10 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical/electrical facilities or services.

3.11 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owners designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide, operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer’s certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e., variable frequency drive and air handling unit) both manufacturer’s shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.

C. Refer to Division 01 SpecificationsSection 019113 – Commissioning Requirements for additional startup and Contract Closeout requirements.

3.12 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. Include one copy each of approved Shop Drawings, wiring diagrams, piping diagrams, spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, seasonal changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer Representative and service agency for all major equipment items. Bind above items in a three ring binder with name of project on the cover. Provide required number of hard copies and disk(s) containing pdf files of all documents and deliver to Owner's Representative before request for acceptance.

3.13 RECORD DOCUMENTS

A. Prepare record or as-built documents in accordance with Division 01 Specifications. In addition to those requirements provide the following:
   1. Document the routing major raceway systems, location of control devices, branch circuit numbers for all devices and equipment and fuse and circuit breaker sizes for major equipment and branch circuit home runs.
   2. Provide stamp on each drawings including: Company Name, Date and “Record Drawings”
   3. Refer to each Division 26, 27 and 28 section for additional items to be included in the record drawings.
   4. Provide required number of hard copies and disk(s) containing pdf files of all documents.

3.14 REMOVALS

A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated. Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl spaces and roofs to determine total Scope of Work.

B. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all equipment, conduit, junction boxes, devices, panels, and all hangers, including the top connection and any fastenings to building structural systems. Patch, paint and seal all removals, openings and other penetrations in roof, walls, ceilings, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

3.15 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the owners asbestos management plan. Prior to performing such work identify areas containing asbestos. Notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Refer to division 2 sections for further requirements.

END OF SECTION

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SECTION 260100 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SCOPE

A. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:
   1. Miscellaneous Supports
   2. Access Doors and Panels
   3. Fire Stopping
   4. Boxes and Cabinets
   5. Supporting Devices
   6. Identification
   7. Potential and Arc Flash Hazard Labeling

1.2 SUBMITTALS

A. Product data for:
   1. Boxes and Cabinets
   2. Fire Stopping Materials

1.3 QUALITY ASSURANCE

A. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, and cutting and patching.

B. All work shall be done in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

C. Materials specified herein shall comply with the applicable requirements of :
   1. The following Articles of the National Electric Code (NFPA 70)
      a. 314 - Outlet, Device, Pull and Junction Boxes, Conduit bodies and fittings
      b. 312 - Cabinets, Cutout Boxes and Meter socket Enclosures

PART 2 - PRODUCTS

2.1 MISCELLANEOUS SUPPORTS

A. Metal bars, plates, tubing, etc. shall conform ASTM standards:
   1. Steel plates, shapes, bars, and grating - ASTM A 36
   2. Cold-Formed Steel Tubing - ASTM A 500
   3. Hot - Rolled Steel Tubing - ASTM A 501
   4. Steel Pipe - ASTM A 53, Schedule 40, welded

B. Metal Fasteners shall be Zinc-coated (type, grade and class as required)

2.2 ACCESS DOORS AND PANELS

A. Steel access doors and frames shall be factory fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush.

B. Construction:
   1. Frames:
      a. 16 gage steel with 1 inch wide exposed perimeter flange and adjustable masonry anchors for units installed in masonry, pre-cast, cast in place concrete, ceramic tile.
      b. 16-gage steel, perforated flanges with bead for gypsum or plaster wall board.
      c. 16-gage steel with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame for full bed plaster applications.

   2. Access Doors:
      a. Provide 14 gage sheet steel flush panel doors with concealed continuous piano hinge factory installed, primed and painted, set to open 175 degrees.
      b. Provide fire rated, insulated flush panel doors, with continuous piano hinge and self-closing mechanism rated for 1 ½ hour “B” labeled, in fire rated partitions.

C. Provide flush, screwdriver operated cam locks on all access doors.

2.3 FIRE STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems”. The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

B. Acceptable Manufacturers:
1. Dow Corning Fire-Stop System Foams and Sealants
2. Nelson Electric Fire-Stop System Putty, CLK and WRP
3. Thomas & Betts - S-100 FS500/600
4. Specified Technologies Inc. (STI)
5. Hilti Firestop Systems

2.4 BOXES AND CABINETS

A. Outlet Boxes and Covers
1. General Use Boxes shall be galvanized steel, not less than 1-1/2" deep, 4" square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 314 of the National Electrical Code for the conductors and devices installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
2. Boxes installed in damp or wet locations shall be of rain tight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
3. Acceptable manufacturers:
a. Steel City
b. RACO
c. Appleton
d. Crouse Hinds

B. Pull and Junction Boxes
1. Shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of rain tight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
2. Acceptable manufacturers:
a. Hoffman
b. Keystone
c. Cooper B-Line
d. Custom fabricated per. NEC and UL guidelines

3. Flush floor junction boxes shall be recessed cover boxes designed for flush mounting in masonry. Provide checkered plate gasketed cover suitable for foot traffic. Make: O.Z. Gedney Type YR or approved equal.

C. Terminal and Equipment Cabinets:
   1. Terminal and Equipment Cabinets shall be code gauge galvanized steel with removable endwalls. Fronts shall be of code gauge steel, flush or surface type (as indicated) with concealed trim clamps, concealed hinges, flush lock, and grey baked enamel finish. Boxes and front shall be U.L. listed and shall be minimum 35"H x 24"W x 6"D. Provide removable insulated plywood terminal board mounted on inside back wall of cabinet.
   2. Acceptable manufacturer:
      a. Square D "Mono-Flat"
      b. Approved equal

2.5 SUPPORTING DEVICES

A. Supports, support hardware and fasteners shall be protected with zinc coating or treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic. Products used for outdoor applications shall be hot dipped galvanized.

B. Provide clevis hangers, riser clamps, conduit straps, threaded c clamps with retainers, ceiling trapeze hangers, wall brackets and spring steel clamps as applicable.

C. 14 gauge U-Channel systems with 9/16 inch diameter holes at a minimum of 1 7/8 inches on center in the top surface. Provide fittings and accessories that match and mate channel.

D. Provide carbon steel or wedge or sleeve type expansion anchors, steel spring head toggle bolts and heat treated steel power driven threaded stud fastening equipment as required by construction types.

E. Provided field fabricated supporting devices such as angles, channels, pipe supports, etc. All fabricated supports shall be of metal construction.

F. Acceptable Manufacturers:
   1. Allied Tube
   2. American Electric
   3. B-Line
   4. Unistrut Diversified Products
   5. Cooper Industries
   6. Killark Electric Mfg. Co.
   7. O/Z Gedney
   8. Spring City Electrical Mfg. Co.
   9. Thomas & Betts Corporation

2.6 IDENTIFICATION

A. Equipment Identification Nameplates
1. Machine engraved, plastic laminated labels, signs and instruction plates.
2. Material: Engraving stock melamine plastic laminate.
3. Thickness:
a. 1/16-inch minimum thick for signs up to 20 square inches or 8 inches in length.
b. 1/8-inch thick for larger sizes.

4. Color:
a. Background: Black
b. Lettering: White

5. Text:
a. Equipment Designation: Helvetica 3/8" lettering.
b. Supplementary Information (i.e. source, location, nominal voltage, etc.): Helvetica 3/16” lettering.

6. Identification nameplates shall be punched and permanently affixed to the equipment via stainless steel mechanical fasteners.

B. Wiring Device Labeling
1. 0.5” tall, plastic, tear resistant, printer tape label.
2. Color: Black text on clear tape.

C. Raceway & Cable Labeling
1. Adhesive marking labels for raceway and metal-clad cable. The labels shall indicate voltage and service, and be located above ceilings every 75 feet and on wall mounted conduit in mechanical and equipment rooms.
2. Colored self-adhesive vinyl tape, minimum 3 mils thick by 1 inch wide for all phase marking on cable.

PART 3 - EXECUTION

3.1 ACCESS DOORS AND PANELS

A. Install access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, duct mounted fire alarm detectors and other electrical equipment requiring access for maintenance or operation.

B. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.2 FIRE STOPPING

A. Installation of Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be as follows:
   1. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for dry wall construction.
   2. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.
   3. The methods used shall incorporate qualities that permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.
   4. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.3 BOXES AND CABINETS

A. Consider location of outlets, wiring devices, motor control equipment and other electrical equipment shown on drawings as approximate only. Study architectural, process piping, mechanical, plumbing, structural, roughing-in, etc., drawings and note surrounding areas in which each outlet or equipment is to be located. Locate outlet and electrical equipment so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet or electrical equipment will serve its desired purpose. Where conflicts are noted between drawings, contact Owner's Representative for decision prior to installation. Comply with Article 314 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls.

B. Outlet boxes in separate rooms shall not be installed "back-to-back" without the approval of the Owner's Representative.

C. Outlet boxes shall be sized to accommodate the wiring device(s) to be installed.

D. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers.

E. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-1/2" deep boxes with square corners and dimensions to accommodate conductors installed.

F. Surface ceiling mounted outlet boxes shall be minimum 4" square, 1-1/2" deep, galvanized sheet metal.

G. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.

H. Floor outlet boxes shall be installed flush with finished floor, adjust level and tilt as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet or tile, provide floor outlet with proper flange.

I. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and size as required by the National Electrical Code.

3.4 OUTLET BOX ROUGH-IN HEIGHTS:

A. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline, except fire alarm as follows:

1.	Light switches	46"
2.	Receptacle outlets	18"
3.	Receptacle outlets, above hot water or steam baseboard heaters. Do not install receptacle outlets above electric baseboard heaters.	30"
4.	Receptacle outlets, hazardous areas	48"
5.	Receptacle outlets, weatherproof, above-grade	24"
6.	Secondary Clock	90"
7.	Wall Mounted Public Address Speaker	90”
8.	Horn Type Public Address Speaker	Min. 180”
9.	Large Venue Fire Alarm Speaker	Min. 180”
10.	Data outlets	18"
11.	Telephone outlets, wall mounted	46"
12.	Fire alarm manual station	46"
13.	Fire alarm audio/visual (bottom of device)	80"
14.	Branch circuit panelboards, to top of backbox	72"
15.	Distribution panelboards, to top of backbox	72"
16.	Terminal cabinets, control cabinets	72"
17.	Disconnect switches, motor starters, enclosed circuit breakers	48"
18.	Roof mounted receptacles and disconnect switches	24”
19.	Where structural or other interference’s prevent compliance with mounting heights listed above, consult Owner's Representative for approval to change location before installation.	

3.5 SUPPORTING DEVICES

A. Hangers and Supports:

1. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, pendant-mounted lighting fixtures, etc.

2. Panelboards, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Owner's Representative, may be supported on walls. Racks for support of conduit and heavy electrical equipment shall be secured to building construction by substantial structural supports.

3.6 IDENTIFICATION

A. Provide equipment identification nameplates on the outside of the enclosure for all equipment indicating the following information:
   1. Switchgear, Switchboards, Panelboards, Transformers, Motor Control Centers, Equipment Cabinets, Control Panels, Generators, Uninterruptable Power Supplies:
      a. Equipment designation.
      b. Source and location of the source.
      c. Nominal system voltage.

   2. Contactors, Disconnect Switches, Enclosed Circuit Breakers:
      a. Equipment designation.
      b. Source and location of the source.
      c. Nominal system voltage.
      d. Location of the load that the switch or breaker serves.

   3. Motor Controllers:
      a. Motor designation.
      b. Type of service.
      c. Source and location of the source.
      d. Nominal system voltage.
      e. Location of the motor.

   4. Transfer Switches:
      a. Equipment designation.
      b. Equipment designation and location of the first downstream distribution device served.
      c. Normal and standby/emergency sources and location of the sources.
      d. Nominal system voltage.

B. Provide equipment identification nameplates for each circuit breaker in all switchgear, switchboards and distribution panelboards listing the panelboard or equipment load connected to each device.

C. Provide wiring devices labeling of all wiring devices. Labeling shall be attached to the outside of the device face plate. Label shall indicate the following information:
   1. Panelboard designation and circuit number from which it originates.

D. Provide permanent black marker labeling on all pull boxes and junction boxes indicating the following information:
   1. Power & Lighting:
      a. Feeder, branch circuit, and circuit numbers on cover.
      b. Source(s) and location(s) of the sources.
      c. Load(s) and location(s) of the load(s) served.
      d. Nominal system voltage.

   2. Systems:
      a. System type.
      b. Panelboard designation and circuit number from which it originates, if applicable.
      c. Equipment location(s) from which enclosed cables originate.
      d. Equipment and location(s) of the equipment served.
      e. Nominal system voltage.

E. Feeders Circuits, Branch Circuits, Control Circuits:
   1. 600-volts and Below:
      a. Provide cable tags, wire markers, and phase identification tape as appropriate.
      b. Identify circuits in each junction box, pull box, outlet box, enclosure, wireway, manhole, handhole, lighting standard base, and at each termination.
      c. Identify with source panelboard, circuit number, load, and location served.
      d. Include the identification of the building from which it originates for exterior circuits.

