INVITATION FOR BIDS (IFB)
Johnston County Public Schools
Clayton Middle School AHU 16 and 17 Equipment Owner Purchase

Sealed bids from equipment manufacturer representatives will be received by Johnston County Public Schools, Smithfield, North Carolina on **Thursday, February 27, 2025** for furnishing of equipment, delivery, warranty, and manufacturer startup for the JCPS Clayton Middle School AHU 16 and 17 replacement. Bids will be received up to **3:00 PM** from bidders at which time and place all bids will be publicly opened and read aloud. Deliver bids to the **Johnston County Public Schools Simpson Building located at 2320 US HWY 70 Business East, Smithfield, NC 27577.** USPS mail is automatically routed to our PO Box which creates issues for large packages, do NOT use this method to send proposals.

- Manufacturer pricing must be good for at least a period of sixty (60) days.
- Manufacturer must include in bid proposal:
    - Total price including equipment cost, delivery to Johnston County Public School Facilities Warehouse or Clayton Middle School, warranty of 12 months on all components, and manufacturer startup including field pressure testing to leakage requirement to be scheduled with installing contractor.
    - Lead time in weeks. Manufacturers must commit to a lead time based on purchasing release date of March 12, 2025.
    - Product submittal for each air-handling unit indicated, provide unit dimensions and weight; cabinet material, metal thickness, finishes, insulation, and accessories; certified fan-performance curves with system operating conditions indicated; certified fan-sound power ratings; fan construction and accessories; motor ratings, electrical characteristics, and motor accessories; certified coil-performance ratings with system operating conditions indicated; dampers including housings, linkages, and operators; and filters with performance characteristics.
    - Terms and Conditions of proposal.
- Equipment must conform to equipment schedule, specification, and dimensional drawings attached to RFP. Unit sections must fit through mechanical room double door. Unit must not exceed dimensions in dimensional section drawings and meet performance, provide access sections for air handling unit components and each equipment component, no exceptions.
- Johnston County Public Schools reserves the right to reject any and all proposals and to waive informalities or irregularities.

For information regarding this bid, drawings, and specifications, please contact:

Designer Contact Information:	Owner Contact Information:
Dewberry Engineers Inc.	Johnston County Public Schools
Weston Hockaday, Project Manager	Joshua Woodard, HVAC Coordinator
whockaday@dewberry.com	joshuawoodard@johnston.k.12.nc.us
(cell) 919-524-3668	919-934-2021, ext. 7044

Thank you for your consideration.

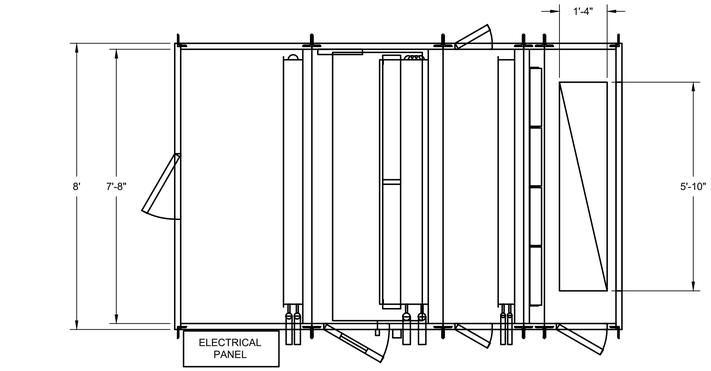
Signed: Joshua Woodard
HVAC Coordinator
Johnston County Public Schools, Smithfield, North Carolina

SEMI CUSTOM AIR HANDLING UNIT SCHEDULE

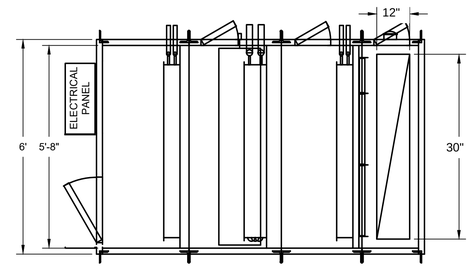
MARK		AHU-16	AHU-17					
SERVICE		GYM AREA	LOCKERS					
MECHANICAL ROOM		MECH RM G06	MECH RM G06					
TYPE		SEMICUSTOM INDOOR	SEMICUSTOM INDOOR					
BASIS OF DESIGN MANUFACTURER		TEMTROL LC	TEMTROL LC					
TOTAL CAPACITY AIR FLOW (CFM)		16,500	2,650					
TOTAL CONNECTED AIR FLOW (CFM)		16,400	2,400					
OA	ECONOMIZER (Y/N)	Y (RELIEF FAN)	N					
	DESIGN MAX. VENT. AIR FLOW (CFM)	6,925	2,400					
	DEMAND CTRL. MIN. VENT. AIR FLOW (CFM)	1,200	2,400					
FILTER PRE	TYPE & THICKNESS	4" PLEATED PANEL	2" PLEATED PANEL					
	LOAD STYLE	UPSTREAM FACE LOAD	SIDE LOAD					
	SIZE (QUANTITY)	20x24 (12)	20x24 (3)					
	MAX. FACE VELOCITY (FPM)	450	450					
	INITIAL APD (IN WG)	0.37	0.25					
	FINAL APD (IN WG)	0.73	0.50					
	EFFICIENCY (MERV)	8	8					
PREHEAT COIL AIR	COIL FLOW (CFM)	16,500	2,650					
	EAT (Fdb)	30.0	0.0					
	LAT (Fdb)	55.0	55.0					
	MAX. FACE VELOCITY (FPM)	500	500					
	MAX. APD (IN WG)	0.15	0.15					
PREHEAT COIL HEATING WATER	CAPACITY (MBH)	447.6	158.1					
	EWT (F)	150.0	150.0					
	LWT (F)	120.0	120.0					
	FLOW (GPM)	30	10.75					
	MIN. ROWS	1	2					
	MIN. FINS PER INCH	8	8					
	MAX. WPD (FT)	10.0	10.0					
	MIN. TUBE VELOCITY (FT/S)	4.0	4.0					
	PIPE SIZE (INCHES)	1.5	1.25					
	CONTROL VALVE	2-WAY PI	2-WAY PI					
COOLING COIL AIR	COIL FLOW (CFM)	16,500	2,650					
	EAT (Fdb/Fwb)	81.8/65.7	95.0/78.0					
	LAT (Fdb/Fwb)	53.9/53.6	53.7/53.6					
	MAX. FACE VELOCITY (FPM)	500	500					
	MAX. APD (IN WG)	0.50	0.25					
COOLING COIL CHILLED WATER	TOT. CAP. (MBH)	642.3	237.7					
	SENS. CAP. (MBH)	497.2	114.5					
	EWT (F)	45.0	45.0					
	LWT (F)	57.0	57.0					
	FLOW (GPM)	107.25	39.75					
	MIN. ROWS	5	4					
	MIN. FINS PER INCH	9	10					
	MAX. WPD (FT)	10.0	10.0					
	PIPE SIZE (INCHES)	2.5	2					
	CONTROL VALVE	2-WAY PI	2-WAY PI					
SUPPLY AIR FAN	TYPE	PLENUM	PLENUM					
	DRIVE TYPE	DIRECT	DIRECT					
	TOTAL CAPACITY AIR FLOW (CFM)	16,500	2,650					
	TOTAL CONNECTED AIR FLOW (CFM)	16,400	2,400					
	SPEED (RPM)	1,852	2,378					
	DESIGN MAX. SPEED (RPM)	1,853	4,190					
	MIN. WHEEL DIAMETER (IN)	22	12					
	TSP (IN WG)	3.70	2.7					
	ESP (IN WG)	2.25	1.25					
	NUMBER OF FANS (MINIMUM)	2.0	2.0					
PER FAN	BRAKE HORSEPOWER (HP/KW)	7.4 HP / 5.6 KW	1 HP / 0.75 KW					
	NOMINAL MOTOR RATING (HP/KW)	10 HP / 6 KW	1.5 HP / 3.9 KW					
	SPEED (RPM)	1850	2378					
	VOLTAGE/PHASE	480/3	480/3					
	STARTER/DISCONNECTING MEANS	ECMi (0-10V) WITH DISCONNECT OR VFD	ECMi (0-10V) WITH DISCONNECT OR VFD					
REHEAT COIL AIR	COIL FLOW (CFM)	16,500	2,650					
	EAT (Fdb)	55.0	55.0					
	LAT (Fdb)	90.0	90.0					
	MAX. FACE VELOCITY (FPM)	450	500					
	MAX. APD (IN WG)	0.15	0.15					
REHEAT COIL HEATING WATER	CAPACITY (MBH)	626.6	100.6					
	EWT (F)	150.0	150.0					
	LWT (F)	120.0	120.0					
	FLOW (GPM)	42	6.75					
	MIN. ROWS	2	1					
	MIN. FINS PER INCH	8	8					
	MAX. WPD (FT)	7.5	7.5					
	PIPE SIZE (INCHES)	2	1.25					
	CONTROL VALVE	2-WAY PI	2-WAY PI					
UVGI LAMPS		YES (740 W / 120V)	YES (160 W / 120V)					
FOOTPRINT (FT x FT)		12.5'Lx8'W	9.2'Lx6'W					
HEIGHT (FT)		6.75' COIL SECTION & 10.6' FAN DISCHARGE	3.25' COIL SECTION & 6.25' FAN DISCHARGE					
SA CONNECTION		TOP / 56"x26"	TOP / 30"x12"					
RA CONNECTION		TOP / 70"x16"	NA					
OA CONNECTION		END / 56"x26"	TOP / 30"x12"					
RELIEF CONNECTION		NA	NA					
UNIT SINGLE POINT CONNECTION FLA/MCA		20/22	12/15					
WEIGHT (LBS)		6,183	2,568					
NOTES		1,2,3,4,5,6,7,8	1,2,3,4,5,6,7,8					

NOTES:

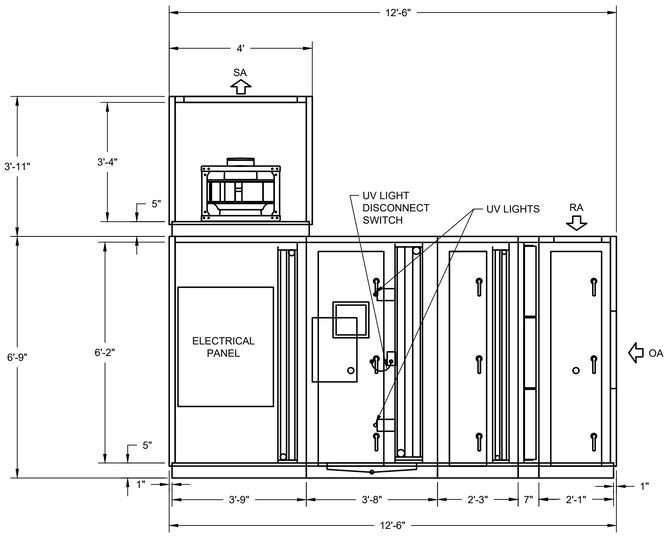
1. REFER TO SECTION 237319 - AHUS FOR ADDITIONAL REQUIREMENTS. REFER TO UNIT DETAILS AND DIAGRAMS FOR COMPLETE CONFIGURATION AND DIMENSIONAL DETAILS.
2. PROVIDE FAN STARTING AND DISCONNECTING MEANS AS SCHEDULED. (ECMi = INTELLIGENT ELECTRICALLY COMMUTATED MOTOR WITH 0-10V SIGNAL SPEED CONTROL WITH THERMAL OVERLOAD AND DISCONNECT OR VFD = VARIABLE FREQUENCY DRIVE WITH INTEGRAL DISCONNECT (PROVIDE VFD PER FAN IN ARRAY BYPASS NOT REQUIRED))
3. UNIT CASING, COIL CAPACITIES AND COMPONENT APD'S ARE BASED ON THE TOTAL CAPACITY SUPPLY FAN AIRFLOW. TOTAL CONNECTED SUPPLY AIRFLOW IS INTENDED FOR TAB PURPOSES ONLY.
4. INTERNAL STATIC PRESSURE SHALL INCLUDE SCHEDULED PRESSURE FOR DIRTY FILTERS. FILTER FRAMES SHALL BE SELECTED FOR A SINGLE FILTER SIZE.
5. VFDS SHALL NOT EXCEED 75 HZ AND MOTORS SHALL NOT EXCEED 3000 RPM FOR DIRECT-DRIVE FANS IN ARRAY CONFIGURATIONS.
6. PROVIDE STAINLESS STEEL COOLING COIL FRAME AND PAN WITH CONDENSATE DISCHARGE ABOVE BASE RAIL.
7. UNIT SECTIONS MUST FIT THROUGH MECHANICAL ROOM DOUBLE DOOR.
8. PROVIDE MINIMUM 5-INCH HIGH CONTINUOUS PERIMETER AND INTERMEDIATE BASERAILS.
9. PROVIDE ELECTRICAL PANEL FOR SINGLE POINT OF CONNECTION INCLUDING BUT NOT LIMITED TO FAN THERMAL OVERLOADS, DISCONNECTS, VFDS, AND TRANSFORMER FOR UV LIGHTS.



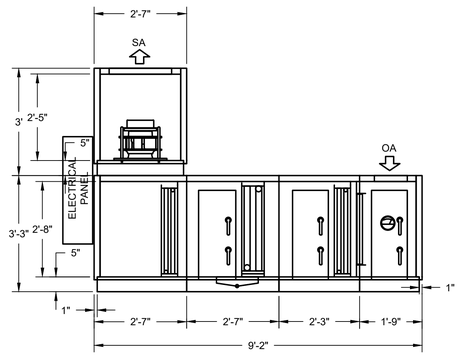
1 AHU 16 SECTION 1 — SCALE: NTS



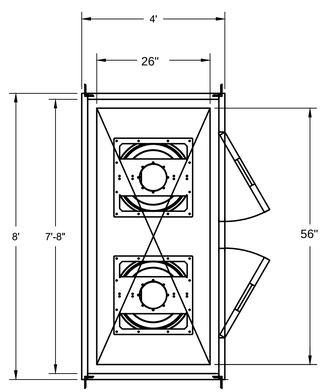
2 AHU 17 SECTION 1 — SCALE: NTS

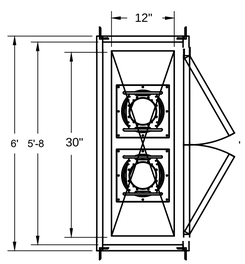


3 AHU 16 SECTION 2 — SCALE: NTS



4 AHU 17 SECTION 2 — SCALE: NTS





Dewberry

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JOHNSTON COUNTY PUBLIC SCHOOLS

JCPS

CLAYTON MIDDLE SCHOOL

AHU 16 AND 17 REPLACEMENT

490 GUY RD,
CLAYTON, NC 27520

EARLY EQUIPMENT

SEAL

KEY PLAN

SCALE

REVISIONS

NO.	DESCRIPTION	DATE

DRAWN BY SF
APPROVED BY WH
CHECKED BY WH
DATE 02/05/2025

TITLE

DETAILS

PROJECT NO. 50185618

M-501

SHEET NO.

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SECTION 23 73 19 – SEMI CUSTOM INDOOR AIR HANDLING UNITS

PART 1 - GENERAL

1.1. SUMMARY

A. Section includes semi-custom indoor central-station air handling units.

1.2. SUBMITTALS

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

1. Product Data: For each air-handling unit indicated, provide unit dimensions and weight; cabinet material, metal thickness, finishes, insulation, and accessories; certified fan-performance curves with system operating conditions indicated; certified fan-sound power ratings; fan construction and accessories; motor ratings, electrical characteristics, and motor accessories; certified coil-performance ratings with system operating conditions indicated; dampers including housings, linkages, and operators; and filters with performance characteristics.

2. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved: mechanical-room layout and relationships between components and adjacent structural and mechanical elements; support location, type, and weight; and field measurements.

B. Close-Out Submittals:

1. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals. Information shall include descriptive literature, model and serial numbers of all components, performance data, and operation and maintenance instructions.

1.3. QUALITY ASSURANCE

A. Applicable components of the air handling units shall comply with:

1. Fan Sound-Power Level Ratings: Comply with AMCA 300 and 301. Fans shall bear AMCA-certified sound ratings seal.

2. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210.

3. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

4. NFPA 70 (National Electric Code) and 90A

5. AMCA 204, 205, 211 and 311

6. AHRI 260, 261, 430 and 1060
7. ASHRAE 62.1, Section 5 and 7
8. ASHRAE/IESNA 90.1, Section 6

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Flame-spread index of 25 or less and smoke-developed index of 50 or less.

C. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

D. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

E. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

1.4. COORDINATION

A. Coordinate sizes, weights (operational and shipping) and locations of supports and opening with the actual equipment provided, including:

1. Concrete bases
2. Structural steel support members

1.5. EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Two set(s) for each air-handling unit.
2. Fuses: One-set of main fuses in unit-mounted cabinet.
3. EC Fan: Provide spare fan for units with combination motor / fan selection.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product by one of the following for custom and semi-custom built air handling units with standard quality casings:

1. Nortek Air Solutions (Temtrol LC)
2. Daikin
3. Trane (Custom Performance Climate Changer CSAA and PSCA series)
4. VTS

2.2. UNIT CASINGS

A. Standard Quality Casing Fabrication: Factory-fabricated and constructed self-supporting wall, roof and floor double-wall casing panels with 2-inch (R-16) closed-cell injected-foam insulation within formed channel framing or greater. The casing construction shall provide thermal breaks. All joints shall be air-tight and water-resistant sealed.

1. Casing Performance:

a. Leakage: Casing shall meet AHRI 1350 Casing Air Leakage Rate CL3 with less than 10 cfm leakage per 100 sqft. at 6.0-inches w.g. positive or negative internal pressure.

b. Deflection: Casing shall meet AHRI 1350 Casing Deflection Rate CD3 with less than 0.0042-inches (1/240) deflection per inch of span at 6.0-inches positive or negative internal pressure. Floor deflection shall not exceed 0.0625-inches at 6-inches internal pressure and 300-pound per sqft. live load.

2. Casing Materials:

a. Exterior: G90 galvanized-steel, smooth, 20-gauge (0.036-inch thick) minimum.

b. Interior: G90 galvanized-steel, smooth, 20-gauge (0.036-inch thick) minimum with galvanized-steel structure,

1) Exceptions:

a) Cooling coils sections will be Type 304 stainless steel, smooth, 20-gauge (0.038-inch thick) minimum or aluminum 16-gauge (0.050-inch-thick) minimum with stainless steel screws.

3. Casing Finish: None

4. Casing Section Gaskets: Neoprene gasket around entire perimeter of casing section joints.

B. Floor: Each section shall have a 2-inch tall lip at the perimeter to form a water-tight pan. Walking surfaces of floor panels shall have a solid 3/16-inch thick checker-plate aluminum solid lining with water-tight welded seams and reinforcements to support 300-pound per sqft. live load

C. Monorail Beams: Each fan section shall include a structural I-beam monorail capable of lifting the fan motor(s) through the fan section access door on the primary service side of the unit.

D. Access Doors and Panels: Factory-fabricated double wall, to match casing and insulation materials, finish and performance and suitable for unit pressure and leakage classification. Doors shall open against positive pressure and be large enough to remove associated

components such as motors, filters, etc. but no smaller than 12-inches wide and 48-inches tall. Additional access panels shall be provided to aid in removal of components such as fans, coils, etc.

1. Door Hinges, Latches and Handles: Minimum of two ball-bearing or piano hinges, two wedge-lever latches and quarter-turn handles.

2. Door Gaskets: Neoprene gasket around entire perimeter of door frames.

E. Condensate Drain Pans: Drain pans shall be factory-fabricated, minimum 16-gauge, Type 304 or 316 stainless steel, water-tight sealed, and minimum 2-inch deep. Pans shall be sloped in two directions to collect condensate from cooling coils (including coil piping connections, coil headers and return bends). They shall direct water toward drain connection. Drain connection shall be on the bottom side and at the lowest point of the pan.

1. Main Drain Pans: Pans shall be insulated and extend 6-inches upstream and 24-inches downstream of coil face.

2. Intermediate Drain Pans: Units with stacked coils shall have intermediate drain pans to collect condensate from upper coils. Intermediate pans shall extend 3-inches upstream and minimum 4-inches downstream of coil face. They shall have 1-inch minimum diameter stainless steel downspout to guide condensate to the main drain pan. Downspouts shall be non-cascading.

3. Locate drain connection above the base rail of the air handling unit. Drain pan, cooling coil, and section construction must be adjusted to accommodate. This requirement is to ensure adequate p-trap height is available to install above finished floor. Manufacturer to provide estimated static pressure in condensate drain section for worst case p-trap conditions to ensure that drain outlet is higher that combination of discharge height plus concrete pad to consider base rail discharge.

F. Test Ports: Factory-fabricated test ports shall be provided at each component section for measurement and testing devices. Ports shall be 1-inch diameter with threaded cap. Ports shall be installed prior to pressure and leakage testing. Field drilled ports are not acceptable.

G. Power and Control Conduit: Conduits from internal components to exterior surface junction boxes shall be factory-installed. The number, minimum sizes and locations of the conduits and junction boxes shall be coordinated with the installing contractor prior to fabrication. All wiring shall be installed in rigid and/or flexible conduit. Flexible liquid-tight conduit shall be used for connections to equipment subject to vibration. Flexible conduit lengths shall be limited to 48-inches. EMT conduit shall not be used inside the unit.

H. Base Rails: Structural steel channel rails continuous at the unit's perimeter and at intermediate locations needed to support internal components suitable for mounting on structural steel platform or concrete pad. Base rails shall be galvanized with epoxy-based paint finish. Minimum 4" height or as scheduled. See condensate drain discharge location.

I. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.

J. Modular Provisions: Units shall include modular design to fit through a 6 foot mechanical room door with provisions for connecting sections.

2.3. FAN, DRIVE AND MOTOR SECTION

A. Fans: Comply with requirements of Section 233400.

B. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower. Shafts shall be designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

C. Fan Housings:

1. Plenum Fan Housings: Direct-drive centrifugal type, steel frame and panel, fabricated without fan scroll and volute housing.

D. Fan Wheels:

1. Centrifugal Plenum Fan Wheels: Airfoil wheels shall be single-width single-inlet (SWSI) construction with heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Fan Arrays: Direct-drive modular-plenum fans in a parallel array, using number of fans indicated on the drawings but not less than 2, arranged to provide equal air flow across the unit's cross-section. The fans in each array shall be identical.

1. Performance: The fans operating in parallel shall meet the performance requirements scheduled. The fans shall be selected to have non-overloading design with self-limiting horsepower characteristics in the normal operation area.

2. Fan Sections: Array support structure materials shall match interior casing material and have 6-inch minimum depth. Monorail or trolley system shall be provided to assist the removal of fan wheels and motors.

3. Backdraft Dampers: Each fan shall have a factory-mounted motor-operated low-leakage backdraft damper that complies with the requirements of Section 233300 unless prohibitive by mounting position.

a. Pressure losses across the dampers shall be included in the fan performance data and not considered to be included in the unit's scheduled pressure drop.

4. Variable Speed Drives: Comply with the requirements of Section 230514. Drives manufactured by the air handling unit manufacturer are also acceptable in addition to the manufacturers listed in Section 230514.

a. Each fan motor shall be equipped with a dedicated variable speed drive without bypass, unless otherwise noted.

b. All drives in an array shall be mounted in a NEMA-1 enclosure with power and control wiring, disconnect switch, and a single-point electrical connection. Individual drives shall have circuit breaker disconnects for individual maintenance.

c. Over-Speeding: Air Handling Units with Setback Schedules: Variable frequency drives shall not operate over 90 Hz and motors shall not operate over 3,000 RPM for direct-drive fans used in air handling units at normal operating conditions.

5. Air Flow Measuring Stations: Differential pressure type piezometer ring mounted on the throat of the inlet cone. Accuracy shall be plus or minus 5 percent, including transducer and conversion error, at 100 to 5,000 fpm.

F. Fan Shaft Bearings:

1. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings, L10 rated for 200,000 hours with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit.