   2. Above 600-volts:
      a. Cables shall be identified at each manhole, handhole, junction box, transformer, switch, and at each termination using cable tags.
      b. Identify nominal voltage, circuit number, circuit size, load served, and equipment designation/location from which it originates.
      c. Exposed conduit runs shall be identified continuously reading “DANGER – 4,160 VOLTS” or as appropriate.

F. Underground Conduits & Circuits
   1. Provide warning ribbon above the underground electrical installation and 12-inches below finished grade or as appropriate.

G. Empty Conduit Runs and Conduits with Conductors for Future Use:
   1. Provide cable tags.
   2. Indicate proposed future use.
   3. Label conduits and conductors at both ends, including location of another end.

H. Provide complete, typed directory for each panelboard listing the room number, function, etc., for each circuit. Provide updated, typed panelboard directories for all existing panelboards affected by this work.

3.7 FLASHING AND SEALING

A. Opening through roofs shall be flashed in manner not to affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of contract. Provide non-ferrous flashing pieces, EDPM skirts, EDPM hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

3.8 CUTTING AND PATCHING

A. Provide all required Cutting and Patching as outlined in the Summary of Work Div. 1 specifications.

B. Provide priming and finish coat of paint on walls and surfaces at locations of removed raceways and equipment locations. The paint finish color and sheen shall match the existing surrounding finish.

C. All penetrations thru masonry walls and floors shall be patched with Sakrete FastSet Non-Shrink 3-hour 2,000 psi Grout or equal.

D. All penetrations thru drywall where electrical materials were removed shall be patched with cores or partial pieces of 5/8” minimum thickness drywall and Qty. (3) sanded coats of drywall compound. This shall be followed by priming and painting.

E. The following requirements apply:
   1. Perform cutting, fitting and patching of electrical equipment in all following cases:
      a. To uncover work for installation of poorly coordinated or ill-timed electrical work.
      b. To remove and replace defective work.
      c. To remove and replace work not conforming to requirements of the Contract Documents.
   2. Remove samples of installed work as specified for testing.
   3. Install equipment and materials in existing structures.
   4. Cut, remove and legally dispose of all electrical equipment, components, and materials as called for and all other items not indicated on plans but made obsolete by the installation of new work.
   5. Protect the structure, furnishings, finishes and adjacent materials not being removed and maintain temporary

END OF SECTION

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SECTION 260519 - LOW-VOLTAGE CABLES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:
   1. Low Voltage Conductors
   2. Type MC Metal Clad Cable
   3. Connectors and Terminations

1.3 SUBMITTALS

A. Provide product data for the following:
   1. Low Voltage Conductors
   2. Type MC Metal Clad Cable
   3. Connectors and Terminations

1.4 QUALITY ASSURANCE

A. All conductors shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of :
   1. The following Articles of the National Electric Code (NFPA 70)
      a. 300 - Wiring Methods
      b. 310 - Conductors for General Wiring
      c. 330 - Type MC Metal Clad Cable
      d. 400 - Flexible Cords and Cables
      e. 402 - Fixture Wires

   2. The following U.L. Standards:
      a. UL 83 Thermoplastic-Insulated Wires and Cables
      b. UL 44 Thermoset-insulated Wires and Cables

c. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.
d. UL 854 Service Entrance Cable
e. UL 1277 Electrical Power and Control Tray Cables
f. UL 6, 1981 Rigid Metal Electrical Conduit
g. All Other Applicable Standards

PART 2 - PRODUCTS

2.1 LOW VOLTAGE CONDUCTORS

A. General purpose feeder and branch circuit and control wiring:
1. Annealed Copper, 98% conductivity.
2. Minimum wire size:
a. #12 AWG for branch circuits
b. #14 AWG for control and signal circuits

3. Wire shall be stranded per ASTM B8.
4. 600 volt insulation for all wiring above 50 volts.
5. 300 volt insulation permitted for all wiring below 50 volts.
6. Thermal plastic with PVC insulation with nylon jacket.
7. Suitable for wet or dry locations, THHN/THWN-2 90 degree Celsius.
8. 90 degree C maximum operating temperature rating.
9. UL 83 Listed

B. Color Coding
1. Cable outer jackets shall be manufacturer color dyed the entire length for each phase and neutral conductor.
2. Equipment grounding conductors shall be green unless otherwise noted or approved.
3. All conductors shall be color coded according to the following schedule:

Voltage	A PHASE	B PHASE	C PHASE	NEUTRAL
208Y/120V, 3 Phase	Black	Red	Blue	White
480Y/277V, 3 Phase	Brown	Orange	Yellow	Gray
240/120V, 1 Phase	Black	Red		White

*ALL GROUNDING CONDUCTORS SHALL BE GREEN

4. Switched legs shall be identified with the same color insulation as the phase leg.

C. Acceptable Manufacturers:
1. General Cable
2. Southwire

3. Okonite
4. Prysmian

2.2 TYPE MC METAL CLAD CABLE

A. Construction:
1. Stranded or solid copper conductors, each individually insulated, and enclosed in an armor of flexible metal tape.
2. Suitable for wet or dry locations.
3. Suitable for cable tray installations.
4. Do not install direct buried, in concrete, or in the presence of corrosive vapors.
5. Provide with separate integral grounding conductor.
6. Support every 6 feet.
7. MC cable listed for Health Care facilities use per. NEC Article 517.
8. Manufactured and installed in accordance with NEC Article 330.
9. Design Make: Same as building wire.

2.3 LOW VOLTAGE CONNECTORS AND TERMINATIONS

A. Straight Splices, #26 AWG To #10 AWG
1. Nylon Insulated compression butt-splices.
2. 600 volt, 90 degree C rated.
3. Make: Burndy “Insulink”, T&B “Sta-Kon”, or approved equal

B. Straight Splices, #8 AWG and Larger
1. Two way, long barrel, compression type, copper
2. Provide heat shrink tubing over splice.
3. 600 volt rated.
4. Make: Burndy “Hylink”, T&N 54800 Series, or approved equal.

C. Pigtail Splices, #26 AWG to #10 AWG
1. Twist type pressure connector.
2. 600 volt rated, 105 degree C.
3. Size as required for number and size of conductors used.
4. Make: T&B Scotchlock, or approved equal

D. Three Way Splices, #8 AWG and Larger
1. Three way, long barrel, compression type, copper.
2. Provide tape or heat shrink tubing over splice.
3. 600 volt rated.
4. Make: Burndy “Hylink”, T&B 54700 Series, or approved equal.

E. Lug Terminations for Control and Signal Wiring.
1. Nylon insulated fork with compression termination of #26 AWG to #10 AWG.
2. Nylon insulated ring with compression termination for #8 AWG and larger.
3. 300 volt rated.

4. Make: Burndy “Insulug”, T&B “Sta-Kon”, or approved equal.

F. Lug Terminations for Power Wiring
1. Long barrel, compression type, copper body, on hole for #8 AWG to #2/0 AWG.
2. Long barrel, compression type, copper body, two hole, for #3/0 AWG and larger.
3. 600 volt rated.
4. Make:
   a. One-hole lug: Burndy “Hylug”, T&B 54900 Series, or approved equal.
   b. Two-hole lug: Burndy “Hylug”, T&B 54800 Series, or approved equal.

PART 3 - EXECUTION

3.1 LOW VOLTAGE WIRE AND CABLE

A. General
1. Install cables in raceway as called for after the entire raceway system has been completed.
2. Install splices and connections in accessible outlet, pull, and junction boxes.
3. Insulate all splices and connections with UL Labeled plastic tape, heat shrink tubing, or plastic molded caps.
4. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified.
5. Provide insulated green jacket grounding conductor in each raceway.
6. Provide dedicated white jacket insulated neutral conductor for each individual branch circuit. Shared neutrals are not acceptable.
7. Adhere to NEC de-rating requirements for raceway fill.
8. Provide stranded wire to motors, transformers, equipment, and vibrating machinery.
9. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors.
10. Where multiple conductors are installed in a common raceway they shall be pulled simultaneously. Use of pulling compound or lubricant shall be avoided unless absolutely necessary. Where pulling lubricant is required, use UL approved compounds approved for cable type. Lubricant shall meet all OSHA and Toxic Control Act standards.

Application	Cable Types	Design Make

General Purpose Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon	Ideal – Yellow 77
High Temperature Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Ideal – Yellow 190
Utility Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua – Gel II
Cold Weather Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua – Gel CW

11. Use pulling means including fish tape, cable, rope and basket type grips which will not damage cables or raceways. Use approved mechanical pullers for feeders and branch circuits as required for #6 AWG cable and larger. Do not use mechanical means to pull conductors No. 8 or smaller.
12. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equivalent.
13. Reconnect branch circuit wiring at panelboards as required to obtain a balanced three phase load on the feeders.
14. Provide conduit seals in explosion proof areas as called for on the plans and as required by the National Electrical Code.

3.2 TYPE MC METAL CLAD CABLE

A. MC cable shall only be permitted for use in 6-feet maximum whips from conduit connected junction boxes above accessible ceiling areas to individual recessed luminaires. Do not daisy chain luminaires with MC cable.

B. Type MC cable may not be used for home runs to panelboards.

C. Type MC cable may not be used for any connections to wiring devices.

D. Type MC cable may not be used for connections to equipment.

E. Type MC cable may not be used for and emergency branch circuits per. Article 517 in the NEC.

F. Support cable per the National Electrical Code. Secure the cable to fixture hangers using nylon or plastic ties.

G. Bending radius shall comply with Article 330.24 of the NEC.

H. Provide insulating bushing at all termination points between the metal sheath and luminaire or junction box.

I. Type MC cable shall not be installed exposed.

3.3 CONNECTORS AND TERMINATIONS

A. Cover un-insulated splices, joints, and free ends of conductor with rubber friction tape or PVC electrical tape. Plastic insulating caps may serve as insulation.

3.4 TESTS

A. Low Voltage Feeders

1. After low voltage feeders are pulled in, and before being connected, test feeders with a 1000 volt, 60 Hz insulation tester for one minute to determine that the conductor insulation to ground is greater than that recommended by the manufacturer.

END OF SECTION

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide a complete grounding system meeting or exceeding the requirements of Article 250 of the latest National Electrical Code. Install all raceway systems, including metal conduit, wireways, pullboxes, junction boxes, bus ducts, enclosures, and motors, to provide a continuous ground path with the lowest possible impedance.

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:
   1. Conductors
   2. Hardware

1.3 QUALITY ASSURANCE

A. All grounding systems shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of:
   1. The National Electrical Code, Article 250.

1.4 SUBMITTALS

A. None Required.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Exposed grounding conductors such as bars, straps, cables, flexible jumpers, braids, shunts, etc., shall be bare copper unless otherwise called for.

B. Conductors shall be copper, as called for in Specification Section 260519 - Low Voltage Cables.

C. Provide conductors with THHN/THWN insulation. Sizes #6 AWG and smaller shall be green in color. Conductor sizes #4 AWG and larger may have green taped bands at each end, and in all pullboxes.

D. Acceptable Manufacturers:
   1. Same as for low-voltage conductors. Refer to Specification Section 260519 – Low Voltage Cables.

2.2 CONNECTORS, CLAMPS, TERMINALS

A. General: Connectors specified are part of a system. Furnish connectors and components, and use specific tools and methods as recommended by connector manufacturer to form complete connector system.

B. Splices:
   1. Spring Type (for #10AWG conductors and smaller only):
      a. Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s B-Cap, Electrical Products Div./3M's Scotchlok Type Y, R, G, B, O/B+, R/Y+, or B/G+, or Ideal Industries Inc.'s Wing Nuts or Wire Nuts.

   2. Indent Type with Insulating Jacket:
      a. Rated 150° C, 600V; Ideal Industries Inc.'s High Temperature Wire-Nut Model 73B, 59B.
      b. Indent Type with Insulating Jacket: Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s Crimp Connectors, Ideal Industries Inc.'s Crimp Connectors, Penn-Union Corp.'s Penn-Crimps, or Thomas & Betts Corp.'s STA-KON.
      c. Indent Type (Uninsulated): Anderson/Hubbell's Versa-Crimp, VERSAtile, Blackburn/T&B Corp.'s Color-Coded Compression Connectors, Electrical Products Div./3M's Scotchlok 10000, 11000 Series, Framatome Connectors/Burndy's Hydent, Penn-Union Corp.'s BCU, BBCU Series, or Thomas & Betts Corp.'s Compression Connectors.

   3. Connector Blocks: NIS Industries Inc.'s Polaris System, or Thomas & Betts Corp.'s Blackburn AMT Series.
   4. Resin Splice Kits: Electrical Products Div./3M's Scotchcast Brand Kit Nos. 82A Series, 82-B1 or 90-B1, or Scotchcast Brand Resin Pressure Splicing Method.
   5. Heat Shrinkable Splices: Electrical Products Div./3M's ITCSN, Raychem Corp.'s Thermofit Type WCS, or Thomas & Betts Corp.'s SHRINK-KON Insulators.
   6. Cold Shrink Splices: Electrical Products Div./3M's 8420 Series.