2. Permanently Sealed Ceramic Bearings

G. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

H. Motors: Comply with requirements of Section 230513.

I. Variable Frequency Controllers: Refer to Section 230514.

1. Where indicated to be unit-mounted, mount variable frequency drives on exterior of indoor units per manufacture’s recommendations and within dedicated pre-manufactured casing compartment of outdoor units. Variable frequency drives shall not be installed outdoors without supplemental cooling.

J. Motor Starters and Disconnects: Refer to Section 230511.

1. Where indicated to be unit-mounted, mount motor starters and disconnect switches on exterior of unit per manufacture’s recommendations.

2.4. COIL SECTION

A. Heating and Cooling Coils: Provide coil types in positions indicated. Comply with requirements of Section 238216. Coils shall comply with ARI 410.

1. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).

2. Coils shall not act as structural component of unit.

3. Individual cooling coils shall be no more than 36-inches tall. When multiple cooling coils are used in height, provide intermediate condensate drain pans.

4. Coil sections shall have stainless steel casing liner, coil supports, and accessories.

2.5. MAINTENANCE ACCESS SECTION

A. Maintenance Access Sections: Provide access sections as indicated in the documents; but not less than 18-inch long section between coils unless otherwise noted.

2.6. ULTRAVIOLET GERMICIDAL IRRADIATION LAMPS

A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:

1. Lumalier
2. Sterile-Air
3. UV Resources

B. Ultraviolet Germicidal Irradiation (UVGI): Ultraviolet radiation shielded (UV-C) lamps that are UL listed for disinfection in HVAC applications. The UVGI system shall be located for maximum effectiveness and to constantly irradiate the surfaces of the cooling coil and drain pan with a 90% efficiency. Light fixture shall be constructed of stainless steel and suitable for operation in saturated air.

1. Automatic Disconnect: UVGI system shall automatically switch off when the unit access door is opened.
2. Interlocked Disconnect: UVGI system shall automatically switch on when the unit supply fan is operating and off when it is not.
3. Status Indication: Provide contacts for indication of status.
4. Manual Disconnect: UVGI system shall have a unit-mounted manual disconnect switch to turn lights off for testing and maintenance while air handler is in operation. Label switch in compliance with Section 230553.

   UVGI DISCONNECT SWITCH
   DANGER: TURN UVGI LAMPS OFF
   BEFORE ENTERING AHU.

   INTERRUPTOR DE DESCONEXION DE LAMPARAS
   DE IRRADIACION GERMICIDA ULTRAVIOLETA (UVGI)
   PELIGRO: APAGUE LAS LAMPARAS (UVGI)
   ANTES DE ENTRAR UTA (AHU).

5. Access Door View Panel: View panel glass in access section with UVGI system shall be ultraviolet light filtering to allow inspection from outside the unit while in operation.
6. UVGI Lamps: UV-C radiation lamps that emit minimum 85% of 253.7 nm wave length; do not generate ozone; and are rated for minimum lamp life of 9000 hours.
   a. Lamps shall be hermetically sealed within a thin layer of UV-C transmissible Teflon® to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained. “Encapulated lamps”
7. Warning Sign: Post warning signs on access doors that are exposed to UV light as follows: “Caution: Ultraviolet energy. Protect eyes and skin. Do not switch off safety button or activate lamps with door open.”
   a. Apply warning signs on the access door used to access UV-C lamps and the next door upstream and downstream.

      WARNING: ULTRAVIOLET LIGHT HAZARD.
      DIRECT EXPOSURE TO UV-C LIGHT PRODUCED BY UVGI LAMPS MAY RESULT IN EYE AND SKIN DAMAGE.
      NEVER LOOK AT LAMPS WHILE THEY ARE LIT.
      DO NOT DISABLE SAFETY DEVICES.

DISCONNECT UVGI POWER BEFORE SERVICING.

PELIGRO: PELIGRO LUZ ULTRAVIOLETA.
EXPOSICION DIRECTA A RADIACION UV-C PRODUCIDA POR LAS LAMPARAS UVGI PUEDE RESULTAR EN DAÑOS A LOS OJOS Y PIEL.
NUNCA MIRE LAS LAMPARAS MIENTRAS ESTÁN ENCENDIDAS.
NO DESACTIVE LOS DISPOSITIVOS DE SEGURIDAD.
DESCONECTE EL PODER DEL UVGI ANTES DE REPARAR.

2.7. AIR FILTRATION SECTION

A. Filters: Filter sections shall be designed for the indicated filter types and orientations. Provide filters that comply with requirements of Sections 234100.

B. Filter Holding Frames: Provide filter holding frames arranged for flat or angled orientation, with access doors.

1. Frame Material: Galvanized steel

2. Panel Filters: Factory-fabricated filter holding frames arranged for flat or angular orientation as indicated, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

3. Filter frames shall be set up to utilize the same size filter and not mix matched for each unit. Filter sizes shall be standard filter dimensions, such as 16x20, 16x25, 20x20, or 24x24.

C. Filter Gage: Provide filter gage to measure pressure loss, 0 to 2-inches w.g., across each filter bank. Flush-mount gages on unit casing directly above filter section access doors. Dwyer “Magnehelic” or equal.

D. No air handler shall use more than 1 filter size.

2.8. DAMPERS

A. Leakage Rate: Dampers shall not exceed AMCA 511 Leakage Class 1A, 3 cfm/sqft at 1-inch w.g. pressure differential. Ruskin model CD60 or equal.

1. Isolation Dampers: Refer to Section 233300.

B. Damper Operators: Comply with requirements in Section 230900.

C. Electronic Damper Operators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque. Electronic damper position indicator shall have visual scale indicating percent of travel and 2 to 10-V dc, feedback signal.

1. Operator Motors: NEMA Premium Efficient motor, complying with Section 230513, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Permanent split-capacitor or shaded-pole type with gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

2. Non-spring-return motors for dampers larger than 25 sqft. shall be sized for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

3. Spring-return motors for dampers larger than 25 sqft. shall be sized for running and breakaway torque of 150 in. x lbf.

4. Size dampers for running torque calculated as follows:

   a. Parallel-blade dampers shall have running torque based on 7 inch-lb/sqft. of damper with edge seals and 4 inch-lb/sqft. of damper without edge seals.

   b. Opposed-blade dampers shall have running torque based on 5 inch-lb/sqft. of damper with edge seals and 3 inch-lb/sqft. of damper without edge seals.

   c. Increase running torque by 1.5 when dampers are exposed to 2 to 3-inches of pressure drop or 1000 to 2500 fpm face velocities. Increase running torque by 2.0 when dampers are exposed to 3 to 4-inches of pressure drop or 2500 to 3000 fpm face velocities.

5. Coupling: V-bolt and V-shaped, toothed cradle.

6. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

7. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on non-spring-return actuators.

8. Power Requirements (Two-Position Spring Return): 24 V ac.

9. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

11. Temperature Rating: Minus 22 to plus 122 deg F.

12. Run Time: 12 seconds open and 5 seconds closed, unless otherwise indicated.

D. Outdoor and Return-Air Mixing Dampers: Aluminum dampers mechanically fastened to cadmium-plated steel operating rod in reinforced cabinet. Actuate dampers independently and simultaneously. Comply with Section 233300.

1. Outside Air (OA): Parallel blade type.

2. Return Air (RA): Parallel blade type.

E. Combination Filter and Mixing Section: Cabinet support members shall hold 2-inch thick, pleated, flat, permanent or throwaway filters. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.9. IDENTIFICATION

A. Manufacturer's Name-Plate: Name-plate shall be installed on or near the supply air fan section access door.

B. Points of Connection: All piping and wiring utilities available for connection at the exterior of the unit shall be clearly identified with permanent labels.

C. Internal Wiring: All internal wiring shall be clearly identified with permanent labels.

2.10. TESTING

A. Field Testing: Representatives from the owner, project engineer, and installing contractor may witness the testing if they choose. Provide proposed test procedures for review and coordinate schedule 2 weeks prior to testing. Test results shall be published for review. Units shall pass all quality control testing prior to acceptance.

1. Unit Testing: Perform unit and component testing in the field.

a. Casing shall be pressure, leak and deflection tested per AHRI 1350 to meet the minimum requirements defined in “Unit Casings” section above. Deflection criteria shall apply to wall, roof, floor and door panels.

PART 3 - EXECUTION

3.1. DELIVERY

A. All air handling unit openings shall be protected during shipping and rigging with sheet metal covers. The entire unit including each shipping section shall be wrapped in 7 mils plastic shrink wrap to maintain unit cleanliness.

3.2. EXAMINATION

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

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.3. INSTALLATION

A. Equipment Mounting:

1. Install indoor air-handling units on cast-in-place concrete equipment bases.

2. Comply with requirements for vibration isolation in Section 230548.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.4. CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect condensate drain pans and extend to nearest discharge location. Discharge to either sanitary sewer floor drain, storm water floor drain, or exterior grade as indicated on plans to meet local regulations. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

D. Connect wash-down drain piping and extend to nearest sanitary floor drain. Install line sized ball valves for each section. The valves shall be closed during unit operation.

E. Hot and Chilled Water Piping: Comply with applicable requirements in Sections 232113 and 232116. Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300.

3.5. FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Prepare written report summarizing findings and recommended corrective actions prior to start-up. Verify corrections have been made prior to start-up.

B. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

3.6. STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Verify that shipping, blocking, and bracing are removed.

3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.

4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor- and return-air mixing dampers open and close and maintain minimum outdoor-air setting.
7. Comb coil fins for parallel orientation.
8. Verify that proper thermal-overload protection is installed for electric coils.
9. Install new, clean filters.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Manufacturer's Start-up: Factory authorized representative shall perform the air handling unit start-up procedures, including the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7. ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 for air-handling system testing, adjusting, and balancing.

C. Replace fan and motor pulleys as required to achieve design airflow. Coordinate with the TAB Contractor.

3.8. CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units inside and out. Internally remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9. DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION

SECTION 23 05 11 – HVAC ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.1. SUMMARY

A. This section includes electrical equipment, materials and work that are the responsibility of Division 23.

1.2. SUBMITTALS

A. Product Submittals:

1. Product Data: For each type of device, include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

2. Electrical Connections: Submitted equipment nameplates shall be coordinated with the indicated design electrical characteristics. If the submitted equipment requires changes to the electrical connection(s) (including conduit, wire, circuit breaker, fuse, starter, and disconnect sizes, connection locations, etc.) comply with the requirements of Section 230100. Any changes required to accommodate the equipment shall be responsibility of the contractor.

   a. Proposed changes to the design shall be submitted to the Engineer for review and approval.

   b. Accepted changes shall be noted by the contractor on the as-built documentation.

B. Close-Out Submittals:

1. Operation and Maintenance Data: For disconnects, motor starters and combination motor starters and disconnects, to include in emergency, operation and maintenance manuals.

1.3. QUALITY ASSURANCE

A. Source Limitations: Obtain motor starters, disconnect switches and combination motor starters and disconnect switches of a single type through one source from a single manufacturer.

1. Exceptions: Disconnect switches that are factory-mounted to HVAC equipment may be provided by the equipment manufacturer.

B. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

1. Where requirements of Division 23, Division 26 or NFPA 70 conflict, conform to the strictest requirements.

C. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

D. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

1.4. EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One set for each fused device.

PART 2 - PRODUCTS

2.1. EQUIPMENT ENCLOSURES

A. Provide NEMA-rated equipment enclosures for all disconnect switches, motor starters, control panels, variable speed controllers and other similar electrical equipment. When not otherwise indicated, provide enclosures based on the environments of the installations.

1. Inside, Clean Spaces without Water Piping: NEMA 1.

2. Inside, Utility Spaces and Spaces with Water Piping: NEMA 12.

3. Outside, Normal Ambient Conditions: NEMA 3R.

4. Inside or Outside, Water Features and Equipment (Pools, Fountains, Aquariums, etc.) Spaces: NEMA 4X

5. Inside or Outside, Manholes, Tunnels and Sumps: NEMA 6

6. Inside or Outside, NEC Hazard Class 1 Locations: NEMA 8

7. Inside or Outside, NEC Hazard Class 2 Locations: NEMA 9

2.2. DISCONNECT SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Eaton

2. ABB/General Electric

3. Schneider Electric/Square D

B. Fusible Disconnect Switches: Single-throw, heavy-duty, service-rated fusible switch, rated for 200 to 600Vac and labeled and listed UL 98 and NEMA KS 1, Type HD with silver-

tungsten type fuse clips and equipment ground and neutral kit. When a neutral is not necessary, bond the neutral bus to the enclosure for use as grounding bus. Internal current-carrying components shall be solid copper. Provide auxiliary contacts when needed for control system interface.

C. Non-Fusible Disconnect Switches: Single-throw, heavy-duty, service-rated switch, rated for 200 to 600Vac and labeled and listed UL 98 and NEMA KS 1, Type HD with equipment ground and neutral kit. When a neutral is not necessary, bond the neutral bus to the enclosure for use as grounding bus. Internal current-carrying components shall be solid copper. Provide auxiliary contacts when needed for control system interface.

D. Provide switch accessories required to meet the system requirements indicated.

2.3. MOTOR STARTERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Eaton
2. ABB/General Electric
3. Schneider Electric/Square D

B. Description: Full-voltage, electrically-held, non-reversing, magnetic motor controllers with 24Vac control circuit, hand-off-auto (HOA) switch, push-to-start switch, manual reset switch, auxiliary control and monitoring contacts and accessories required to meet the system requirements indicated. Cover door shall have red and green pilot lights. The green light shall illuminate when “on”, and red shall illuminated when “off”.

2.4. COMBINATION MOTOR STARTERS AND DISCONNECT SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Eaton
2. ABB/General Electric
3. Schneider Electric/Square D

B. Description: Combination magnetic motor starter and circuit breaker disconnecting means with auxiliary contacts.

1. Disconnecting Means: Thermal magnetic type molded-case circuit breaker (MCCB) with adjustable instantaneous-trip for each pole, auxiliary control and monitoring contacts and test trip button.
2. Motor Starter: Full-voltage, electrically-held, non-reversing, magnetic motor controllers with 24Vac control circuit, hand-off-auto (HOA) switch, push-to-start switch, manual reset switch, auxiliary control and monitoring contacts and accessories required to meet the system requirements indicated. Cover door shall have red and green pilot lights. The green light shall illuminated when “on”, and red shall illuminated when “off”.

2.5. MANUAL MOTOR SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Eaton

2. ABB/General Electric

3. Schneider Electric/Square D

B. Description: Manual motor starter and disconnect switch with thermal overload protection for fractional horsepower motors. Toggle switch shall provide manual “on/off” control of one or two-pole single-phase motors rated up to 1 horsepower. The enclosure shall have green pilot light. The green light shall illuminate when “on”. The switch shall have a hand guard to prevent accidental operation and provisions for a padlock in the “off” position. The switch shall be rated for single or two-speed applications as indicated. The enclosure shall be for flush wall-mounting where possible and surface wall-mounting where not.

2.6. FUSES

A. Description: Non-renewable cartridge fuses of the type and size required by NFPA 70 and Division 26.

2.7. SHORT-CIRCUIT CURRENT RATINGS

A. Overcurrent protection devices shall be rated for the ampere interruption current rating indicated in the Division 26 documents. Where the rating is not indicated, provide devices rated for 65,000 AIC.

2.8. POWER AND CONTROL CABLING AND RACEWAY

A. Low-Voltage (100 to 600 V) Power Feeders: Size conductors and raceway per NFPA 70 and Division 26 based on equipment nameplate requirements and manufacturer’s installation recommendations.

B. Control-Voltage (Up to 24 V) Cabling: Provide control cabling for HVAC system per NFPA 70 and Division 26 based on the system manufacturer’s installation recommendations.

1. Paired Cabling: No. 16 AWG Type CMP plenum-rated twisted pair.

2. Class 1 and 2 Control Circuits: Stranded copper Type THHN-THWN.

3. Class 3 Control Circuits: Stranded copper Type TW or TF.

C. Power Conductors: Copper, solid for No. 10 AWG and smaller and stranded for No. 8 AWG and larger, with THHN-THWN insulation. Aluminum conductors will not be accepted.

D. Grounding Conductors: Copper, solid for No. 8 AWG and smaller and stranded for No. 6 AWG and larger, with THHN-THWN insulation. Aluminum conductors will not be accepted.

E. Conduit:

1. EMT (electrical metallic tubing): Indoor, above-grade applications not subject to damage.
2. RGS (rigid galvanized steel): Indoor, above-grade applications subject to damage and outdoor, above-grade applications.
3. RNC (rigid non-metallic conduit), Type Schedule 40 PVC: Indoor and outdoor, below-grade applications.
4. FMC (flexible metallic conduit): Indoor, above-ceiling applications.
5. LFMC (liquid-tight flexible metal conduit): Outdoor, above-grade applications.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Disconnect Switches: Provide disconnect switches for all HVAC equipment. Disconnect switches shall be sized to comply with NFPA 70. Single fan, blower and pump motors shall be based on nameplate horsepower. All other applications shall be based on nameplate total kW rating. Disconnects shall be provided with dual-element fuses sized based on equipment nameplate rating.

1. Service Disconnect Switches: Where the disconnecting means is not within the line-of-sight, as defined by NFPA 70 and the authority having jurisdiction (AHJ), an additional service disconnect shall be located adjacent to the equipment it feeds.

DISCONNECT SWITCH SIZES for MOTORS						
AMPERAGE RATING	MAX HP at VOLTAGE/PHASE					
	115V/1ph	200V/1ph	230V/1ph	200V/3ph	230V/3ph	460V/3ph
30A	1.5	3	3	5	7.5	15
60A	3	7.5	10	15	15	30
100A	-	-	-	25	25	60
200A	-	-	-	50	60	100
400A	-	-	-	100	125	250

DISCONNECT SWITCH SIZES for EQUIPMENT							
AMPERAGE RATING	MAX KW at VOLTAGE/PHASE						
	120V/1ph	208V/1ph	240V/1ph	277V/1ph	208V/3ph	240V/3ph	480V/3ph
30A	2.8	5.0	5.8	6.6	8.6	10.0	19.9
60A	5.8	10.0	11.5	13.3	17.3	19.9	39.9
100A	9.6	16.6	19.2	22.2	28.8	33.2	66.4
200A	19.2	33.3	38.4	44.3	57.6	66.4	132.9
400A	38.4	66.6	76.8	88.6	115.1	132.9	265.7
600A	57.6	99.8	115.2	133.0	172.7	199.3	398.6

B. Motor Starters: Provide all motor starters where required for HVAC equipment to operate as intended. Motor starters shall be sized to comply with NFPA 70 and NEMA rated for magnetic starters.

NEMA STARTER SIZES					
NEMA SIZE	MAX HP at MOTOR VOLTAGE/PHASE				
	115V/1ph	230V/1ph	200V/3ph	230V/3ph	460V/3ph
00	0.33	1	1.5	1.5	2
0	1	2	3	3	5
1	2	3	7.5	7.5	10
2	-	7.5	10	15	25
3	-	-	25	30	50
4	-	-	40	50	100
5	-	-	75	100	200

C. Combination Motor Starters and Disconnect Switches: Provide combination motor starters and disconnect switches that meet the requirements of the "Motor Starters" article above. Combination motor starters and disconnect switches shall be used unless otherwise noted or prohibited by NFPA 70.

D. Manual Motor Switches: Provide manual motor switches for fractional horsepower fan, blower and pump motors that do not require automated start and stop functions.

E. Furnish and install devise fuses per equipment unit nameplate.

F. Size and adjust circuit breaker disconnect switches per equipment unit nameplate.

G. Electrical Connections: All electrical connections shall be made in accordance with equipment manufacturer's recommendations and in accordance with NFPA 70. Install and ground equipment connections in accordance with the requirements of NFPA 70 and Division 26.

1. Electrical Connections, Low Voltage (100 to 600 V): Division 23 contractor is responsible for power wiring and conduit from the equipment connections to the disconnecting means. Division 26 is responsible for the power circuit from the power source to the disconnecting means.

2. Electrical Connections, Control Voltage (Up to 24 V): Division 23 contractor is responsible for all control voltage wiring and conduit for HVAC equipment and controls from the low voltage power source disconnecting means. Division 26 is responsible for the low voltage power circuit from the power source to the disconnecting means.

    a. Low Voltage Disconnecting Means: Where dedicated low voltage circuits are indicated in Division 26 documents, the disconnecting means shall be defined as the disconnect switch or junction box provided. Where dedicated low voltage circuits are not explicitly indicated in Division 26 documents, the disconnecting means shall be defined as 20A/1P spare circuit breakers in panelboards.

H. Wiring Pathway, Low and Control Voltage: All low and control voltage power and control wiring shall be installed in conduit unless otherwise noted.

1. Surface-mounted raceway may only be used when indicated or Engineer approved prior to installation. In most cases, conduits shall be installed within walls, above ceilings and below floor slabs. Cut and repair substrates to install raceway.

2. Control voltage cabling shall be plenum-rated and organized with J-hooks when control cabling is not required by the Engineer to be installed in conduit.

I. Conduit:

1. Flexible Connections: Provide flexible connections for all vibrating equipment including fans, pumps, compressors, etc. Flexible connections shall be no more than 24-inches long.

2. Areas Subject to Damage: In areas where the conduit will be exposed and is subject to damage, such as mechanical equipment rooms, RGS conduit shall be installed to no less than 8-feet above finished floor and EMT may be used above 8-feet.

J. Grounding and Bonding: Ground and bond equipment and circuits in accordance with the requirements of NFPA 70 and Division 26.

K. Install duct-mounted smoke detectors, furnished and wired by Division 26. Provide duct access doors for proper maintenance and access.

L. Smoke-rated life-safety dampers shall be wired and controlled by Division 26.

M. Smoke control system devices shall be wired and controlled by Division 26.

3.2. FIELD QUALITY CONTROL

A. Comply with NFPA 70E per OSHA 29CFR Part 1910.5, Appendix A.

3.3. DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain electrical devices.

END OF SECTION

SECTION 23 05 13 – HVAC EQUIPMENT MOTORS

PART 1 - GENERAL

1.1. SUMMARY

A. Section includes general requirements for all HVAC motors

1.2. QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

B. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

C. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

PART 2 - PRODUCTS

2.1. GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

C. Motors for fans and pumps shall be selected for the maximum brake-horsepower listed in the equipment schedules and no more than 85% of the nominal rated horsepower excluding the service factor.

2.2. MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea-level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3. POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motors.

1. General Use:

a. Open drip-proof (ODP) motors.

b. Totally enclosed over air (TEOA).

c. Totally enclosed fan cooled (TEFC).

B. Efficiency: All motors shall be Premium Efficiency conforming to the requirements of NEMA MG1 Part 31. Conform to 10 CFR Part 431 published by the US Department of Energy - Efficiency standard for integral horsepower motors.

1. Minimum efficiency shall meet the requirements of the State Energy Conservation Code and ASHRAE 90.1.

C. Service Factor: 1.15.

1. Multispeed Motors: Variable torque.

2. For motors with 2:1 speed ratio, consequent pole, single winding.

3. For motors with other than 2:1 speed ratio, separate winding for each speed.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Class B.

G. Insulation: Class F.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4. POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Inverter-Duty Motors: Motors shall be "Inverter-Duty" rated according to NEMA MG 1 Part 31, "Requirements for Definite Purpose Inverter-Fed Polyphase Motors", with minimum Class F temperature rise and Class H insulation. NEMA duty rating code on motor nameplate shall indicate "Inverter-Duty". Other duty rating code markings such as "Inverter-Ready" are not acceptable.

3. Shaft Grounding Rings (SGR): Motors shall have solid or split type shaft grounding rings designed to prevent bearing damage due to adjustable speed drive induced currents. SGR shaft diameter shall match the motor's standard NEMA "u" dimension.

4. Thermal Protection: Comply with NEMA MG 1 Part 12.56, "Thermal Protection of Medium Motors" requirements for thermally protected motors, including a manual-reset type thermal protection device.

5. Under-Speed Operation: Motors shall be capable of continuous operation at minimum design operating speed indicated on the drawings. Where minimums are not indicated, motors shall be capable of continuous operation at the following minimum speeds.

    a. Fans: 18 Hz (30-percent).

    b. Pumps: 12 Hz (20-percent).