7. Gutter Taps: Anderson/Hubbell's GP/GT with GTC Series Covers, Blackburn/T&B Corp.'s H-Tap Type CF with Type C Covers, Framatome Connectors/Burndy's Polytap KPU-AC, H-Crimpit Type YH with CF-FR Series Covers, ILSCO's GTA Series with GTC Series Covers, Ideal Industries Inc.'s Power-Connect GP, GT Series with GIC covers, NSI Industries Inc.'s Polaris System, OZ/Gedney Co.'s PMX or PT with PMXC, PTC Covers, Penn-Union Corp.'s CDT Series, or Thomas & Betts Corp.'s Color-Keyed H Tap CHT with HTC Covers.
8. Lugs:
   a. Single Cable (Compression Type Lugs): Copper, one or 2 hole style (to suit conditions), long barrel; Anderson/Hubbell's VERSAtile VHCL, Blackburn/T&B Corp.'s Color-Coded CTL, LCN, Framatome Connectors/Burndy's Hylug YA, Electrical Products Div./3M Scotchlok 31036 or 31145 Series, Ideal Industries Inc.'s CCB or CCBL, NSI Industries Inc.'s L, LN Series, Penn-Union Corp.'s BBLU Series, or Thomas & Betts Corp.'s 54930BE or 54850BE Series.
   b. Single Cable (Mechanical Type Lugs): Copper, one or 2 hole style (to suit conditions); Blackburn/T&B Corp.'s Color-Keyed Locktite Series, Framatome Connectors/Burndy's Qiklug Series, NSI Industries Inc.'s Type TL, Penn-Union Corp.'s VI-TITE Terminal Lug Series, or Thomas & Betts Corp.'s Locktite Series.
9. Acceptable Manufacturers:
   a. Burndy
   b. T & B
   c. Erico

PART 3 - EXECUTION

3.1 INSTALLATION

A. Raceway Systems:
1. All metal supports, cable trays, frames, sleeves, brackets, braces, etc. for the raceway system, panelboards, switchboards, switches, enclosures, starters, controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system. Size the bonding conductor in accordance with NEC Article 250, Table 250.122.
2. Terminate rigid conduit at all boxes, cabinets, and enclosures tightly with two locknuts and a bushing.
3. Conduit which runs to or from all boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers sized in accordance with NEC Article 250, Table 250.122. Connect the bonding jumper between a grounding type bushing on the conduit and a ground bus or stud inside the box, cabinet, or enclosure.

4. Provide bonding jumpers sized in accordance with NEC Article 250, Table 250.122 for all conduit expansion joints.
5. Provide a grounding conductor in all flexible metallic conduit and liquid-tight conduit, sized in accordance with NEC Article 250, Table 250.122.
6. Provide a grounding conductor in all nonmetallic runs of conduit and raceway, sized in accordance with NEC Article 250, Table 250.122.
7. Provide isolated ground conductors of systems as called for on the plans.

B. Grounding:
1. Grounds and grounding systems shall have a resistance to solid earth ground not exceeding following values:
   a. For grounding non-current carrying metal parts associated with secondary distribution system: 25 Ohms
   b. For grounding of 5 KV equipment, enclosures, and cable shields: 10 Ohms
   c. For grounding secondary service neutral: 25 Ohms

2. Providing grounding tests to verify the above values. Add additional ground rods or connections in order to meet these values.

END OF SECTION

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SECTION 260533 – RACEWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:
   1. Galvanized Rigid Steel Conduit (GRS)
   2. Electrical Metallic Tubing (EMT)
   3. Flexible Metal Conduit
   4. Fittings
   5. Surface Raceway
   6. Cable Hangers

1.3 QUALITY ASSURANCE

A. All raceways shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of:
   1. The following Articles of the National Electric Code (NFPA 70)
      a. Wiring Methods
      b. Electrical Nonmetallic Tubing
      c. Rigid Metal Conduit
      d. Electrical Metallic Tubing
      e. Flexible Metal Conduit
      f. Surface Metal Raceways
      g. Outlet, Device, Pull and Junction Boxes, Conduit Bodies and Fittings

   2. The following American National Standards Institute (ANSI) standards:
      a. ANSI-C80.1 Electric Rigid Steel Conduit
      b. ANSI-C80.3 Specification for Electrical Metallic Tubing, Steel

3. The following U.L. Standards:
   a. UL 1 Flexible Metal Electrical Conduit
   b. UL 5 Surface Metal Raceways and Fittings
   c. UL 6 Electrical Conduit Rigid Metal Conduit, Steel
   d. UL 514B Conduit, Tubing and Cable Fittings
   e. UL 797 Electrical Metallic Tubing, Steel

1.4 SUBMITTALS

A. Provide product data for the following:
   1. None

PART 2 - PRODUCTS

2.1 CONDUIT

A. Galvanized Rigid Steel Conduit
   1. Shall be hot-dipped galvanized steel, including threads.
   2. Acceptable manufacturers:
      a. LTV Steel
      b. Triangle
      c. Allied Tube
      d. Steel Duct
      e. Wheatland

B. Electrical Metallic Tubing
   1. Electrical Metallic Tubing shall be electro-galvanized steel.
   2. Acceptable manufacturers:
      a. Triangle
      b. Wheatland
      c. Allied Tube
      d. Steel Duct
      e. LTV Steel

C. Flexible Metal Conduit
   1. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocked, zinc coated strip steel. Interior surface shall be free from burrs or sharp edges.
   2. Acceptable manufacturers:
      a. Anaconda
      b. American Flexible Conduit Co.
      c. O-Z/Gedney
      d. Thomas and Betts

2.2 FITTINGS

A. Non-Hazardous Location Fittings:
   1. Rigid galvanized steel fittings shall be fully threaded and shall be of the same material as the respective raceway system.
   2. Fittings for PVC coated rigid galvanized steel conduit shall be threaded, hot dipped galvanized, and coated inside and outside with a urethane coating.
   3. Fittings for electrical metallic tubing shall have plastic insulated throat type. Connection be single set screw indenter for conduits up to 2" and double set screw indenter for conduits 2" and larger.
   4. Fittings for flexible metal conduit shall be center stopped, plastic insulated throat type, U.L. E-11852 listed.
   5. Fittings for liquid tight flexible metal conduit shall have zinc plated steel ferrule, compression type with sealing ring.
   6. Fittings for rigid non-metallic conduit shall be solvent cemented in accordance with the manufacturer's instructions.
   7. Die-cast or pressure cast fittings are not permitted.
   8. Provide conduit bodies types, shapes and sizes as required to suit application and NEC requirements. Conduit bodies for installation in conduit systems shall allow in-line pull outlets, make 90° bends, “T” take-offs, etc. Provide matching gasketed covers secured with corrosion-resistant screws.
   9. Acceptable Manufacturers:
      a. O.Z. Gedney
      b. Steel City
      c. Thomas & Betts
      d. Crouse-Hinds
      e. Carlon

B. Expansion Fittings
   1. Galvanized steel expansion joints for RGS or EMT conduit.
   2. Minimum 4” movement in either direction.
   3. Design Make: O.Z./Gedney, Type "AX" (exposed), “DX” (Concrete Pour)
   4. Acceptable manufacturers:
      a. O.Z./Gedney
      b. Crouse-Hinds
      c. Appleton

2.3 SURFACE METALLIC RACEWAY

A. One-Piece raceway suitable for (8) #12 AWG conductors or (2) 0.2” O.D. cables
   1. Color shall be factory finished white.
   2. One-piece steel construction.
   3. Surface box w/ matching knockouts as requited at end(s).
   4. Design Make: 700 Series

B. Provide miscellaneous boxes, mounting bezels, covers, entrance fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.

C. Acceptable Manufacturers:
1. Hubbell
2. Panduit
3. Wiremold
4. Mono-Systems

2.4 CABLE HANGERS

A. Provide prefabricated, zinc coated, carbon steel hangers UL listed to support category 6, 6A, optical fiber cable, and innerduct installations.

B. Hangers shall have open top with spring loaded cable retainer clip.

C. 4” high with rolled vertical and horizontal edges and a 3” deep and 2” wide support flange.

D. Flat bottom profile to reduce cable crushing in center.

E. Stackable with same model hangers below.

F. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.

G. Design Make: Mono-Systems H-433-S or Approved Equal

PART 3 - EXECUTION

3.1 GENERAL

A. Size raceways as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed.

B. Provide completely independent raceway systems for normal and emergency branch circuits and feeders as required by the National Electrical Code.

C. Paint all new junction and pull boxes on the emergency power branch in a yellow color identifying them as “EMERGENCY POWER” with the panel name that supplies thru them. Label all new emergency power branch raceways at 25-feet intervals with yellow tape and text “EMERGENCY POWER” where no junction or pull boxes are present.

D. Minimum 3/4" trade size for branch circuit and fire alarm wiring.

E. Minimum 1" trade size for voice/data outlets, television outlets, and branch circuit "Home Runs" to panelboards.

F. Where cable quantities are identified on drawings provide telecom conduit sleeves and raceways according to the below schedule (Note this table is an estimate and the actual quantity is dependent on the installed cable diameter):

Cat. 6 Cable Qty.	Conduit Trade Size
4 Cables	¾” Conduit
6 Cables	1” Conduit
10 Cables	1¼” Conduit
20 Cables	2” Conduit
70 Cables	4” Conduit
Cat. 6A Cable Qty.	Conduit Trade Size
2 Cables	¾” Conduit
4 Cables	1” Conduit
6 Cables	1¼” Conduit
10 Cables	1½” Conduit
20 Cables	2½” Conduit
70 Cables	4” Conduit

*Coordinate with owner communications vendor.

G. Support raceways from building structure and wall construction. Do not support raceways from ceiling systems ductwork, piping, or equipment hangers. Do not support raceways from pre-existing conduit runs, banks, racks, hangers, etc.

H. Support outlet, pull, and junction boxes independently from building structure and wall construction. Do not support from raceways.

I. Install raceways parallel or perpendicular to building walls, floors and ceilings.

J. Install raceways concealed except in the following areas:

1. Mechanical Rooms
2. Electric Rooms
3. Manufacturing areas
4. Garage or maintenance areas
5. Unfinished basements or crawl spaces

K. Provide a code compliant ground path between all outlets and the established electrical system ground.

L. Cut raceways square, ream ends to remove burrs, and bush where necessary.

M. Coordinate all raceway runs with other trades.

N. Do not install raceways adjacent to hot surfaces or in wet areas.

O. Provide expansion fittings with external grounding straps at building expansion joints.

P. Do not install conduit horizontally in concrete block or dry wall partitions.

Q. Arrange neatly to permit access to the raceway, outlet, pull, and junction boxes, and work installed by other trades.

R. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.

S. Core drill, sleeve, and fire stop all penetrations through existing floors.

T. Support all raceways with malleable iron pipe clamps or other approved method. In exterior or wet locations, provide minimum ¼" air space between raceway and wall. Secure raceway within 3 ft. of each outlet box, junction box, cabinet or fitting.

U. Provide conduit seals and explosion proof devices as indicated on the plans and as dictated by the National Electrical Code for all hazardous locations indicated on the drawings.

V. Provide green ground wire in all EMT, flexible conduit..

3.2 CONDUIT

A. EMT conduit is approved for installations in indoor dry locations only.

B. Install with a minimum of bends and offsets. Bends shall not kink or destroying the interior cross section of the raceway. Factory made bends shall be used for raceways 1" trade size and larger.

C. Provide at least one junction or pullbox for each 270 degrees of bends.

D. Plug the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.

E. Provide UL approved rain-tight and concrete-tight couplings and connectors.

F. Secure within three feet of each outlet box, junction box, cabinet or fitting.

G. Provide a #14 AWG fish wire in all "Spare" or "Empty" conduit runs to facilitate future installation of conductors.

H. Install raceways in concrete floor slabs as follows:
   1. All conduit in concrete floor slabs shall be rigid galvanized steel with concrete tight threaded fittings.
   2. Provide expansion fittings where conduits cross building expansion joints.
   3. Install conduit below the reinforcing mesh.
   4. Locate conduits to provide a minimum of 1” of concrete around conduit.
   5. Obtain approval from the Owner's Representative prior to installing conduit larger than 1" trade size in concrete slabs.

I. Wherever a cluster of four (4) or more conduits rise out of floor exposed, provide neatly formed 4 in. high concrete envelope, with chamfered edges, around raceways.

J. Provide conduit supports based on the following table:

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
3/4"	Concealed	7	10
1”, 1-1/4"	Concealed	8	10
1-1/2” & larger	Concealed	10	10
½”, 3/4"	Exposed	5	7
1”, 1-1/4"	Exposed	7	8
1-1/2” & larger	Exposed	10	10

K. Where conduits puncture roof, install pitch pockets as required in order that the roof warranty is maintained.

3.3 RACEWAY SYSTEM INSTALLATION:

A. Wiring below 600 volts in exterior, above grade locations:
   1. Rigid Galvanized Steel where exposed and for complete Roof Penetration

B. Wiring below 600 volts, interior above grade locations:
   1. Electrical Metallic Tubing where concealed within walls, above ceilings and in unfinished or unoccupied areas.
   2. Where unable to conceal in finished occupied areas: Surface Metal Raceway.
   3. Final connections to luminaires: Flexible Metal Conduit (6-foot maximum length from EMT conduit & junction box to individual luminaire) or MC cable (6-foot maximum length from EMT conduit & junction box to individual luminaire).