C. Electronically-Communicated (EC) Motors

1. Electronically-communicated (EC) motors, also known as brushless DC electric (BLDC) motors, shall be NEMA MG 1, totally enclosed fan cooled (TEFC), inverter-use, motors with integrated microprocessor speed controller designed for variable speed and torque fan and pump applications.

    a. Speed controller shall be programmed with safeties to avoid damaging conditions and unstable fan / pump operation. Firefighter's safety override mode shall allow bypass of most speed controller safeties.

    b. Speed controller shall comply with requirements of Section 230514.

2.5. SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 23 05 14 – VARIABLE SPEED CONTROLLERS

PART 1 - GENERAL

1.1. SUMMARY

A. This section includes solid-state, pulse-width modulated, variable speed motor controllers for three-phase, squirrel-cage induction motors.

1.2. SUBMITTALS

A. Delegated Design Submittals:

1. Harmonic Distortion Analysis: Submit the harmonic distortion analysis, including all assumptions, calculations and results for review by the Engineer.

B. Product Submittals:

1. Product Data: For each type of variable speed controller, include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

C. Close-Out Submittals:

1. Operation and Maintenance Data: For variable speed controllers, all installed devices, and components to include in emergency, operation, and maintenance manuals.

a. Routine maintenance requirements for variable speed controllers and all installed components.

b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.3. QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain variable speed controllers of a single type through one source from a single manufacturer.

1. Exceptions: Variable speed controllers that are factory-mounted to HVAC equipment, such as chillers and cooling towers, and branded by the equipment manufacturer may be provided by the equipment manufacturer.

C. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

D. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

E. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for variable speed controllers minimum clearances between the controllers and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.4. DELIVERY, STORAGE, AND HANDLING

A. Deliver variable speed controllers in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store variable speed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.5. PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without de-rating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 32 to 105 deg F.

2. Humidity: Less than 90 percent (non-condensing).

3. Altitude: Not exceeding 3300 feet.

B. NEMA-rated enclosures for the installed environment. Refer to Section 230511.

1.6. COORDINATION

A. Coordinate layout and installation of variable speed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

C. Coordinate features of variable speed controllers, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each variable speed controller and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.7. WARRANTY

A. Special Warranty: Manufacturer's complete parts and labor warranty for 3-years from the date of Owner Acceptance.

1.8. EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: One set of three for each variable speed controller.

2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB.

2. Danfoss.

3. Yaskawa.

2.2. VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA 2, integrated-gate bipolar transistor (IGBT), pulse-width modulated (PWM), variable frequency controller listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency. Provide unit suitable for operation of premium efficiency motor as defined by NEMA MG 1.

1. Provide 6-pulse drives.

B. Design and Rating: Match load type such as fans, blowers and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 66 Hz, with torque constant as speed changes.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of 208 V, plus or minus 5 percent; 380 to 500 V, plus or minus 10 percent; and 525 to 575 V, plus or minus 10 percent.

2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.

3. Minimum Efficiency: 96 percent at 60 Hz, full load.

4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range with an electrical signal of 4 to 20 mA at 24V.

F. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
6. Self-Protection and Reliability Features:
7. Input transient protection by means of surge suppressors.
8. Under and over-voltage trips; inverter over-temperature, overload, and overcurrent trips.
9. Motor Overload Relay: Adjustable and capable of NEMA 2, Class 20 performance.
10. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
11. Instantaneous line-to-line and line-to-ground overcurrent trips.
12. Loss-of-phase protection.
13. Reverse-phase protection.
14. Short-circuit protection.
15. Motor over-temperature fault.

G. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto-speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

I. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

J. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

K. Input Line Conditioning: 5% Line Reactor.

L. VFC Output Filtering: Load reactors (dV/dt filters) for distances greater than 50 feet between drive and load.

M. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (Vdc).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

P. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the building automation system (BAS) or other control systems:
   a. 0 to 10-V dc.

b. 0-20 or 4-20 mA.

c. Potentiometer using up/down digital inputs.

d. Fixed frequencies using digital inputs.

e. RS485.

f. Keypad display for local hand operation.

3. Output Signal Interface: Minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

a. Output frequency (Hz).

b. Output current (load).

c. DC-link voltage (VDC).

d. Motor torque (percent).

e. Motor speed (rpm).

f. Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.

b. Set-point speed reached.

c. Fault and warning indication (over-temperature or overcurrent).

d. PID high- or low-speed limits reached.

Q. Communications: Provide an RS485 interface allowing variable frequency controller to be used with an external system within a multi-drop local area network (LAN) configuration. Interface shall allow all parameter settings of variable frequency controllers to be programmed via building automation system (BAS) control. Provide capability for variable frequency controllers to retain these settings within the nonvolatile memory.

1. BAS Interface: Factory-installed hardware and software to enable the building automation system (BAS) to monitor, control and display unit status and alarms. BACnet communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

R. Integral Disconnecting Means: Door interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000A.

S. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3. ENCLOSURES

A. Provide NEMA-rated enclosure appropriate for the installed environment. Refer to Section 230511 for more information.

2.4. ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays: Door mounted display shall include:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

F. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

PART 3 - EXECUTION

3.1. EXAMINATION

A. Examine areas, surfaces, and substrates to receive variable speed controllers for compliance with requirements, installation tolerances and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before variable speed controllers installation.

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

3.2. APPLICATIONS

A. Select features of each variable speed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

C. Select amperage rating of controllers to suit multiple motor applications.

D. Variable speed drives shall be furnished for each motor. Do not operate more than one motor on a single variable speed drive unless otherwise noted.

3.3. INSTALLATION

A. Anchor each variable speed controller assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Comply with mounting and anchoring requirements specified in Division 26.

C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26.

D. Seal interior electronics in plastic wrap to protect from dirt during installation. Remove plastic wrap when complete. Cover enclosure vents with MERV-5 filter media prior to using VFD’s during construction. Keep VFD’s clean. Vacuum dirt and metal shavings from inside and outside of VFD enclosure.

3.4. IDENTIFICATION

A. Identify variable speed controllers, components, and control wiring according to Section 230553.

3.5. CONTROL WIRING INSTALLATION

A. Install wiring between variable speed controllers and remote devices according to Division 26.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6. CONNECTIONS

A. Conduit installation requirements are specified in Division 26. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26.

3.7. FIELD QUALITY CONTROL

A. Factory-trained technician shall perform start-up.

1. Technician shall utilize manufacturer’s software with laptop to upload parameters in compliance with manufacturer’s warranty.

2. Start-ups shall be witnessed by the Owner and performed prior to TAB.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8. ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9. DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers.

END OF SECTION

SECTION 23 05 53 – HVAC SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1. SUMMARY

A. Section includes equipment, pipe and duct labels and tags.

1.2. SUBMITTALS

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

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

2. Samples: For color, letter style, and graphic representation required for each identification material and device.

B. Close-Out Submittals:

1. Valve Schedules: For each piping system to include in maintenance manuals.

1.3. COORDINATION

A. Coordinate the identification requirements with the Owner’s up-to-date standards prior to purchasing materials.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with locations of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1. EQUIPMENT LABELS

A. Plastic Labels for Equipment: 1/8-inch multilayer, multicolor, plastic labels for mechanical engraving suitable for temperatures up to 160 deg F with pre-drilled holes for stainless steel rivets or self-tapping screws. Labels shall be minimum 2-1/2 inches wide and 3/4-inch tall with 3/8-inch white letters on black background.

1. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's drawing designation or unique equipment number.

2.2. WARNING SIGNS AND LABELS

A. Warning Signs and Labels: 1/8-inch multilayer, multicolor, plastic labels for mechanical engraving suitable for temperatures up to 160 deg F with pre-drilled holes for stainless steel rivets or self-tapping screws. Labels shall be minimum 2-1/2 inches wide and 3/4-inch tall with 3/8-inch letters.

1. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3. PIPE LABELS

A. Pipe Labels: Pre-printed, color-coded, self-adhesive vinyl labels with lettering and flow direction arrows. They shall have minimum 1 1/2-inch tall block lettering. The labels shall be suitable for temperatures up to 160 deg F and compatible with each substrate material.

2.4. DUCT LABELS

A. Duct Labels: Pre-printed, color-coded, self-adhesive vinyl labels with lettering and flow direction arrows. They shall have minimum 1 1/2-inch tall block lettering. The labels shall be suitable for temperatures up to 160 deg F and compatible with each substrate material.

2.5. STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; 3/4-inch for rated penetrations, and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions. Stencil paint shall be exterior, gloss, acrylic enamel.

2.6. VALVE TAGS

A. Valve Tags: 0.032-inch thick brass or 0.025-inch thick stainless steel, stamped or engraved, with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers with pre-drilled or stamped holes for beaded chain or S-hook attachment hardware.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.7. CEILING TAGS

A. Ceiling Tags: 0.030-inch thick and 3/4 to 7/8-inch diameter rigid vinyl, self-adhesive, plastic tags with pre-printed, minimum 1/8-inch tall block-letter text indicating the service, equipment, valve or accessory tag and number designations.

2.8. WARNING TAGS

A. Warning Tags: 5-1/4 inches wide and 3-inches tall, pre-printed or partially pre-printed, accident-prevention tags, of plasticized card stock with matte finish suitable for writing, fastened with reinforced grommet and wire. Tags shall have letters with large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

2.9. SENSOR TAGS

A. Sensor Tags: 1/4-inch wide, pre-printed, clear vinyl adhesive tags with 1/8-inch tall block-letter black text. Each sensor shall be clearly and neatly labelled. Tags shall denote the associated piece of equipment, for example “TU-123”.

PART 3 - EXECUTION

3.1. PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.

3.2. JACKET COLOR

A. Piping and Piped Equipment Insulation Jacket: Paint or provided pre-colored jacketing for all piping system insulation jacket meeting the requirements of this section.

1. P/M/E Equipment Rooms: Color per System Identification Schedule.
2. Exposed-to-View: Color per System Identification Schedule.
3. Exposed-to-View: Flat Black.
4. Concealed: Not required.
5. Concealed: Color per System Identification Schedule.

B. Duct and Ducted Equipment Insulation Jacket: Paint or provided pre-colored jacketing for all duct system insulation jacket meeting the requirements of this section.

1. PME Equipment Rooms: Color per System Identification Schedule.
2. PME Equipment Rooms: Not required.
3. Exposed-to-View: Flat Black.
4. Exposed-to-View: Not required.
5. Concealed: Not required.

3.3. PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4. EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment. Equipment to be labelled includes but is not limited to:

1. Air handling equipment, including AHU, BCU, FCU, RTU, DOAS, ERU, CRAC, etc.
2. Fans.
3. Hydronic equipment, including pumps, water treatment, tanks and separators.
4. Boilers.
5. Chillers.
6. Unit heaters.
7. Carbon Monoxide monitors.
8. Emergency Stop Switch
9. Control panels and main sensors.
10. Variable speed controllers, motor starters and disconnects.
    a. Coordinate labeling with Division 26.

B. Central HVAC system equipment labels shall include capacity and design information. Submit proposed label information for Engineer approval. The following are examples:

1. Boilers

   BOILER B-1
   INSTALLED: JUNE 2030
   OUTPUT: 1600 MBH

INPUT: 2000 MBH
HHW FLOW: 160 GPM
HHW TEMPS: 160F / 180F

2. Fans

EXHAUST FAN EF-1
INSTALLED: JUNE 2030
SERVICE: ROOM 201 FUME HOOD
CAPACITY: 500 CFM at 0.5" ESP

C. Locate equipment labels where accessible and visible.

D. Equipment Color Schedule: Insulation color and label scheme shall match the associated piping system.

3.5. DUCT LABEL INSTALLATION

A. Duct Labels: Install self-adhesive duct labels with permanent adhesive on air ducts.

1. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1-inch high is needed for proper identification because of distance from normal location of required identification.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 25 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6. VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.7. CEILING TAG INSTALLATION

A. Install ceiling tags on lay-in grid and access doors below equipment, valves and accessories above finished ceilings. Center tags on grid members and doors.

3.8. WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.9. SENSOR TAG INSTALLATION

A. Install sensor tags for wall or ceiling-mounted sensors on faceplates centered below the device. Install sensor tags for concealed sensors on sensor enclosures or backboxes. Where

sensors are located above lay-in ceilings, behind access doors, or otherwise remotely accessible, label the grid or door in addition to the device itself. Tags shall be centered and neatly applied.

3.10. RATED PENETRATION INSTALLATION

A. Stencil penetration ratings and UL detail numbers on wall surfaces directly adjacent to the penetrations. UL detail number shall match the material used. This information shall be readily visible in non-occupied spaces, within chases and above ceilings. The following is an example:

2-HR RATED FIRE BARRIER
UL DETAIL SYSTEM NO. ABC-0000

3.11. SYSTEM IDENTIFICATION SCHEDULE

A. Install equipment, piping and duct identification materials with the color and abbreviations that match the Owner's standard practice. Refer to System Identification Schedule below.

SYSTEM IDENTIFICATION SCHEDULE			
PIPING SYSTEMS	ABBREV.	BACKGROUND	LETTERING
CHILLED WATER	CHWS/CHWR	DARK BLUE	WHITE
CONDENSER WATER	CDWS/CDWR	LIGHT BLUE	WHITE
DUAL TEMPERATURE WATER	DTWS/DTWR	PURPLE	WHITE
ENERGY RECOVERY GLYCOL	ER	BRIGHT BLUE	WHITE
REFRIGERANT	REF	WHITE	BLACK
DOMESTIC WATER	DCW/DHW/DHWR	GREEN	WHITE
NON-POTABLE WATER	NPW	LIGHT GRAY	WHITE
CONDENSATE DRAIN	CD	WHITE	BLACK
HEATING WATER	HWS/HWR	DARK RED	WHITE
HPS STEAM / CONDENSATE RETURN	HPS/HCR	ORANGE	BLACK
MPS STEAM / CONDENSATE RETURN	MPS/MCR	ORANGE	BLACK
LPS STEAM / CONDENSATE RETURN	LPS/LPR	ORANGE	BLACK
PUMPED CONDENSATE RETURN	PCR	ORANGE	BLACK
BOILER FEED WATER	BFW	DARK GRAY	WHITE
FIRE PROTECTION	FIRE	BRIGHT RED	WHITE
NATURAL GAS	NG	YELLOW	BLACK
PROPANE GAS	LPG	YELLOW	BLACK
FUEL OIL	FO	YELLOW	BLACK
DIESEL FUEL	DIESEL	YELLOW	BLACK
OTHERS	SEE PLANS	WHITE	BLACK
VALVE TAGS		BRASS	BLACK
EQUIPMENT AND DUCT SYSTEMS	ABBREV.	BACKGROUND	LETTERING
GENERAL BUILDING AIR	SA/RA/EA/OA	WHITE	BLACK
HAZARDOUS EXHAUST	SEE PLANS	SAFETY YELLOW	BLACK
WARNING SIGNS	SEE PLANS	SAFETY YELLOW	BLACK
CEILING GRID MARKERS	SEE PLANS	CLEAR	BLACK
EQUIPMENT TAGS	SEE PLANS	BLACK	WHITE

NOTE: PROVIDE FLOW ARROWS ON ALL DUCT AND PIPE MARKERS.

END OF SECTION

SECTION 23 33 00 – METAL DUCT ACCESSORIES

PART 1 - GENERAL

1.1. SUMMARY

A. Section includes air duct accessories including relief, volume, control and life-safety dampers; flexible ducts; flange and flexible connectors; turning vanes; duct silencers; duct-mounted access doors; pressure relief doors and duct hardware.

1.2. SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Close-Out Submittals:

C. Life-Safety Damper Inspection Reports: Document testing and results for all life-safety dampers including installation and operation inspection, engineer’s inspections and AHJ’s inspections.

1. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.3. EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed but no less than 10 total.

PART 2 - PRODUCTS

2.1. ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Provide dampers constructed with materials matching the duct system.

1. Exception: Use Type 304 stainless steel in galvanized duct subject to moist airstreams such as humidifiers, locker room exhaust, pool rooms, steam autoclaves, etc.

2.2. MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.

2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36-inches or less; 3/8-inch minimum diameter for lengths longer than 36-inches.

2.3. STATIC PRESSURE GAGES

A. Dial Gages: 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2-percent of full scale accuracy.

B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4-inch diameter tubing. Provide 3-way vent valves.

2.4. GRAVITY BALANCED BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Description: Gravity-balanced dampers for backdraft or pressure relief. Dampers shall have adjustable tension return spring; steel ball bearings; counter-weights and spring-assist kits for vertical flow applications; and bird screens. Unless otherwise indicated, dampers shall be rated for 2000 fpm maximum air velocity and 2-inches w.g. maximum system pressure.

1. Frame: Hat-shaped with welded corners or mechanically attached and mounting flange, constructed of one of the following to match the duct system material type for each: 12-gauge thick, galvanized sheet steel; 0.063-inch thick extruded aluminum; or 0.05-inch thick stainless steel.

2. Blades: Parallel-action, multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch thick, roll-formed aluminum with mechanically-locked neoprene blade seals and 0.20-inch diameter stainless steel blade axles.

2.5. BAROMETRIC RELIEF DAMPERS

A. Description: Barometric relief dampers for pressure relief. Dampers shall have return spring or adjustable tension counter-weight; stainless steel bearings; and bird screens. Unless otherwise indicated, dampers shall be rated for 2000 fpm maximum air velocity and 2-inches w.g. maximum system pressure.

1. Frame: Hat-shaped with welded corners or mechanically attached and mounting flange, constructed of one of the following to match the duct system material type for each: 16-gauge thick, galvanized sheet steel; 0.093-inch thick extruded aluminum; or 18-gauge stainless steel.

2. Blades: Parallel-action, multiple single-piece blades, center pivoted, maximum 6-inch width, 0.050-inch thick, roll-formed aluminum with mechanically-locked neoprene blade seals and 0.20-inch diameter stainless steel blade axles.

2.6. MANUAL VOLUME DAMPERS

A. Standard Rectangular, Steel, Manual Volume Dampers: Standard leakage rating suitable for horizontal or vertical volume control applications with molded synthetic bearings. Unless otherwise indicated, dampers shall be rated for 2000 fpm maximum air velocity and 2.5-inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin MD35.

1. Frame: Hat-shaped with welded corners, constructed of 16-gauge thick, galvanized sheet steel, with flanges for wall attachments or flangeless for in duct installations.

2. Blades: Opposed-blade action, multiple single-piece blades, center-pivot, maximum 8-inch width, 16-gauge thick galvanized steel, galvanized steel blade axles and exposed linkage. Provide 2-inch handle extension wherever duct system will be insulated.

B. Standard Round, Steel, Manual Volume Dampers: Standard leakage rating suitable for horizontal or vertical volume control applications with molded synthetic bearings. Unless otherwise indicated, dampers shall be rated for 1500 fpm maximum air velocity and 2-inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin MDRS25

1. Frame: Constructed of 20-gauge thick galvanized sheet steel, flangeless for in duct installations.

2. Blades: Single-blade, center-pivot, 20-gauge thick galvanized sheet steel, 0.375-inch diameter galvanized steel blade axle and 90-deg quadrant handle. Provide 2-inch handle extension wherever duct system will be insulated.

C. Damper Hardware: Zinc-plated, die-cast core with hand quadrant dial and handle made of 3/32-inch thick zinc-plated steel, and hexagon locking nut. Include elevated platform for insulated duct mounting.

1. Handle operation shall be painted orange.

2.7. CONTROL DAMPERS

A. Standard Low-Pressure Rectangular, Steel, Control Dampers: Standard leakage rated damper suitable for horizontal or vertical volume control applications with synthetic or stainless steel bearings. Dampers shall be rated for 2,000 fpm maximum air velocity, 2.5-inches w.g. maximum system pressure and maximum leakage of 10 cfm/sqft. at 1.0-inches pressure. Provide dampers equivalent to Ruskin CD35.

1. Frame: Hat-shaped with welded corners, constructed of 16-gauge thick, galvanized sheet steel, with flanges for wall attachments or flangeless for in duct installations.

2. Blades: Opposed-blade action, multiple single-piece blades, center-pivot, maximum 6-inch width, 16-gauge thick galvanized steel, galvanized steel blade axles and exposed linkage. Provide 2-inch handle extension wherever duct system will be insulated.

3. Applications:

   a. Operating Pressure: Up to 2.0-inches w.g.

   b. Operating velocity: Up to 1,500 fpm.

   c. Throttling: Opposed-blade type.

   d. Two-Position (Open/Closed): Parallel type.

B. Standard Medium-Pressure Rectangular, Steel, Control Dampers: AMCA Class 2 leakage damper suitable for horizontal or vertical volume control applications with oil-impregnated stainless steel bearings. Dampers shall be rated for 3,000 fpm maximum air velocity and 5.0-inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin CD36.

1. Frame: Hat-shaped with welded corners, constructed of 16-gauge thick, galvanized sheet steel, with flanges for wall attachments or flangeless for in duct installations.

2. Blades: Opposed-blade action, multiple single-piece blades, center-pivot, maximum 6-inch width, 16-gauge thick galvanized steel, galvanized steel blade axles and exposed linkage. Provide 2-inch handle extension wherever duct system will be insulated.

3. Applications:

   a. Operating Pressure: Up to 4.0-inches w.g.

   b. Operating velocity: Up to 2,500 fpm.

   c. Throttling: Opposed-blade type.

   d. Two-Position (Open/Closed): Parallel type.

C. Standard Low-Pressure Round, Steel, Control Dampers: Standard rating suitable for horizontal or vertical volume control applications with molded synthetic bearings. Unless otherwise indicated, dampers shall be rated for 1,500 fpm maximum air velocity and 2.0-inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin MDRS25.

1. Frame: Constructed of 20-gauge thick galvanized sheet steel, either with flanges on both sides or internal duct mounting.

2. Blades: Single-blade action, 20 gauge-thick steel, center-pivot, closed cell rubber edge seals and galvanized steel blade axles.

3. Applications:

   a. Operating Pressure: Up to 1.0-inches w.g.

   b. Operating velocity: Up to 1,000 fpm.

D. Medium-Pressure Round and Oval, Steel, Control Dampers: AMCA Class 2 damper suitable for horizontal or vertical volume control applications with stainless steel bearings. Unless otherwise indicated, dampers shall be rated for 4,000 fpm maximum air velocity and 10.0-

inches w.g. maximum system pressure. Provide dampers equivalent to Ruskin CDR25 (round) / CDO25 (oval).

1. Frame: Constructed of 14-gauge thick galvanized sheet steel, either with flanges on both sides or internal duct mounting.

2. Blades: Single-blade action, 12 gauge-thick steel, center-pivot, closed cell rubber edge seals and galvanized steel blade axles.

3. Applications:

   a. Operating Pressure: Up to 8.0-inches w.g.

   b. Operating velocity: Up to 3,200 fpm.

2.8. LIFE-SAFETY DAMPERS

A. General Requirements:

1. Temperature Activation Rating: Fusible links and/or heat sensors shall be rated for 165 deg F in general air duct systems (up to 120 deg F) and rated for 212 deg F in high temperature duct systems (greater than 120 deg F) such as smoke control.

2. Frame Style: Rectangular life-safety dampers shall have Type B curtain-style blades outside the air stream except for tight locations where otherwise noted or pre-approved by the Engineer.

3. Minimum Dimensions: Damper height or width dimension shall be minimum 8-inches to allow a minimum 12-inch by 6-inch access door and adequate space to test and maintain damper, regardless of duct dimensions. Refer to 'Duct-Mounted Access Doors' in this section for more information about sizing.

4. Sidewall Grilles: Dampers installed behind sidewall grilles shall be fully serviceable through the grille.

B. Fire Dampers: 1-1/2 and 3-hour UL 555 and FM rated and labeled dynamic fire dampers suitable for horizontal or vertical applications with 4-inch w.g. closing rating static pressure class and minimum 2000 fpm rated velocity.