3.4 SURFACE RACEWAYS

A. Support with expansion anchors, concrete inserts, masonry inserts or toggle bolts as field conditions require. Provide supports at five foot centers.

B. Install a separate green ground conductor in raceway from the junction box where surface raceway begins to the ground terminal of the device, fixture or equipment being supplied.

C. Provide all fittings, connectors, elbows, tees, boxes etc. as required for the installation.

D. Submit factory drawings detailing the installation. Include a complete part list.

END OF SECTION

SECTION 260620 - WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:
   1. Receptacles
   2. Switches
   3. Coverplates

1.3 QUALITY ASSURANCE

A. All wiring devices shall be installed neatly, and parallel with building lines. Recessed devices shall be flush with the face of the wall. Provide extension rings on outlet boxes as required. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

1.4 SUBMITTALS

A. Provide product data for all wiring devices and cover plates.

B. Indicate selected part numbers.

C. Indicated selected color selections.

PART 2 - PRODUCTS

2.1 GENERAL

A. Wiring devices shall be specification grade or heavy duty as a minimum. Standard commercial grade is not acceptable.

B. Wiring device color shall be ivory when connected to normal branch and red when connected to emergency branch..

C. Suitable for installation in a 2-1/2” deep outlet box, unless otherwise noted.

D. All receptacles and switches shall be from the same manufacturer.

E. Acceptable Manufacturers:
1. Hubbell
2. Pass & Seymour/Legrand
3. Arrow Hart
4. Eaton
5. Bryant

2.2 CONVENIENCE DUPLEX RECEPTACLES

A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.

B. Side and back wiring.

C. 0.32” thick brass three prong power contacts and #8 brass screws

D. Brass center rivet

E. All brass grounding system

F. Nylon face with glass reinforced nylon back

G. Dielectric Voltage withstands 2,000V minimum

H. Terminals Identified in accordance with UL 498

I. Tamper-Resistant

J. UL 94V-2 Flame rating

K. Design Make: Hubbell 5362TR Series

2.3 GFI RECEPTACLES

A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.

B. LED trip/test indication

C. Tamper Resistant

D. Side and back wiring.

E. Nylon face and back.

F. 2006 UL 943 revisions including “no power to the face when miswired” and “end of life indication” when unit is no longer capable of providing GFCI protection

G. Designed to trip at maximum 6mA leakage current to ground.

H. Suitable for feed through protection.

I. Provide Red colored where connected to emergency branch circuiting.

J. Design Make:
1. Hubbell GFR5362TR Series (Specification Grade)

2.4 SPECIAL RECEPTACLES

A. Terminals identified in accordance with UL 498 (X, Y, Z, white, green)

B. H and cord clamp housing material: Black Nylon.

C. Terminal material: Clear Polycarbonate.

D. Contact spring material: Brass.

E. Dielectric Voltage withstands 2,000V minimum

F. Include NEMA type as called for on drawings to match equipment. At a minimum the manufacturer shall have special purpose receptacles available to meet the following NEMA connection types:
1. 125 volt, 20 ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L5-20R
2. 125 volt, 30 ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L5-30R
3. 250 volt, 20 ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L6-20R.
4. 250 volt, 50 ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L6-30R.
5. 250 volt, 20 ampere, 2 pole, 3 wire, grounding, NEMA 6-20R
6. 250 volt, 30 ampere, 2 pole, 3 wire, grounding, NEMA 6-30R
7. 125/250 volt, 50 ampere, 3 pole, 3 wire, grounding, NEMA 10-50R
8. 125/250 volt, 30 ampere, 4 pole, 4 wire, grounding, NEMA L14-30R (Dryer Receptacle). Plug configuration to match equipment furnished by equipment supplier.
9. 125/250 volt, 50 ampere, 4 pole, 4 wire, grounding, NEMA L14-50R (Range Receptacle). Plug configuration to match equipment furnished by equipment supplier

G. Design Make: Hubbell

H. Acceptable Manufacturers: Pass & Seymour, Leviton

2.5 COVERPLATES

A. Provide high impact nylon with ivory finish coverplates for general purpose flush devices.

B. Provide utility cover plates for surface mounted devices in mechanical rooms.

C. Provide gasketed weatherproof cover plates with a hinged cover on a cast aluminum outlet box for all devices in wet areas designated “WP”.

D. Provide high impact red cover plates for emergency circuits.

PART 3 - EXECUTION

3.1 GENERAL

A. Install devices generally where called for.

B. Coordinate exact locations of all devices with equipment, millwork, counters, fin radiation, windows, etc. and adjust locations as required as part of this contract.

C. Provide steel box for all devices.

D. Install receptacles with the grounding pin up..

E. Do not install devices “back to back” in the same stud cavity without prior approval of the Owner. Offset devices as required to maintain code required fire rated assemblies or provide fire-stopping assembly around adjacent devices.

F. Provide plaster rings on all outlet boxes to permit flush installation of devices.

G. In all wet or damp areas, provide a surface mounted cast aluminum outlet box with threaded connections, gasketed cover, and non-ferrous screws.

H. Prior to installation and as part of the contract, relocate any device a distance of 5 feet in any direction at the request of the Owner.

I. Size outlet boxes in accordance with the NEC, based on the number and size of wires in the box.

J. Provide a coverplate on all devices.

3.2 EQUIPMENT MOUNTING HEIGHTS:

A. Refer to Specification Section 260100 – Basic Materials and Methods for mounting heights.

3.3 LABELING

A. Provide tape labels indicating panelboard and circuit on the outside of all device coverplates.

3.4 TESTING

A. Test all receptacles for proper voltage, polarity, and grounding.

B. Test all GFI receptacles for proper voltage, polarity, grounding, and verify the receptacle trips at 6 milliamperes or less.

C. Rewire receptacles as required until receptacles test properly.

END OF SECTION

SECTION 260923 – WIRED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide complete installation, including luminaires, standards, hangers, supports, fittings, lamps, wiring, connections and controls, as indicated in the Contract Documents. Types of luminaires in this project include LED.

B. Provide startup of all lighting control systems by a factory certified manufacturer's representative in order to maintain all warranties. The contractor shall complete all startup request forms and complete all pre-startup installations a minimum of 2-weeks in advance or as otherwise required by the manufacturer. Provide initial system settings and owner training.

C. Provide Lighting System Functional Testing as described in this section by a factory authorized manufacturer's representative hereby referred to as the Testing Agent.

D. Refer to the General and Supplementary Conditions, Division 1 Specifications Sections for proposed phasing of this project. Provide manufacturer certified startup of all lighting control systems and Lighting System Functional Testing in each phased project area as required to turn each area over independently. The appropriate number of site visits to accomplish this phased scope of work shall be included in the base bid.

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:
   1. Room Controllers
   2. Low-Voltage Switches
   3. Occupancy Sensors
   4. Dimmer Switches
   5. System Functional Testing

1.3 SUBMITTALS

A. Submit shop drawings as described in Section 260010. Shop drawings shall include photometric data for each luminaire utilizing the specified lens/louver type, lamp(s) and ballast(s). All luminaire types and lighting control system components shall be submitted in a single complete brochure which shall be in the form of a soft cover binder with each luminaire separated by an identified index tab.
   1. Room Controllers and Wiring Diagrams
   2. Low Voltage Switches
   3. Occupancy Sensors

4. Dimmer Switches

B. Submit for approval information detailing startup of the lighting control systems and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they certify said individual(s) to perform this work. Submittal will be rejected if this information is not included.

C. Submit for approval a testing plan for all lighting control systems. Testing plan shall, at a minimum, observe and record all items described in the "Lighting System Functional Testing" part of this section and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they authorize said individual(s) to perform this work. Submittal will be rejected if this information is not included.
1. Lighting System Functional Testing
   a. Submittal of Functional Testing company name
   b. Light meter to be used
   c. Functional Testing Report after final adjustments are made

D. Warranty Information

1.4 QUALITY ASSURANCE

A. Lighting controls shall be standard products of manufacturers regularly engaged in the manufacture of the specific type of controls specified and shall be the manufacturer's latest standard design that complies with specification requirements. Firms installing the lighting controls shall have a minimum of five (5) years of successful installation experience on projects with interior lighting and controls work similar to the requirements of this project.

B. Codes and Standards
1. NEC:
   a. Shall comply with Articles 220, 410 and 510 as applicable to installation and construction.
2. NEMA:
   a. Shall comply with Standard Publication Nos. LE 1 and LE 2 as applicable to lighting equipment.
3. UL:
   a. All interior lighting components shall be UL listed and labeled.
   b. Comply with all applicable UL standards including UL 486A and B.
4. All work shall comply with applicable local code requirements of the authority having jurisdiction.

1.5 SEQUENCE OF OPERATION

A. Configure set-points and provide necessary programming to the local Room Controller(s) or stand-alone line voltage or low-voltage controls devices to operate as listed below.

B. Initially Unoccupied Room with Multiple Luminaires:
1. Turn on manual switch for each lighting zone (single, multi-level, daylight) to initially turn on luminaires (Per NYS Energy Conservation Code).
2. Within a daylight zone, lighting output dims up/down via output from a photocell(s) to adjust and maintain a 40-footcandle minimum light level in the daylight zone.
3. Occupancy sensor utilizes infrared or dual-technology (infrared/ultrasonic) to detect occupants and keep luminaires on at 100% output level.
4. Upon occupants leaving room, occupancy sensor keeps luminaires on for a set time delay (20-minutes). If no occupants are detected over the course of the time delay, occupancy sensor turns all luminaires off.
5. Upon occupants re-entering room, light switch shall be manually used to turn the luminaires back on.
6. Sequence then repeats.

PART 2 - PRODUCTS

2.1 ROOM CONTROLLERS

A. Modular, stand-alone one room lighting control system (0-10V dimming and switching) with control of multiple user presets and room occupancy and daylight sensing for daylight harvesting.

B. Concealed mounting, self-contained, multi-channel lighting controller designed to communicate with occupancy and photo sensor inputs without the use of external power packs.

C. Shall allow for on-site commissioning controls via an infrared handheld remote control.

D. Lighting loads: Refer to floor plans for quantity of lighting channels per room. Where any room exceeds three channels, provide multiple room controllers networked together for proper system operation.

E. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so the individual load numbers are sequentially assigned using each controller's device ID's from highest to lowest.

F. Each load shall at minimum be configurable to operate in the following sequences based on occupancy:
1. Auto-on/Auto-off
2. Manual-on/Auto-off

G. Manual override and LED indicated for each load.

H. Compatible with 120/277 VAC systems.

I. Maximum 20A combined 20A combined load per Room Controller.

J. All digital parameter data programmed into each room controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

K. Room controller shall include:
   1. Real time current monitoring
   2. Efficient 250 mA switching power supply
   3. RJ-45 network ports with integral strain relief and dust covers
   4. One dimming output per relay
      a. The 0-10-volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.
      b. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. The LED level indicators on connected dimmer switches shall utilize this new maximum and minimum trim.
      c. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0—100% dimming range defined by the minimum and maximum calibration trim.
      d. Calibration and trim levels must be set per output channel.
      e. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

   5. Fade rates for dimming loads shall be specific to connected switch buttons, and the load shall maintain a default value for any connected buttons that do not specify a unique value.

L. Class 2 dimming control signal: 0-10VDC, sinks up to 100mA per channel for control of compatible drivers.

M. UL 2043 Plenum rated.

N. IR window built-in to room controller for commissioning with remote control.

O. Provide (1) infrared remote control for startup, programming, and commissioning.

P. Provide with digital input/output interface that includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC.

Q. Five year warranty.

R. Design Make: Wattstopper LMRC-210 Series with LMIO-101 Digital I/O Interface

S. Approved Equivalents:
1. Crestron ZUM Series
2. Douglass Controls
3. Hubbell NX Series

2.2 LOW-VOLTAGE SWITCHES FOR ROOM CONTROLLERS:

A. Low-Voltage Switch
1. On/Raise & Off/Lower dimming control button with led status indicator
2. Dimming switch with seven bi-level LED's to indicate load levels using 14 steps.
3. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
4. All digital parameter data programmed into each wall switch shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
5. Two RJ-45 ports for connection to the Room Controller network and other devices.
6. Multiple digital wall switches may be installed in a room by simply connecting the to the room controller network. No additional configuration shall be required to achieve multi-level switching.
7. Ramp rate may be adjusted for each dimmer switch.
8. Color by Architect.
9. Five year warranty.
10. Shall be of the same manufacturer as the room controller.
11. Design Make: Wattstopper LMDM-101 Series
12. Acceptable Manufacturer's:
    a. Crestron
    b. Douglass Controls
    c. Hubbell

2.3 OCCUPANCY SENSORS

A. General:
1. All occupancy sensor layouts have been done using the "design make" sensors. Contractor shall be responsible for providing additional sensors and all associated equipment required to provide coverage for required areas.

B. Wall Mounted Sensors
1. Switchbox type (single circuit):
    a. 120-277 volt, 800/1200 watts
    b. 600 sq. ft. of coverage, 180 degree viewing angle.
    c. Passive infrared technology.
    d. Adjustable time delay from 30 seconds to 30 minutes.
    e. Adjustable sensitivity from 20% to 100%.
    f. Manual on switch operation (vacancy mode).
    g. Internal photocell.

h. Decorator style, ivory color.
i. Install in single gang switch box.
j. Design Make: Wattstopper CS-50 series.
k. Acceptable Manufacturers:
1) Crestron Steinel
2) Hubbell
3) Douglass Controls

2. Switchbox Dimming Type (single circuit):
a. 120-277 volt, 800/1200 watts
b. 900 sq. ft. of coverage, 180 degree viewing angle, passive infrared technology.
c. Adjustable time delay from 30 seconds to 30 minutes.
d. Adjustable sensitivity from 20% to 100%.
e. Manual on switch operation (vacancy mode).
f. Decorator style, white color.
g. Install in single gang switch box.
h. Internal photocell.
i. Include with PowPak dimming module with 0–10V control
j. Design Make: Lutron Maestro 0-10V dimming sensor
k. Acceptable Manufacturers:
1) Crestron Steinel
2) Hubbell
3) Douglass Controls

3. Switchbox type (two circuit):
a. 120-277 volt, 800/1200 watts
b. 600 sq. ft. of coverage, 180 degree viewing angle.
c. Passive infrared technology.
d. Adjustable time delay from 30 seconds to 30 minutes.
e. Adjustable sensitivity from 20% to 100%.
f. Two manual on switches for independent control of two separate circuits.
g. Decorator style, ivory color.
h. Install in single gang switch box.
i. Design Make: Wattstopper CS-350 Series
j. Acceptable Manufacturers:
1) Crestron Steinel
2) Hubbell
3) Douglass Controls

C. Ceiling Mounted Sensors
1. Type OS-A Ceiling Mounted Sensors
a. Minimum 450 square feet of coverage, 360 degree viewing angle.
b. Passive infrared technology. Adjustable sensitivity.
c. Adjustable time delay from 5 to 30 minutes.
d. Install semi-flush in single gang switch box above the ceiling.

e. Standalone Sensors:
   1) Includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC
   2) Provide with relay power packs compatible with manual on operation and day-light operation and multi-level switching as shown on drawings.
   3) Compatible with optional low voltage switch for manual-on operation.
   4) Design Make: Wattstopper CI-300
   5) Approved Equivalents:
      a) Crestron Steinel
      b) Hubbell OMNIIRRP
      c) Douglass Controls

f. Sensors connected to Room Controllers:
   1) Two RJ-45 ports for connection to the Room Controller and other devices.
   2) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
   3) Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.
   4) Shall be of the same manufacturer as the Room Controller
   5) Design Make: Wattstopper LMPC-100 Series
   6) Acceptable Manufacturers:
      a) Crestron Steinel
      b) Hubbell
      c) Douglass Controls

2. Type OS-B Ceiling Mounted Sensors
   a. Minimum 1,000 square feet of coverage, 360 degree viewing angle.
   b. Dual technology (Ultrasonic/PIR or Microphonic/PIR). Field selectable for either setting or both. Adjustable sensitivity.
   c. Adjustable time delay from 5 to 30 minutes.
   d. Installs surface mounted in 4” octagon J-box above the ceiling.
   e. Standalone Sensors:
      1) Includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC
      2) Provide with relay power packs compatible with manual on operation and day-light operation and multi-level switching as shown on drawings.
      3) Compatible with optional low voltage switch for manual-on operation.
      4) Design Make: Wattstopper DT-300
      5) Approved Equivalents:
         a) Crestron Steinel
         b) Hubbell OMNIDT1000RP
         c) Douglass Controls

f. Sensors connected to Room Controllers:
   1) Two RJ-45 ports for connection to the Room Controller and other devices.
   2) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
   3) Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.
   4) Shall be of the same manufacturer as the Room Controller
   5) Design Make: Wattstopper LMDC-100 Series
   6) Acceptable Manufacturers:
      a) Crestron Steinel
      b) Hubbell
      c) Douglass Controls

2.4 LOW-VOLTAGE WIRING FOR LIGHTING CONTROLS

A. 0-10VDC Wiring
   1. UL Type CMP plenum rated cable
   2. 0-10VDC wiring shall be white outer jacket with 2-conductor purple and gray jacket insulation on the internal 18AWG solid copper conductors.
   3. Design Make: Liberty AV Solutions 18-2C-LVBP-WHT or Approved Equal

B. Unshielded Twisted Pair (UTP) Wiring
   1. UL Type CMP plenum rated cable
   2. RJ-45 factory terminated RJ-45 connectors
   3. ANSI/TIA-568-C.1 certified Cat. 6 Cable
   4. Max. length 100-meters
   5. Design Make: Belden, West Penn Wire, Hubbell, Leviton

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions, under which luminaires are to be installed, and substrate for supporting luminaires. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PRE-INSTALLATION MEETING

A. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation meeting after receipt of approved submittals to review the following:
   1. Confirm the location and mounting of all digital lighting control devices, with special attention to placement of occupancy and photo sensors.
   2. Review the requirements for low-voltage control wiring and termination.
   3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.

3.3 COORDINATION

A. Refer to respective reflected ceiling plan for each area. Reflected ceiling plans indicate proper luminaire location only. Locate occupancy sensors and photo sensors per the manufacturer's recommendations. Coordinate the proper arrangement with all other ceiling mounted items. Contract Documents indicate luminaire characteristics (type), quality, quantity, etc. Verify with the ceiling supplier design of actual ceiling installed in each area and coordinate compatible luminaire flange/trim type.

B. General
   1. Install interior lighting controls at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's 'Standard of Installation", NEMA standards, and with recognized industry practices.
   2. Make installation such that the lighting controls are free of finger marks, flaws, scratches, dents or other imperfections.

3.4 DELIVERY, STORAGE, AND HANDLING

A. Luminaires and equipment shall be delivered with UL and manufacturer's labels intact and legible in factory fabricated containers.

B. Luminaires and accessories shall be stored in protected dry locations in their original unbroken package or container. Luminaires shall be protected from dust and dampness both before and after installation. Luminaires shall be protected from paint and cleaning solvents during all phases of construction.

C. Handle interior lighting luminaires carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged luminaires or components; replace with new.

3.5 SEQUENCING AND SCHEDULING

A. Coordinate with other work including ceiling type, wires/cables, electrical boxes, fittings, and raceways, to properly interface installation of interior luminaires with other trades.

B. The contractor shall provide the lighting control systems manufacturer with three weeks written notice of the system startup and adjustment date.

3.6 OCCUPANCY SENSORS

A. Provide all necessary mounting brackets, wiring, low voltage transformers and control relays required to provide control of areas indicated.

B. Provide initial time delay and sensitivity settings per owner's representative.

C. Install in location as recommended by the manufacturer.

D. Refer to "Lighting System Functional Testing" part of this section for additional information.

3.7 CONTROL WIRING

A. Provide all required low-voltage control wiring for lighting control system components.

B. Provide RJ-45 factory terminated Cat. 6 or better Unshielded Twisted Pair (UTP) cable with RJ-45 connectors to connect switching, photo control, and occupancy sensing devices on the Room Controller network. Cables shall manufacturer approved for the connectivity solution.

C. Provide 0-10VDC wiring for dimming from Room Controller and dimming switches to the drivers.

D. Control Wiring Installation:
   1. All interior cabling shall be installed concealed inside the wall cavities and ceiling space.
   2. Provide a continuous raceway system in accordance with NEC Article 800 for horizontal cable runs through all inaccessible ceiling (including drywall) and wall cavity spaces. All flexible raceway system runs shall be securely attached to ceiling joists and wall studs 3-feet O.C and removal and addition of cables in the future.
   3. UTP Cables shall be supported by Cable Hangers 3-foot on center. When installed in cable tray zip-tie to cable tray away from STP, coaxial cables, and optical fiber cables. Provide additional stacked Cable Hangers when filled greater than 50%.

3.8 LIGHTING SYSTEM FUNCTIONAL TESTING

A. Lighting system functional testing shall comply with the following requirements:
   1. Provide plan markup which indicates the exact location of each sensor, direction of aim, and certify on the plan that the direction of aim and placement are in compliance with manufacturer's requirements. Include this plan with the Operation & Maintenance Manuals.
   2. Occupancy Sensor Controls:
      a. Certify that the occupancy sensor has been located and aimed in accordance with the manufacturer's recommendations.
      b. All devices shall be tested. Verify the following:
         1) Where occupant sensor controls include status indicators, verify correct operation.
         2) The controlled lights turn off or down to the permitted level within the specified time.
         3) The lights turn on only when manually activated.
         4) The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

   3. For Time – Switch Controls:
      a. Verify that timers are properly programmed with weekday, weekend and holiday schedules.
      b. Provide documentation to the Owner of time-switch controls programming including weekday, weekend, and holiday schedules and set-up and preference program settings. Include a copy in testing documentation package for approval by the Engineer.
      c. Verify time of day and day of week are properly set.
      d. Verify that any battery back-up is installed and energized.
      e. Verify that any override timer is set for less than 2 hours.
      f. Simulate occupied condition and verify the following:
         1) All lights can be turned on or off by respective area control switch.
         2) Light switches control only those lights in the enclosed area where the switch is located.

      g. Simulate unoccupied condition and verify the following:
         1) Non-exempt lights turn off.
         2) Manual override switches allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.

      h. For Daylight Responsive Controls:
         1) Verify that the control sensing devices have been properly located, field calibrated and set for accurate control set points and threshold lighting levels.
         2) Daylight controlled lighting loads adjust to light levels set points in response to available daylight.
         3) The location of calibration adjustment equipment is readily accessible only to authorized personnel.

4) Record all set points and verify with calibrated light meter the actual field recorded lighting control levels.
5) Upon request, repeat measurements in the presence of the Design Professional or their authorized representative to validate lighting level control response.

4. Create a log of deficiencies noted during testing. Correct all deficiencies and update log with corrective action records.
5. Complete and submit as part of the Operation and Maintenance Manuals the submitted and approved lighting testing plan.

B. Test Form:
1. Instruction: Contractor to complete either the following form or the form contained in the approved testing plan for each room in the project that receives lighting controls. Include completed forms in the Operation and Maintenance Manuals.

Room Name/Number:	***Date:***	
Testing Agent's Name:		
Testing Agent's Signature:		
Testing Agent's Company & Position:		
Occupancy Sensor Controls	*Initials*	*N/A*
Verify that the occupancy sensor has been located and aimed in accordance with the manufacturer's recommendations such that occupants within the space properly trigger lighting operation without false trigger from adjacent areas.		
Verify that the status indicators on the occupancy sensor are operating correctly.		
Verify that the controlled lights turn OFF or down to the permitted level within the specified time.		
Verify that the controlled lights turn ON only when manually activated.		
Verify that the lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.		
Record sensitivity level and delay settings for occupancy sensor control:		
Time - Switch Controls	*Initials*	*N/A*
Verify that the timers are properly programmed with weekday, weekend, and holiday schedules.		
Record time schedule as programmed:		
Verify that the time of day and day of week are properly set.		

Verify that battery back-up is installed and energized.		
Verify that the override timer is set for less than 2 hours.		
Simulate occupied condition: I verify that all lights can be turned on or off by respective area control switch.		
Simulate occupied condition: I verify that the lighting switches control only those lights in the enclosed area where the switch is located.		
Simulate unoccupied condition: I verify that all non-exempt lights turn off.		
Simulate unoccupied condition: I verify that the manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.		
Daylight Responsive Controls	*Initials*	*N/A*
Verify that the control sensing devices have been properly located, field calibrated, and set for accurate control set points and threshold lighting levels.		
Verify that the daylight controlled lighting loads adjust to light levels set points in response to available daylight.		
Verify that the location of calibration adjustment equipment is readily accessible only to authorized personnel.		
Record set point (foot-candles):		
Record lighting control level with calibrated light meter (foot-candles):		
Record cut-off time (minutes):		
Record fade rate (units/second):		

3.9 TRAINING

A. Upon completion of the system startup, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the lighting control system. Include sign in sheet with Operation & Maintenance Manuals.

3.10 SPARE PARTS

A. Provide the following spare parts to the owner with sign-off receipt prior to job close-out:
   1. (1) Low-voltage switches

3.11 WARRANTY

A. All lighting controls equipment included in this section shall be fully tested and guaranteed for a period of five years after Owner's Representative written acceptance.