1. Frame: Factory-fabricated with roll-formed 20-gauge thick galvanized steel and mitered and interlocking corners.

2. Mounting Sleeve: Factory installed galvanized sheet steel, minimum thickness to suit application.

3. Blades: Roll-formed, interlocking, 20-gauge thick, galvanized sheet steel. In place of interlocking blades, use full-length, 20-gauge thick, galvanized-steel blade connectors.

C. Smoke Dampers: UL 555S and FM rated and labeled, Class 1 leakage rated smoke dampers with stainless steel permanently lubricated bearings suitable for wall or floor applications and rated for pressure up to 8-inches w.g. and velocity up to 4000 fpm. Dampers shall have two-position, fail closed, 115 V / 1 phase / 60 Hz actuator motors and disconnect.

1. Frame: Hat-shaped, 16-gauge thick, galvanized sheet steel, with welded, interlocking, gusseted or mechanically attached corners and mounting flange.

2. Mounting Sleeve: Factory installed galvanized sheet steel, minimum thickness to suit application and length to suit wall or floor application.

3. Blades: Airfoil, horizontal, maximum 6-inch wide, 14-gauge thick, galvanized sheet steel with silicone edge type blade seals and stainless steel flexible metal compression type jamb seals.

4. Linkage: Concealed in frame.

5. Damper Test and Reset Control Panel: Damper test switch with remote damper position indicator (open or closed) and manual reset button to re-open damper after a fire or test.

6. Duct-Mounted Smoke Detector: Integral, factory wired for single-point connection. Detectors are required to be installed within 5 feet of each smoke damper in a ducted system without air inlets or outlets between the damper and detector.

    a. Exception: When the building has "total coverage" by the fire alarm system, damper dedicated smoke detectors are not needed when the fire alarm system signals the dampers.

7. Smoke Detector: Ceiling or wall-mounted spot-type smoke detector wired for single-point connection. Detectors are required to be installed within 5 feet horizontally of the damper when the damper is located above smoke barrier doors in a smoke barrier door opening or when the damper is located in a non-ducted opening in a smoke barrier.

    a. Exception: When the building has "total coverage" by the fire alarm system, damper dedicated smoke detectors are not needed when the fire alarm system signals the dampers.

D. Combination Fire and Smoke Dampers: 1-1/2 and 3 hour UL 555, UL 555S and FM rated and labeled, Class 1 leakage rated combination fire and smoke dampers with stainless steel permanently lubricated bearings suitable for horizontal or vertical applications and rated for pressure up to 8-inches w.g. and velocity up to 4,000 fpm. Dampers shall have two-position, fail closed, 115 V / 1 phase / 60 Hz actuator motors and disconnect. Electric resettable link with heat sensor shall be rated for 165 deg F activation, except for high temperature applications.

1. Frame: Hat-shaped, 16-gauge thick, galvanized sheet steel, with welded, interlocking, gusseted or mechanically attached corners and mounting flange.

2. Mounting Sleeve: Factory installed galvanized sheet steel, minimum thickness to suit application and length to suit wall or floor application.

3. Blades: Airfoil, horizontal, maximum 6-inch wide, 14-gauge thick, galvanized sheet steel with silicone edge type blade seals and stainless steel flexible metal compression type jamb seals.

4. Linkage: Concealed in frame.

5. Duct-Mounted Smoke Detector: Integral, factory wired for single-point connection. Detectors are required to be installed within 5 feet of each smoke damper in a ducted system without air inlets or outlets between the damper and detector.

a. Exception: When the building has "total coverage" by the fire alarm system, damper dedicated smoke detectors are not needed when the fire alarm system signals the dampers.

6. Smoke Detector: Ceiling or wall-mounted spot-type smoke detector wired for single-point connection. Detectors are required to be installed within 5 feet horizontally of the damper when the damper is located above smoke barrier doors in a smoke barrier door opening or when the damper is located in a non-ducted opening in a smoke barrier.

   a. Exception: When the building has "total coverage" by the fire alarm system, damper dedicated smoke detectors are not needed when the fire alarm system signals the dampers.

7. Actuator Location: Actuator shall be located outside the airstream unless otherwise indicated.

   a. Exception: Dampers at wall grilles shall have actuators either inside the airstream or in a separated compartment and accessible through the opened grille face. Dampers shall be rated for pressure up to 4-inches w.g. and velocity up to 2000 fpm.

E. Fan Smoke Isolation Dampers: UL 555S and FM rated and labeled, Class 1 leakage rated smoke dampers with stainless steel bearings suitable for horizontal or vertical mounted fan isolation applications and UL listed and labeled for pressure up to 6-inches w.g. and velocity up to 2000 fpm. Dampers shall have modulating, fail closed, 115 V / 1 phase / 60 Hz actuator motors.

1. Frame: 12-gauge thick, galvanized sheet steel, with welded, interlocking, gusseted or mechanically attached corners and mounting flange.

2. Blades: Airfoil, horizontal, maximum 8-inch wide, 0.08 thick, extruded aluminum with silicone edge type blade seals and stainless steel flexible metal compression type jamb seals.

3. Position Switches: Two-position switches linked to damper blade to remotely indicate damper blade position.

F. Smoke and Combination Smoke and Fire Damper Test Panels: Factory-fabricated accessory provided with smoke and combination smoke and fire dampers with test button, damper open indicator light and damper closed indicator light. Provide panels rated for either 120V or 24V to match the damper voltage. Unit shall be designed for flush-mounting and surface-mounting as required. Ruskin MCP4/MCP44 or Engineer approved equal.

2.9. TURNING VANES

A. Turning Vanes for Metal Ducts: Factory-fabricated, double-wall, curved airfoil-shaped blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting. Comply with details in SMACNA "HVAC Duct Construction Standards – Metal and Flexible"

2.10. DUCT-MOUNTED ACCESS DOORS

A. General: Factory-fabricated access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Doors: Factory-fabricated access doors shall be air-tight suitable for associated duct pressure and leakage classification. All doors shall be rigid and close fitting and include sealing gaskets and quick locking devices. Door construction materials shall match metal duct type, galvanized steel, stainless steel or aluminum.

    a. Access doors must be installed prior to duct pressure and leakage testing. If the Engineer determines the access doors cannot meet the requirements of the testing, they shall be replaced with a higher quality door at the contractor’s expense.

    b. Access panels with sheet metal screw fasteners are not acceptable.

2. Frames: Galvanized sheet steel, with bend-over tabs and foam or neoprene gaskets. Security chain to restrain door to frame.

3. Hinges and Latches:

    a. Doors up to 12-inches Square: Secure with sash locks.

    b. Doors up to 18-inches Square: Provide two hinges and two sash locks.

    c. Doors up to 24 x 48 Inches: Three hinges and two compression latches with outside and inside handles.

    d. Larger door sizes: Provide an additional hinge.

B. Standard Duct-Mounted Access Doors: Doors in uninsulated duct shall be single-wall. Doors in insulated duct shall be double-wall with 1-inch of mineral fiber or foam insulation fill.

1. Rectangular Duct-Mounted Access Doors: Rectangular and square access doors for rectangular and flat oval duct.

    a. Life-Safety Damper Access: Doors installed to provide access to life-safety dampers shall be minimum 12-inches square.

        1) Duct without a 14-inch or larger dimension shall transition to a size with at least one 14-inch dimension to allow for 12-inch square access door.

            a) Exemptions: Sidewall grilles and ceiling radiation dampers.

        2) Ducts with a dimension from 14 to 24-inches shall have square access doors 2-inches less than largest duct dimension.

        3) Ducts with a dimension of 26-inches or larger shall have 24-inch by 24-inch duct access doors.

    b. Equipment and Sensor Access: 12 x 6-inch rectangular access doors shall be used in 8-inch largest dimension ducts; 12 x 8-inch rectangular doors in up to 12-inch ducts; 12-inch square doors in up to 18-inch ducts; 18-inch square doors in up to 24-inch ducts; and 24-inch square doors in 26-inch and larger ducts.

2. Oval and Round Duct-Mounted Access Doors: Oval access doors for round and oval ducts. Equivalent to Ruskin ADR Series.

    a. Door Sizes: 8-inch by 4-inch access doors shall be used in 4 and 6-inch diameter round ducts; 10-inch by 6-inch doors in 6 to 12-inch ducts; and 16-inch by 12-inch doors in 14-inch and larger ducts.

        1) Life-Safety Damper Access: Transition round and oval duct to rectangular duct matching life-safety damper dimensions. Install access doors in accordance with Rectangular Duct-Mounted Access Doors paragraph above.

C. Plenum-Mounted Access Doors: Open outward for positive-pressure ducts and inward for negative-pressure ducts. Full height plenums shall have 72-inch tall x 30-inch wide door with vision panel and mounted between 4 and 12-inches above the floor unless otherwise indicated.

2.11. DUCT TEST HOLES

A. Permanent Test Holes: Factory-fabricated, air-tight, flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

2.12. FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene with a minimum weight of 26 oz/sqyd; tensile strength of 480 lbf/inch in the wrap and 360 lbf/inch in the filling; and a service temperature range of (-) 40 deg F to 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone with a minimum weight of 24 oz/sqyd; tensile strength of 530 lbf/inch in the wrap and 440 lbf/inch in the filling; and a service temperature range of (-) 50 deg F to 250 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct. They shall be factory-fabricated for HVAC applications up to 10-inches w.g. of pressure.

G. Grounding Straps: Flexible braided copper grounding strips, flat or round, providing an equivalent ampacity of a #6 AWG conductor.

2.13. FLEXIBLE DUCTS

A. General: Flexible duct shall comply with UL 181, Class 1 and have flame spread rating of less than 25 and smoke developed rating of less than 50.

B. Non-Insulated, Flexible Duct: Aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire. Duct shall have 10-inch w.g. positive and 1-inch w.g. negative pressure ratings; maximum air velocity of 4000 fpm; and temperature rating of (-) 20 deg F to 210 deg F.

C. Insulated, Flexible Duct: Double-ply polyester film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film. Duct shall have 10-inch w.g. positive and 1-inch w.g. negative pressure ratings; maximum air velocity of 4000 fpm; and temperature rating of (-) 10 deg F to 160 deg F. Insulation value shall meet or exceed R-value of connected duct insulation.

D. Flexible Duct Connectors: Stainless steel bands with cadium-plated hex screws to tighten band with a worm gear action sized to suit duct size.

2.14. DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.

1. Provide instruments with scale ranges selected according to service with largest appropriate scale. Filter gauges shall be 0 to 2-inch scale.

D. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

E. Whether or not indicated on plans, install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and

terminate liner with nosing at hat channel. Damper construction materials shall match duct system materials.

1. Volume damper handle positions shall match volume damper positions. If the damper is closed, the handle should be perpendicular to the direction of airflow. If the damper is open, the handle should be parallel to the direction of airflow.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated.

H. Install life-safety dampers according to UL listing and coordinate their location and adjacent installations to ensure they are fully accessible for maintenance and testing.

I. Connect ducts to duct silencers rigidly unless otherwise indicated.

J. Access Doors: Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. Upstream or downstream from duct silencers.
8. Control devices requiring inspection or cleaning.
9. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. Label access doors according to Section 230553 to indicate the purpose of access door.

M. Install pressure relief doors in manufacturer recommend orientation, generally vertical, and in locations within mechanical space and opening away from maintenance walkways. Paint doors safety orange.

N. Install temporary duct test holes as required for testing and balancing purposes. Cut or drill ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

O. Install flexible connectors to connect ducts to equipment. Install flexible grounding strip(s) from equipment to duct.

P. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

Q. Connect diffusers to ducts with up to 6-foot maximum lengths of flexible duct clamped or strapped in place, unless otherwise indicated.

R. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws and tape.

S. Install duct test holes where required for testing and balancing purposes.

T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2. CONTROL DAMPERS

A. Control Dampers for Air Handling Equipment:

1. Outside Air (OA) Dampers: Provide damper types noted in the air handling unit sections and on the drawings. Dampers sized for 2,000 FPM face velocity at full flow and 100 FPM at 5-percent flow.

   a. Opposed-blade type.

   b. Parallel-blade type. Orient blades to direct air flow away from coils and toward outside air flow to promote mixing.