END OF SECTION

SECTION 262400 - SWITCHBOARDS AND PANELBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:
   1. Circuit Breaker

1.3 QUALITY ASSURANCE

A. All low voltage power distribution equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and installation practices specified herein shall comply with the applicable requirements of:
   1. The following Articles of the National Electric Code (NFPA 70)
      a. 240 - Overcurrent Protection
      b. 408 - Switchboards and Panelboards
   2. The following National Electrical Manufacturers Association (NEMA) Standards:
      a. NEMA AB 1 1993 - Molded Case Circuit Breakers and Molded Case Switches
      b. NEMA PB 1 - Panelboards
      c. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.
      d. NEMA 250 - Enclosures for Electrical Equipment
   3. The following U.L. Standards:
      a. UL 50 - Enclosures for Electrical Equipment
      b. UL 67 - Panelboards
      c. UL 98 - Enclosed and Dead-Front Switches
      d. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures
      e. UL 943 - Standard for Ground Fault Circuit Interrupters

1.4 SUBMITTALS

A. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:
   1. Thermal Magnetic Molded Case Circuit Breakers

1.5 MINOR MODIFICATIONS

A. Provide modifications to circuit breaker trip rating within the frame size at no additional cost, until shop drawings are reviewed and submitted.

1.6 FIELD SUPERVISION

A. Provide field supervision and start-up by a qualified representative of the equipment manufacturer. Provide certification that the equipment has been installed in accordance with the manufacturer's requirements.

PART 2 - PRODUCTS

2.1 CIRCUIT BREAKERS

A. General
   1. UL 489 listed.
   2. Below 250Amps – Unless otherwise noted, operation shall be from a fixed thermal magnetic trip unit. Permanent trip unit containing individual thermal and magnetic trip elements.
   3. 250Amps and above - Include field adjustable electronic Long Time, Short Time, and Instantaneous trip unit.
   4. 400Amps and above - Include field installed interchangeable rating plugs.
   5. Provide an over-center, trip-free handle to provide quick-make, quick-break contact action.
   6. Provide multi-pole breakers with common trip.
   7. When the circuit breaker has tripped, the handle shall move to a position between the "on" and "off" positions. Provide a visual indication that the circuit breaker has tripped.
   8. The ampere rating shall be clearly marked on the face of the circuit breaker.
   9. Series rated fuse/circuit breaker installations are not acceptable.
   10. Make provisions to add circuit breaker handle locks.
   11. Circuit breakers shall have voltage, ampere, and interrupting ratings as called for on the Panelboard Schedule.
   12. New circuit breakers installed in existing panelboards shall be UL listed for use in panelboard.

B. Thermal Magnetic Molded Case Branch Circuit Breakers
   1. Molded case circuit breakers shall be constructed of a glass reinforced insulating material. All current carrying components shall be completely insulated and isolated from the outside of the circuit breaker.
   2. 60°C terminal temperature rating for circuit breakers rated 125 amperes or below.
   3. 75°C terminal temperature rating for circuit breakers rated above 125 amperes.
   4. All 20 and 30 ampere, single pole circuit breakers shall be UL listed for switching duty.
   5. Circuit breakers shall be bolt-on. Plug-on acceptable in load centers on residential applications only.
   6. Circuit breakers rated 250 amperes and below shall be UL listed HACR type.
   7. Where ground fault circuit breakers are required, provide a shunt trip circuit breaker with a zero sequence sensing ground fault module.
   8. Design Make: Square D QOB (250 volt), EH, EHB (480 volt), I-Line style (600 volt).

PART 3 - EXECUTION

3.1 GENERAL

A. Provide identification for all equipment and devices as indicated in section 260100.

B. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, hardware, etc. as required to install equipment.

C. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items ad required.

D. Provide minimum NEC working clearance for all equipment.

E. Verify cable/lug sizes for terminations. Where a feeder is sized larger the lug provide replacement lug or in line splice as directed by Owner's Representative.

F. Provide testing in accordance with ANSI/NETA-2013 ATS for Electrical Power Equipment and Systems.

3.2 CIRCUIT BREAKERS

A. Install circuit breakers in panelboards and switchboards as called for on the plans and as recommended by the manufacturer.

END OF SECTION

SECTION 265100 - LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide complete installation, including luminaires, standards, hangers, supports, fittings, lamps, wiring, and connections as indicated in the Contract Documents. Types of luminaires in this project include LED.

B. Refer to the General and Supplementary Conditions, Division 1 Specifications Sections for proposed phasing of this project.

C. Refer to section 260923 for Wired Lighting Controls.

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:
   1. LED Luminaires
   2. LED Drivers
   3. Lamps
   4. Diffusers

1.3 SUBMITTALS

A. Submit shop drawings as described in Section 260010. Shop drawings shall include photometric data for each luminaire utilizing the specified lens/louver type, lamp(s) and ballast(s). All luminaire types and lighting control system components shall be submitted in a single complete brochure which shall be in the form of a soft cover binder with each luminaire separated by an identified index tab.
   1. Information on each luminaire shall include:
      a. Manufacturer and Catalog Number.
      b. Dimensioned Construction Drawing(s).
      c. Standard Catalog "Cut" Sheet.
      d. Photometrics.
      e. Lens/Louver Type.
      f. Driver Type and Rating.
      g. Socket Type.
      h. Lamp Type.
      i. Maintenance Data

B. Warranty Information

1.4 QUALITY ASSURANCE

A. Luminaires shall be standard products of manufacturers regularly engaged in the manufacture of the specific type luminaires specified and shall be the manufacturer's latest standard design that complies with specification requirements. Firms installing the luminaires shall have a minimum of five (5) years of successful installation experience on projects with interior lighting work similar to the requirements of this project.

B. Codes and Standards
   1. NEC:
      a. Shall comply with Articles 220, 410 and 510 as applicable to installation and construction.
   2. NEMA:
      a. Shall comply with Standard Publication Nos. LE 1 and LE 2 as applicable to lighting equipment.
   3. UL:
      a. All interior lighting luminaires and components shall be UL listed and labeled.
      b. Comply with all applicable UL standards including UL 486A and B.
   4. CBM:
      a. Fluorescent and HID ballasts shall comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

   5. All work shall comply with applicable local code requirements of the authority having jurisdiction.

C. Verify the availability of all luminaires proposed to be used in the execution of the work prior to submitting for approval. The discontinuance of production of any luminaire after such approval has been granted shall not relieve the Contractor from furnishing an approved luminaire of comparable quality and design at no additional cost.

D. Luminaires shall be as specified in the "Luminaire Schedule." Luminaire types, characteristics, photometrics, finishes, etc., correspond to the first manufacturer, and associated catalog number, listed in the "Luminaire Schedule." Provide a sample luminaire from the factory for any products not listed as acceptable for approval. The Owner's Representative reserves the right to disapprove any luminaire type submitted which is not equal in quality, appearance or performance to the luminaire specified.

E. All luminaires shall meet the Total Luminaire Efficiency (TLE) requirements of the New York State Energy Conservation Construction Code.

PART 2 - PRODUCTS

2.1 LED LUMINAIRES

A. General:

1. Manufacturers shall be a registered with the Department of Energy (DOE) as a Quality Advocate and taken the pledge to be listed on the LED lighting facts website.
2. Luminaire measurements have been standardized and are in compliance with IESNA Standard LM-79 test procedure.
3. LED's have been standardized and are in compliance with IESNA Standard LM-80 and demonstrate L70 life after 50,000 hours.
4. Luminaires and/or replacement lamps shall be either Energy Star certified or Design Lights Consortium listed where noted on the luminaire schedule to qualify for NYSERDA or Utility provider rebate incentives. Submitted luminaires not currently on the DLC qualified products list (http://www.designlights.org/) will be rejected.
5. Manufacturers shall prove color consistency across all LED's via 4 step MacAdam Ellipse.
6. Luminaires shall be tested at an ambient temperature of +25 degrees for a minimum of 6000hrs.
7. Maximum junction temperature of 80°C.
8. Minimum drive current of 350mA. Maximum drive current of 700mA.
9. All LED luminaires shall have a minimum Color Rendering Index (CRI) of 80.
10. Luminaires shall a minimum 5 year warranty.
11. Refer to Luminaire Schedule on drawings for complete Luminaire makes and models.

2.2 LED DRIVERS

A. Dimmable Driver (0-10v):

1. Driver shall be of the constant current type.
   a. Voltage: 120/277 as noted on drawing
   b. Driver Current: 350mA – 700mA.
   c. 0-10v dimming capable down to 10% min.
   d. Maximum THD: 10%
   e. Minimum Power Factor: 0.9

2. Acceptable Manufacturers.
   a. eldoLED - ECOdrive
   b. Signify Advance – Xitanium
   c. Lutron – Hi-lume
   d. Osram Sylvania - Optotronic

2.3 LAMPS

2.4 DIFFUSERS

A. Lenses:

1. Extruded 100 percent virgin acrylic material with a minimum weight of ten ounces per square foot.
2. Type 12 - Clear material with 0.125 inch overall thickness with .080 Inch penetration comprised of 3/16 inch square based female cones aligned 45 degrees to the length and width of the panel.
3. Type 19 - Clear material with 0.156 inch overall thickness with 0.080 inch penetration comprised of 3/16 inch square based male cones aligned parallel and perpendicular to the length and width of the panel.
4. White matte - White material with 0.125 inch overall thickness.
5. While overlay - White material with 0.040 inch overall thickness.
6. The maximum deflection at the center of a 2 foot x 4 foot lens shall be no greater than 0.250 inch. Arched or warped lenses will not be accepted.
7. Parabolic Louvers
   a. Medium cell louver - One piece injection molded acrylic, with all parabolic surfaces prepared with a primary undercoat, highly specular vacuum metalized finish, and encapsulated in a protective acrylic lacquer coating. Cell dimensions shall be nominal 1-1 /2 inches x 1-1 /2 inches x I inch deep, and shall provide approximately 38 degree shielding with a louver efficiency of not less than 52 percent. This louver shall have a VCP index rating of 0.93 for semi-specular silver finish. Panel finish shall be specular silver.

8. Baffles and Louvers
   a. Cross Baffle - Constructed of 0.050 inch aluminum with one-way blades to provide 45 degree shielding. Blades 1-1/2 inches high and spaced 1-1/2 inches apart. While enamel finish. Side shields for support of the blades. Width to extend the full width of the lighting unit and of lengths to form a continuous baffle with no visible joints. Where inside and outside comers are required, the blades shall be mitered.
   b. Parabolic Baffle - Constructed of 0.050 inch aluminum with one-way blades to provide 45 degree shielding. Blades 1-1/2 inches high and spaced 1-1/2 Inches apart. Clear anodized finish. Side shields for support of the blades. Width to extend the full width of the lighting unit and lengths to form a continuous baffle with no visible joints. Where inside and outside comers are required, the blades shall be mitered.
   c. Directional Louver - Constructed and fabricated of aluminum with a "cold bonding joint method for integral vibration free and precise alignment of cells. Louver finish shall be custom color as directed by the Architect.

2.5 LUMINAIRE SCHEDULE

A. Luminaire schedule is found on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions, under which luminaires are to be installed, and substrate for supporting luminaires. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Refer to respective reflected ceiling plan for each area. Reflected ceiling plans indicate proper luminaire location only. Locate occupancy sensors and photo sensors per the manufacturer's recommendations. Coordinate the proper arrangement with all other ceiling mounted items. Contract Documents indicate luminaire characteristics (type), quality, quantity, etc. Verify with the ceiling supplier design of actual ceiling installed in each area and coordinate compatible luminaire flange/trim type.

B. General
   1. Install interior luminaires at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's 'Standard of Installation", NEMA standards, and with recognized industry practices.
   2. Provide luminaires and/or luminaire outlet boxes with hangers to properly support luminaire weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Engineer.
   3. Make installation such that the luminaire is free of finger marks, flaws, scratches, dents or other imperfections.
   4. Arrangement
      a. Align edges of luminaires with walls or other building elements. Where indicated by dimensions or indicated on Drawings, maintain indicated arrangement.
      b. For wall to wall installed luminaires, field measure length required after completion of the wall construction and prior to ordering the luminaires. Fabricate in largest lengths allowable.

5. Recessed Mounting
   a. Verify ceiling construction and material prior to ordering luminaires. Provide plaster frames for plaster ceilings and flanged frames for drywall ceiling. Provide necessary mounting hardware and accessories to adapt luminaire to ceiling construction. Provide gaskets, trims, flanges, etc. as required to prevent light leaks around trim. Where installing 'lay-in' type luminaires, each Luminaire shall be supported completely independent of the ceiling system by way of 12-AWG galvanized steel support wires. Support wires shall be attached from all four corners of the Luminaire housing to the building structure. Each support shall be capable of supporting 100 pounds. Provide saddle hangers or tie bars attached to runners or between crossbars of ceiling systems as a safety measure. Provide mounting splines or other positive means of maintaining alignment and rigidity.

3.3 DELIVERY, STORAGE, AND HANDLING

A. Luminaires and equipment shall be delivered with UL and manufacturer's labels intact and legible in factory fabricated containers.

B. Luminaires and accessories shall be stored in protected dry locations in their original unbroken package or container. Luminaires shall be protected from dust and dampness both before and after installation. Luminaires shall be protected from paint and cleaning solvents during all phases of construction.

C. Handle interior lighting luminaires carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged luminaires or components; replace with new.

3.4 SEQUENCING AND SCHEDULING

A. Coordinate with other work including ceiling type, wires/cables, electrical boxes, fittings, and raceways, to properly interface installation of interior luminaires with other trades.