2. Relief Air (RelA) / Exhaust Air (EA) Dampers:

   a. Fan: Opposed-blade type sized for 2,000 FPM face velocity at full flow.

   b. Barometric: Parallel-blade type sized for 1,000 FPM face velocity at full flow.

3. Return Air (RA) Dampers: Parallel-blade type sized for 1,500 FPM face velocity at full flow. Orient blades to direct air flow away from coils and toward outside air flow to promote mixing.

4. AHU RA Inlet / SA Outlet: Smoke isolation dampers, full duct or opening size.

3.3. FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

4. Inspect turning vanes for proper and secure installation.

5. Operate remote damper operators to verify full range of movement of operator and damper.

6. Life-Safety Damper Testing: Dampers shall be 100% tested and verified to be open and operational through their full range of movement. Damper testing shall be performed by contractor with minimum 5-years of experience in testing life-safety dampers. Within 2 weeks of written certification that all dampers are correct, Engineer shall inspect dampers prior to AHJ inspection.

    a. Test Procedures:

        1) Fire dampers with fusible links shall be tested by removing the fusible link. Observe that damper closes completely.

        2) Fire dampers with firestats shall be tested with a heat gun. Observe that damper closes completely.

        3) Smoke dampers shall be tested by smoking the duct smoke detector with canned smoke. Observe that damper closes completely. In cases where smoke dampers are controlled through the Fire Alarm Control Panel and do not necessarily close on individual duct smoke detectors, use the FACP to close the dampers.

        4) If any dampers do not close completely, correct installation and retest.

        5) After verification of damper closing, verify that damper reopens to normal position without blockage of air flow. Reset fusible links and firestats. Close access door.

    b. Test Report:

        1) Provide written report to Engineer and signed by the responsible Contractor representatives.

        2) Report shall list each fire and smoke damper with test results for each damper including time, date, and name of test technician for each test.

        3) Report shall include a table showing each damper with a unique identification for each damper. Report shall include a notation of whether damper is in supply, return, exhaust or other type of duct.

        4) Report shall include drawings showing the location of each damper on the floor plans.

3.4. DEMONSTRATION

A. Demonstrate re-setting of fire dampers for Owner and Engineer.

B. Provide Owner training in compliance with Section 230200.

END OF SECTION

SECTION 23 34 00 – HVAC FANS

PART 1 - GENERAL

1.1. SUMMARY

A. Section includes centrifugal roof ventilators, modular fan arrays and packaged and terminal equipment centrifugal fans.

1.2. PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

1.3. SUBMITTALS

A. Product Submittals: For each type of product indicated include rated capacities, operating characteristics, and furnished specialties and accessories. The product data shall also include the following: certified fan performance curves with system operating conditions indicated; certified fan sound-power ratings; motor ratings and electrical characteristics, plus motor and electrical accessories; material thickness and finishes; dampers, including housings, linkages, and operators; roof curbs; and fan speed controllers.

B. Close-Out Submittals:

1. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.4. QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

B. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

C. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

1.5. EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: Two set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Greenheck Fan Corp.
2. Loren Cook Company
3. Twin City Fan and Blower
4. Air handling unit or Packaged equipment manufacturer

B. Description: Factory fabricated, assembled, tested, and finished, belt-driven or direct-driven (as scheduled) fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly and support structure with factory installed and wired service disconnect switch. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.

C. AMCA Compliance: Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal. Classify operating limits according to AMCA 99.

1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

D. Shafts: Fan shafts shall be statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning. Shafts shall be turned, ground, and polished hot-rolled steel with keyway and finished with an anti-corrosive coating. They shall be designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Pre-lubricated and Sealed Shaft Bearings: Self-aligning, pillow-block type bearings rated for L10 at 100,000 hours.

1. Extend grease fitting to accessible location outside of unit.

F. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

1. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

2. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

3. Belts: Oil resistant, non-sparking, and non-static V-belts; in matched sets for multiple-belt drives.

4. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

5. Motor Mount: Adjustable for belt tensioning.

G. Direct Drives: Factory-mounted with 1.2 service factor based on fan motor.

H. Motors: Comply with requirements of Section 230513.

I. Speed Controller: Where indicated, provide solid-state, factory-mounted, manual speed controller on 115V or 230V single-phase, direct-drive fans for air flow balancing.

J. Variable Frequency Controllers: Refer to Section 230514.

1. Variable frequency drives shall not be installed outdoors without supplemental cooling.

K. Motor Starters and Disconnects: Refer to Section 230511.

1. Disconnect Switch: Factory wired and mounted non-fusible type with thermal-overload protection mounted to the fan housing, unless otherwise indicated. Wiring shall be enclosed in aluminum conduit.

L. Dampers: Motor-operated, parallel blade aluminum dampers mounted in the curb base shall open when the fan starts and close when it stops. Refer to Section 233300.

1. Where indicated, provide counter-balanced backdraft dampers in lieu of motor-operated type.

M. Roof Curbs: Factory-fabricated welded-seam self-flashing roof curb to match fan and roof-slope, constructed of galvanized sheet metal with 1 1/2-inch pressure-treated wood nailer, water-tight gasket, 1 1/2-inches of rigid fiberglass insulation, damper tray, and finished with primer and powder baked white enamel.

1. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match exhaust fan, used to anchor unit to the curb, and designed for loads at project site. Comply with requirements in Section 230548.

2. Curb Height: 16-inches with a minimum of 12-inches above the finished roof surface.

2.2. CENTRIFUGAL ROOFTOP FANS

A. General Description: Rooftop fan with removable spun-aluminum dome top and outlet baffle; square one-piece aluminum base with venture inlet cone; fan wheel with aluminum hub and wheel with backward-inclined blades; and belt or direct-drive as scheduled. Outlet

shall have removable 1/2-inch aluminum mesh birdscreen. The drive shall be equipped with an automatic belt tensioner.

B. Rooftop Dome-Type Downblast Centrifugal Fans: Greenheck G/GB Series, Loren Cook ACE Series, or Twin City BCRD/DCRD Series.

1. Application: General building exhaust systems.

2.3. CENTRIFUGAL FANS

A. General Description: Fans included in packaged and terminal units shall meet the requirements of this section.

B. Housings: Horizontally-split, bolted-flange curved-scroll housing with shaped cutoff, flanged spun inlet cone and flanged outlet. Panel Bracing shall be steel angle or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

C. Centrifugal Fan Wheels:

1. Plenum Fan Wheels: Airfoil wheel shall be single-width single-inlet (SWSI) construction with heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

2.4. MODULAR PLENUM FAN ARRAYS

A. General Description: Direct-drive modular-plenum fans in a parallel array, using number of fans indicated on the drawings but not less than 2, arranged to provide equal air flow across the unit's cross-section. The fans in each array shall be identical.

B. Performance: The fans operating in parallel shall meet the performance requirements scheduled. The fans shall be selected to have non-overloading design with self-limiting horsepower characteristics in the normal operation area.

C. Fan Sections: Array support structure materials shall match interior casing material and have 6-inch minimum depth. Monorail or trolley system shall be provided to assist the removal of fan wheels and motors.

D. Backdraft Dampers: Each fan shall have a factory-mounted low-leakage backdraft damper that complies with the requirements of Section 233300. Pressure losses across the dampers shall be included in the fan performance data and not considered to be included in the unit's scheduled pressure drop.

E. ECM Controls: Factory-assembled control panel with motor disconnect switches and overload protection for each fan and terminal strips for BAS control interface in a NEMA-rated enclosure complying with the requirements of Section 230511.

F. Variable Speed Drives: Comply with the requirements of Section 230514. Drives manufactured by the air handling unit manufacturer are also acceptable in addition to the manufacturers listed in Section 230514.

1. Each fan motor shall be equipped with a dedicated variable speed drive without bypass, unless otherwise noted.

2. All drives in an array shall be mounted in a NEMA-1 enclosure with power and control wiring, disconnect switch, and a single-point electrical connection. Individual drives shall have circuit breaker disconnects for individual maintenance.

G. Over-Speeding: Variable frequency drives shall not be set above 75 Hz.

H. Air Flow Measuring Stations: Differential pressure type piezometer ring mounted on the throat of the inlet cone. Accuracy shall be plus or minus 5 percent, including transducer and conversion error, at 100 to 5,000 fpm.

I. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

PART 3 - EXECUTION

3.1. GENERAL INSTALLATION

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548.

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Section 230553.

3.2. CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300.

B. Install ducts adjacent to fans to allow service and maintenance.

C. Ground equipment according to Division 26.

D. Connect wiring according to Division 26.

3.3. FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Prepare test and inspection reports.

3.4. ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow. Coordinate with the TAB Contractor.

E. Lubricate bearings.

END OF SECTION

SECTION 23 41 00 – PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1. SUMMARY

A. Section includes standard efficiency pleated panel, filter frames; and filter gages.

1.2. SUBMITTALS

A. Product Submittals: For each type of product indicated include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

1.3. QUALITY ASSURANCE

A. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

B. Comply with NFPA 90A and NFPA 90B.

C. Filters shall be compatible with Ultraviolet Germicidal Irradiation (UVGI) lamps where UGVI lamps are specified for use in air handling units. Do not use synthetic filters in instances where UVGI lamps are specified.

1.4. EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide two (2) complete set(s) of filters for each filter bank.

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Airguard
2. American Air Filter (AAF) / Flanders
3. Camfil (Farr)

B. Filter Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks. Frames shall provide an airtight fit with the enclosing ductwork. All joints between filter segments and enclosing ductwork shall have gaskets or seals to provide a positive seal against air leakage.

2.2. PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, UL 900 Class 2, disposable air filters with holding frames. Media shall be interlaced glass or synthetic fibers coated with non-flammable adhesive. Filter-media frame shall be cardboard sealed or bonded to the media.

1. 2-inch, MERV-8 with maximum initial resistance of 0.25-inches w.g. at 500 fpm.

2. 4-inch, MERV-8 with maximum initial resistance of 0.37-inches w.g. at 500 fpm.

2.3. FILTER GAGES

A. Description: Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

B. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale and logarithmic-curve tube gage with integral leveling gage, graduated to read from 0 to 2.0-inches w.g. and accurate within 3 percent of the full-scale range.

C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Install filter gage for each filter bank.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling-unit installations.

3.2. CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

SECTION 23 82 16 – AIR COILS

PART 1 - GENERAL

1.1. SUMMARY

A. Section includes heating and cooling air coils.

1.2. SUBMITTALS

A. Product Submittals: For each type of product include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.3. QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: UL listed and labeled as defined by NFPA 70, the National Electric Code, or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

B. Mechanical Equipment and Materials: UL listed and labeled as defined by State Building Codes or equivalent by a qualified testing agency marked for the intended location and application and accepted by the Authority Having Jurisdiction and Engineer.

C. Testing and listing laboratories of mechanical and electrical equipment shall be accredited by the North Carolina Building Code Council (NCBCC).

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS

A. Performance Ratings: Hydronic coils shall be tested and rated according to AHRI 410 and ASHRAE 33.

2.2. HYDRONIC COILS

A. Description: Coils shall be factory tested to 300 psig and rated for a minimum working pressure of 200 psig and minimum temperature of 325 deg F. Coil tubes shall be ASTM B 743 seamless copper expanded into fin collars for permanent fin-tube bond and expanded into header for permanent leak-tight joints. Coil fins shall be copper or aluminum. Coil headers shall be cast-iron with drain and air vent tappings for coils 32-inches tall and less and seamless copper tube with brazed joints and prime coated for coils taller than 32-inches. Coil

casings shall be minimum 16 gauge galvanized steel channel frame for slip-in or flanged mounting.

2.3. DRAIN PANS

A. Description: Drain pans shall be stainless steel. Alternative materials, such as galvanized steel and plastic, are not acceptable. Construct insulated pans with drain connection at the lowest point(s) and comply with ASHRAE 62.1. Pans shall extend beyond coil length and width, upstream and downstream of coil face, and under coil header and exposed piping

PART 3 - EXECUTION

3.1. EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

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

3.2. INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

D. Install drain pan under each cooling coil. Connect to condensate trap and drainage.

E. Straighten bent fins on air coils.

3.3. CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Hydronic Coils: Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 239010 and other piping specialties are specified in Section 232116.

END OF SECTION