3.5 REMOVAL OF BALLAST IN EXISTING LUMINAIRES

A. Assume ballast contains PCB materials unless labeled otherwise or test samples to show materials are not PCB; submit test report. Remove all ballast from existing luminaires indicated on contract documents. Dispose of all ballast which do not have non-PCB labels in PCB containers and pay all costs to have containers taken to EPA approved incinerators and disposed of per all EPA regulations. Follow all EPA regulations for transporting containers and materials. If ballast has leaked in existing luminaire, remove material deposited in luminaire and dispose of those materials as listed above. Provide Certificate of Disposal and all associated paperwork to Owners representative.

3.6 REMOVAL OF LAMPS IN EXISTING LUMINAIRES

A. Assume all fluorescent lamps contain Mercury materials unless labeled otherwise or test samples to show materials do not contain Mercury and submit test report. Remove all lamps from existing luminaires indicated on contract documents. Dispose of all lamps which do not have non-Mercury labels in compliance with the requirements of the New York State Department of Environmental Conservation and all applicable Federal Laws. Follow all regulations for transporting materials. Provide Certificate of Disposal and all associated paperwork to Owner's representative.

3.7 WARRANTY

A. All lighting and lighting controls equipment included in this section shall be fully tested and guaranteed for a period of five years after Owner's Representative written acceptance.

3.8 FINAL CLEANING

A. Prior to acceptance, damp clean diffusers, glassware, trim, reflectors, lamps, louvers, lens and similar objects of all luminaires. Remove all dirt, corrosion, foreign material, finger marks, and blemishes. Replace all burned out lamps and failed components.

END OF SECTION

SECTION 283100 - FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. Connect all new fire alarm devices to existing Simplex 4100U Fire Alarm Control Panel.

C. Labeling of addressable devices to be approved by owner and each addressable device shall be provided with a custom label designation (e.g. M1-44) in black text on an adhesive backed plastic label. Labeling on device to be by Electrical Contractor (EC).

1.2 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:
   1. Manual Pull Stations
   2. Photoelectric Smoke Detectors
   3. Audible/Visual Signal Devices
   4. Visual Signal Devices

1.3 QUALITY ASSURANCE

A. All installations shall be accompanied in a professional manner by qualified personnel regularly engaged in have a minimum of 5 year of experienced in this type of Work. All fire alarm installers shall possess a state license for installation of fire alarm systems where required.

B. All raceways shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

C. Materials specified herein shall comply with the applicable requirements of:
   1. The following Articles of the National Electric Code (NFPA 70)
      a. Article 760 - Fire Alarm Systems

2. The following National Fire Protection Agency (NFPA) standards:
   a. NFPA 72 - National Fire Alarm Code
   b. NFPA 90A - Installation of Air Conditioning and Ventilating Systems
   c. NFPA 101 - Life Safety Code

3. The following U.L. Standards:
   a. UL 864/UOJZ,APOU - Control Units for Fire Protective Signaling Systems
   b. UL 268 - Smoke Detectors for Fire Protective Signaling Systems
   c. UL 268A - Smoke Detectors for Duct Applications
   d. UL 521 - Heat Detectors for Fire Protective Signaling Systems
   e. UL 228 - Door Holders for Fire Protective Signaling Systems
   f. UL 464 - Audible Signaling Appliances
   g. UL 1638 - Visual Signaling Appliances
   h. UL 38 - Manually Activated Signaling Boxes
   i. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems
   j. UL 1481 - Power Supplies for Fire Protective Signaling Systems

1.4 SUBMITTALS

A. Provide standard product data for all equipment indicating the type, size, rating, style, catalog number, and listing of the equipment.

B. Provide calculations for sizing all batteries and power supplies. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.

C. Provide power supply calculations listing total current and inrush total current for FACP, and all Notification Appliance Power Supplies and Power Extender Panels.

D. Architectural floor plans and drawings showing system details including specific location of FACP, all system devices, device device ID label addresses, raceway sizes, raceways routings cabling in raceways, end of line devices, power supplies and any other system components.

E. Provide a complete riser diagram indicating all devices with addresses, number of initiation and signal loop circuits, class of wiring system, and type of wiring.

1.5 SYSTEM DESCRIPTION

A. Point addressable fire alarm system with manual and automatic initiation devices.

B. System shall be supervised to continuously monitor the integrity of the circuit conductors and power supplies.

C. Performance of the fire alarm system circuits shall be in accordance with Class B, Style B operation for Initiating Device Circuits (IDC) and Class B, Style Y operation for Notification Appliance Circuits (NAC's).

D. The fire alarm control panel shall permit on-site programming to accommodate facility expansions, renovations, or fire alarm system modifications. All memory shall be non-volatile.

E. The control panel shall have 24 VDC output power supplies for notification appliance circuits. System shall be capable of adding additional power supplies as required to power all notification appliances.

F. Summary Reports:
1. The Fire Alarm Control Panel shall be capable of displaying and printing summary reports. The summary reports shall include:
   a. A list of all alarm points not in their normal state.
   b. A list of all points in the system, including their current status.
   c. A list of data for all control by event programs.
   d. A list of data for all time initiated programs.

G. Alarm Priority:
1. Alarms shall be processed at three levels of priority:
   a. Fire alarms shall have the highest priority.
   b. Other alarms that require interaction by the attendant shall have the second level of priority.
   c. Monitored points which do not require interaction by the attendant shall be the lowest level of priority.

H. System Access:
1. Access to the system shall be controlled by at least three levels of security to prevent programming modifications by unauthorized personnel.
   a. The lowest level of access, shall permit the attendant to view the system display, print alarms and perform life safety control by event functions. The Attendant has minimal access to the system functions.
   b. The mid-level access shall permit the attendant to change user programmable parameters.
   c. The highest level of access shall permit the modification of system software. This level shall be accessed only by a qualified representative of the equipment manufacturer.

1.6 SEQUENCE OF OPERATION

A. Upon an abnormal condition on the fire alarm system, the appropriate LED (alarm, supervisory, or trouble) shall flash. The panel audible alarm shall pulse for alarm conditions and sound steadily for trouble or supervisory conditions. All abnormal events shall be logged into the database, along with the date and time.

B. Operation of any smoke detector, heat detector, or manual pull station alarm initiating device shall cause the following to happen:
   1. Sound all audible alarm signals throughout the building in a temporal Code.
   2. Activate all visual strobe lights throughout the building. Strobes shall continue to operate until Fire Alarm Control Panel is reset.
   3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and update the event log. The visual indication shall remain until the alarm condition is reset.
   4. Notify the UL listed central station via dial up digital communicator.
   5. Operate alarm relay contacts to release all magnetically held doors throughout the building.
   6. Operate the fan shut-down relay for the HVAC systems in the same smoke compartment or smoke zone.
   7. Operate all smoke dampers in the same smoke compartment or smoke zone. Dampers shall close 30 seconds after their respective fan systems have shut down.
   8. Subsequent initiating alarms shall repeat the respective sequence of operations.

C. The Fire Alarm System wiring and power supplies shall be electrically supervised and report trouble conditions to the fire alarm control panel. Any opens, shorts or grounds on the system wiring shall cause the following to happen:
   1. Sound a distinct pulsed audible alarm at the fire alarm control panel.
   2. Flash the yellow common trouble LED.
   3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and update the event log. The visual indication shall remain until the alarm condition is reset.
   4. Notify the UL listed central station via dial up digital communicator.
   5. Subsequent trouble alarms shall repeat the respective Sequence of Operation.

D. Alarm Silencing:
   1. Pressing the “Alarm Silence” button shall cause all notification appliances to be deactivated. A yellow LED located in the fire alarm control panel shall illuminate to indicate the alarm has been silenced.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/SUPPLIERS AND EQUIPMENT

A. The system described in this specification is the Simplex 4100U platform.

2.2 FIRE ALARM CONTROL PANEL

A. Existing Simplex 4100U located in Maintenance and Ground Storage Room 147

B. Enclosure:
   1. Surface mounted, steel with enamel finish.
   2. Hinged, lockable door with viewing window.
   3. Sized to house power supplies, batteries, and charger.

C. System circuits shall be configured as follows:
   1. Analog addressable circuits: Class B in conduit
   2. Zone Address Module (where specified only) Initiating device circuits: Class B in conduit
   3. Notification Appliance Circuits: Class B in conduit

D. Capable of performing a U.L. listed detector sensitivity test.

E. The power supplies shall be high efficiency, switched mode type, and shall monitor the incoming line. Upon power outage or brownout conditions, the power supplies shall automatically switch to the batteries.
   1. The power supply shall provide internal power and 24 VDC for notification appliance circuits.
   2. All output circuits shall be power limited.
   3. The battery shall be sized to support the system for 24 hours, and then operate all notification appliances for 5 minutes.

2.3 PHOTOELECTRIC SMOKE SENSOR

A. Detector shall operate on a light scattering principal. The detector shall have a photo-optic chamber with an infrared light emitting diode and a high speed light sensing photo diode. Capable of sensing visible products of combustion.

B. Alarm conditions shall be indicated by a steady red glow from the LED mounted on the sensor.

C. Sensor shall be microprocessor based, with electronic point addressing to indicate to the system which device is in alarm.

D. The sensor shall be continuously monitored to measure any changes in sensitivity due to dirt, smoke or humidity. Any buildup of foreign material shall cause trouble signal at the control panel indicating that maintenance is required.

E. Sensor shall be capable of automatic device mapping and day/night sensitivity adjustment.

F. Sensors shall be twist lock mounted to a separate base provided with screw terminals for field wiring. The detector shall be tamper resistant and shall be removable only with a special tool.

G. Provide auxiliary relays and 24 VDC power for elevator capture or smoke evacuation control where indicated.

H. Design Make: Simplex True Alarms 4098 Series

2.4 FIXED TEMPERATURE HEAT DETECTOR

A. Self-restoring thermal detector.

B. Rated at 135°F fixed temperature. Provide 200°F fixed temperature in boiler room and as indicate on plans.

C. Design Make: Simplex True Alarms 4098 Series

2.5 CONTROL RELAY MODULE

A. Addressable device with a form “C” dry relay contact used to control external appliances such as door closers, fans, dampers etc.

B. Provide a remote LED alarm and key operated test switch for each damper connection. Install remote test switches in visible (below ceiling space) and accessible locations adjacent each damper.

C. Relay contact rating:
   1. 24 VDC = 2amps (pilot duty)
   2. 120 Vac = .5 amps

D. Polling and alarm/active status provided by on board red and green LEDs.

E. Design make: Simplex 4090 Series

2.6 INPUT MODULE

A. Addressable device used to connect 2 class B analog initiating device circuits.

B. Input circuit wiring requirements
   1. Maximum allowable wire resistance - 50 ohms per circuit
   2. Maximum allowable wire capacitance - .1uF per circuit

C. Polling and alarm/active status provided by on board red and green LEDs.

D. Design make: Simplex 4098 Series

2.7 VISUAL SIGNAL DEVICE

A. Provide backbox for recessed installations except for installations on existing walls.

B. 24 VDC.

C. Visual strobe shall have the following characteristics:
   1. ADA compliant.

2. Adjustable White light output of 15, 30 or 75 candela as indicated on drawings. If no setting is indicated on the drawings set to 75cd.
3. Flash rate from 1 Hz to 3 Hz.
4. Pulse duration of 0.02 seconds.
5. Housing color: Red
6. Label on housing: Red text “FIRE”
7. Provide with wireguard when installed in Gym, Gym Halls, and Locker Rooms.

D. Design Make: Simplex 49VO Series

2.8 AUDIO-VISUAL SIGNAL DEVICE

A. Provide backbox for recessed installations except for installations on existing walls.

B. 24 VDC.

C. Audio output shall be rated for 93 dB at 10’, 520Hz compatible. For extensions to existing systems field verify audible alarm type in existing building and provide to match existing signal type.

D. Visual strobe shall have the following characteristics:
1. ADA compliant.
2. Adjustable White light output of 15, 30 or 75 candela as indicated on drawings. If no setting is indicated on the drawings set to 75cd.
3. Flash rate from 1 Hz to 3 Hz.
4. Pulse duration of 0.02 seconds.
5. Housing color: Red
6. Label on housing: Red text “FIRE”
7. Provide with wireguard when installed in Gym, Gym Halls, Locker Rooms, and Bathrooms.

E. Design Make: Simplex 49AV series

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. During installation and testing, and prior to the system being put into service, all manual stations shall be appropriately marked "NOT IN SERVICE" by the Contractor.
2. Provide all 120 volt, 60 cycle AC required to power the system and all remote power supplies.
3. Wiring to all initiation and signal circuits shall be two wire class B. A fault on a circuit loop shall cause a trouble alarm to initiate for its associated zone at the fire alarm control panel.

4. All wiring shall conform to N.E.C. Articles 725 and 760, and to NFPA-72, "National Fire Alarm Code".
5. Detection and initiating equipment shall be listed by UL or approved by FM.
6. Install smoke detectors a minimum of 3 feet away from any air supply or return diffuser.
7. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.
8. Where detectors are installed on wood or masonry surfaces, attach brackets directly to the surface with tamperproof fasteners. Where detectors are installed on suspended ceilings, provide additional supports in the ceiling, such as channel support system, angle iron or additional runner bars. Fasten the additional supports rigidly to the ceiling runner bar system. Attach bracket to the supports with tamperproof fasteners. Install metal spacers between the bracket and supports so that the ceiling tiles will not be a part of the support system.
9. Mount FACP and all sub panels at working height.
10. Provide and wire fan shutdown relay contacts in series with starters ahead of all control devices.
11. All controlled devices such as smoke dampers, fire dampers, elevator control and door control shall be supervised to within 4’ of the controlled device.

B. Audible/Visible Device Installation:
1. Field verify audible alarm type in existing building and provide to match existing signal type.
2. Visual strobes shall be 75-candela output in all other locations unless otherwise noted.
3. Devices shall be installed at eighty inches (80") minimum above the floor, or six inches (6") below the ceiling, whichever is lower, in accordance with ADA guidelines.
4. Audible devices intended for operation in public spaces shall have a sound level of not less than seventy-five (75) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.
5. Audible devices intended for operation in private spaces shall have a sound level of not less than forty-five (45) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.
6. All audible emergency alarm signals shall be at least 15 dbA over the existing sound level within a space or shall exceed the maximum sound level by 5 dbA for at least 60 seconds, whichever is louder. Within areas occupied by persons with hearing impairments, audible emergency alarms must have the intensity and frequency to provide notification of an alarm condition.
7. Do not exceed 80% loading on any NAC power circuit.

C. Wiring:
1. Install all wiring in accordance with manufacturer's recommendations and the National Electric Code.

2. All interior wiring in exposed finished locations shall be installed in surface metal raceway. All interior wiring installed above accessible corridor ceiling tiles shall be run in 1” wide J-Hook cable supports located 4-feet on center. Provide EMT sleeves with fire-stopping for all wall penetrations. All interior wiring installed in unfinished basements, mechanical rooms, boiler rooms, and electrical rooms shall be installed inside EMT conduit. Paint all junction box covers in the raceway system RED. All surface metal raceway backboxes shall be RED factory enclosures.
3. All wire shall be copper.
4. Type AC or MC Fire Alarm Cable is not permitted as a wiring method for this project.
5. Wire and cable shall be #14 AWG size, solid copper, THHN/TWN for horns, manual stations, smoke or heat detectors, waterflow switches, valve supervisory switches and other initiating and indicating devices. Communication loop wiring shall be shielded in accordance with the Manufacturer's recommendations.
6. Wiring shall be continuous from device to device. Splicing shall be accomplished by use of terminal blocks in locked cabinets keyed alike with the fire alarm control unit, or junction boxes. No connections or splices shall be made underground.
7. Control cabinets shall not be used as pull boxes or raceways. Wiring gutters and locked terminal cabinets shall be used.
8. The Fire Alarm System wiring shall be installed in a workmanlike manner, subject to the approval of the project manager.
9. All harnessing of wires shall be accomplished by use of approved nylon tie wraps.
10. All wiring shall be numbered and color coded in accordance with this Specification.
11. Tests of all wiring shall be conducted for proper connection, continuity, and resistance to ground. The minimum allowable resistance between any two conductors or between conductors and ground is one (1) megohm as checked by a "megger" after all conduit, conductors, detector bases, etc. have been installed, but before the detector devices are plugged into the base or end-of-line devices installed.

D. Routing:
1. All fire alarm system conduits shall be installed either parallel or perpendicular to building structural members.
2. All fire alarm system conduits shall be provided at a height so as not to obstruct any portion of a window, doorway, stairway, or a passageway, and shall not interfere with the operation of any existing mechanical or electrical equipment.
3. All fire alarm system conduits and cable shall be routed to minimize the potential for physical damage, either mechanical or by fire.
4. All fire alarm system junction boxes, pull boxes, terminal cabinets, control enclosures and device backboxes shall be readily accessible for testing, service and maintenance.

E. Wall, Floor and Ceiling Penetrations:
1. All conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.
2. All conduit penetrations of walls, floors, and ceiling shall be sealed around the conduits, restoring the walls, floors and ceilings to their original condition, fire resistance and integrity.

F. Concealment:
1. Conduit shall be concealed except where shown on the drawings.
2. All conduit, raceways, junction boxes, panels, electrical enclosures, relays and device backboxes shall be concealed in ceiling spaces, electrical shafts or closets in all finished areas.
3. Conduit, raceways, junction boxes, panels, electrical enclosures, relays and device backboxes may be exposed in unfinished areas.
4. All fire alarm system components, including devices, junction boxes, electrical enclosures, relays and device backboxes shall be provided so as to be readily accessible for inspection, testing, service and maintenance.

G. Terminations:
1. All fire alarm conductor terminations shall be on numbered terminals or terminal strips. All fire alarm conductor terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other satiable metal enclosures. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.
2. All connections and end-of-line devices shall be accessible for inspection, testing and servicing.
3. Terminations to terminals other than barrier/pressure plate type terminals shall use crimp-on ring-type or Y-type spade connectors.
4. Splices shall be permitted only when routing of existing conductors prohibits point-to-point terminations in existing junction boxes, terminal cabinets, etc. All such splices shall be provided with new terminal strips with proper labeling in junction boxes, terminal cabinets, etc.

H. Control Panel Location and Wiring:
1. All control panel wiring shall be fully dressed and bundled with nylon tie wraps. Bundled wiring shall be routed parallel to terminal strips within control panels, with individual conductors turned out at 90 degree angles to their associated terminal connections. AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 2-inch separation shall be maintained between AC power conductors and low voltage conductors wherever possible. All control cabinets shall be sized to accommodate the requirements of this section.
2. Each conductor terminating within a control panel shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on the record (As-Built) drawings in a manner allowing ready identification of any field wiring conductor in any control panel.

I. Mounting and Labeling of Devices:
1. All fire alarm devices shall be rigidly mounted, using appropriate backboxes, to building structural members, permanent walls, ceilings or fixtures designed for the purpose.
2. All devices shall be labeled with device address or device count as appropriate. Label shall be sticky back type attached to base of device. Label identification shall be consistent with As-Built drawings.

J. Color Coding and Wire Numbering:
1. All conductors entering and leaving terminal cabinets and junction boxes shall be numbered in a logical and consecutive manner.
2. All conductors shall be color coded. Color coding shall be by wire insulation, not taping or banding. The numbering and color coding shall be continuous for each circuit wire.
3. Wires shall be numbered at each connection, termination, and junction point. Wire numbering tags shall be Brady Perma-Code, Westline, or equal.
4. Color coding shall be as follows:

CIRCUITS	COLOR CODES
Alarm Initiating Circuits	Yellow (-) and Orange (+), red (alarm) blue (alarm)
Horns, 24VDC	Slate(-) and Brown (+)
Smoke Detector	Yellow (-) Orange (+) red (alarm) blue (alarm)
Heat Detectors, Pull Stations	Purple (alarm) Black (alarm), connected to the same zone
Fan Shutdown	Blue (-) White (+)
Strobes, 24VDC	Violet (-) and Pink (+)
System AC Power	Black and White
Sprinkler Horn	Black and White
Valve Supervision	Orange and Yellow
DC Power, Door holds	Black (-) and Red (+)

3.2 INTERRUPTIONS TO EXISTING FIRE ALARM SYSTEM

A. General:
1. Do not remove any portion of the existing fire alarm system from operation while installing new work without written approval of the Owner's Representative.
2. Pupil occupied spaces must have existing systems maintained during school operation.
3. In order to accomplish the above requirements, temporary wiring and relocations of some existing and/or new equipment may be necessary. These temporary locations should approved by the Owner's Representative and arranged so as to avoid safety problems.

3.3 INSTALLED SPARES Designer to edit for project as needed

A. Provide the following installed spares. Installed spare include the device, backbox, wiring, programming and up to 50 feet of raceway.

B. (1) smoke detectors, (1) strobes, (1) Audio/Visual Devices, associated system tie-ins.

C. Turn over all unused spare to owner for spare parts.

3.4 TESTING

A. General:

1. After complete installation of the equipment and submittal of as-built drawings, the Contractor shall perform complete tests of the system. After these tests have been completed, the Contractor shall request final acceptance inspection and tests in the presence of the Project Manager and local authority. Coordination of final acceptance test date and times with those to be present is the responsibility of the Contractor. The Contractor shall demonstrate that all conditions of the plans and specifications have been met. The tests shall include proper operation of all devices and testing of supervised circuits. The installation will be checked against the as-built drawings. The Contractor shall furnish all testing materials and instruments. A punch list will be developed and the Contractor shall correct punch list items. There will be a reinspection of punch list items. If additional reinspections are found necessary to assure compliance with the Contract, they shall be made at the Contractor's expense.
   a. The Contractor shall provide, at no additional cost to the Contract price, the following services by the Manufacturer's representative:
      1) Prior to the final inspection, "pre-test" the entire fire alarm system to assure that all new equipment is properly installed and functions in accordance with plans and specifications.
      2) The Manufacturer's representative shall certify that the entire new and existing installation was tested and performed satisfactorily.

2. Final acceptance tests shall be coordinated by the contractor and performed in the presence of the owner’s representative as follows:
   a. Operation of the fire alarm control panel and indicating components in accordance with factory recommended procedures.
   b. Operational tests of all devices (i.e., detector, waterflow indicator, manual pull box, and valve supervisory device) in accordance with the factory recommended procedures.

c. Audible/visible testing of all indicating appliances. Tests shall include sound level (dBa) and light intensity (lumens). Audible testing shall be performed and documented for each space with any doors closed.
d. Checks of each initiating circuit or device address for correct indications at the control unit, and any remote annunciator.
e. A checkout report shall be prepared by the contractor and submitted to the Owner's Representative. The checkout report shall include a listing of detector sensitivity for each detector. The report shall summarize the results of all tests and shall serve as the contractor's certification that the system is properly installed and fully functioning

B. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance.

C. Prior to acceptance testing the contractor shall complete and submit the "Record of Completion" form as identified in NFPA 72.

3.5 IDENTIFICATION

A. All system devices shall be labeled in the field.

B. For each smoke detector, heat detector, flame detector, duct mounted type smoke detector, manual pull station and/or other alarm initiating device, provide the following:
1. Adhesive backed, vinyl cloth, numbered labels, identifying the device specifically by system address.
2. Labels shall be white background color with solid black numbers. Numbers shall be not less than 5/8" high x 1/8" stroke wide.
3. Design Equipment: Seton Nameplate Co.- Style M3847 or equivalent.

C. For each shut down relay and/or auxiliary control relay and for specific remote lamps, provide the following:
1. Adhesive backed, engraved lamicoid type labels specifically identifying what the fan shut down relay is shutting down, what relay is controlling or what the remote lamp is connected to.
2. Labels shall be black face with white sandwich color, nom: 1/2" tall x 2" wide, with capital letters not less than 3/16" tall engraved into the surface.
3. Design Equipment: Local fabrication by contractor.

D. Provide labels for all smoke detectors that activate elevator recall, smoke hatch operation or fireman's car operation.

E. All labels shall be visible once device is installed.

F. Provide label on each power supply indicating power supply designation, 120 volt panel and associated circuit breaker number.

G. All concealed covers for all system outlet and pull boxes installed shall be factory or field painted red.
   1. On the inside face of each outlet box cover, Contractor shall provide labeling, indicating; System address, Circuit Number, Horn/Speaker/Strobe Circuit Number, etc.

H. Provide identification of each circuit breaker feeding on each FACP, Notification Appliance Power Supply Panel and Notification Appliance Power Supply Extender Panel indicating that the circuit feeds the fire alarm system per NFPA 72 by marking in RED “Fire Alarm System”.

3.6 CLEANING AND ADJUSTMENT

A. Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by the manufacturer.

B. Occupancy Adjustments: Within one year of the date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit the actual occupied conditions.

3.7 RECORD DOCUMENTS

A. Provide complete set of as-built record drawings and documents.

B. Record Documents shall include all documents required by the Submittal Section of this specification updated to reflect as-built project conditions.

C. Prior to request for final payment submit a quantity of bound Operator Manuals that shall include as a minimum:
   1. All documents required by the Submittal Section of this specification updated to reflect as-built project conditions
   2. Bill of Material.
   3. Instruction report stating when instruction was given and who was in attendance, signed by the Owner's Representative. Provide written operator instructions for basic system operation, interpretation of system outputs, operation of manual evacuation signaling and ancillary controls and the use of drill functions (if applicable).
   4. Detailed description of routine maintenance and testing as required and recommended for each type of device installed. Maintenance guide shall include:
      a. Listing of each individual device that requires periodic testing and maintenance.
      b. Step by step procedures for the testing and maintenance for each device listed.
      c. Schedule for the testing and maintenance as recommended by NFPA 72 for each device listed.

5. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved. Certificate of Completion, Fire Alarm System Inspection and testing form and all other system acceptance documents as described in NFPA-72.

END OF SECTION