

23-UNIT VENTILATOR SCHEDULE																										
MARK	MANUFACTURER	MODEL	TOTAL AIRFLOW	VENTILATION AIRFLOW	CHILLED WATER COIL								HOT WATER COIL				ELECTRICAL CHARACTERISTICS									
					CAPACITY (MBH)	SENSIBLE (MBH)	ENTERING AIR DB	ENTERING AIR WB	LEAVING AIR DB	LEAVING AIR WB	WATER TEMPERATURE ENTERING	WATER TEMPERATURE LEAVING	FLOW RATE (GPM)	FLUID PRESSURE DROP (FT H <sub>2</sub> O)	CAPACITY (MBH)	EAT (°F)	LAT (°F)	ENTERING WATER TEMPERATURE	LEAVING WATER TEMPERATURE	FLOW RATE (GPM)	FLUID PRESSURE DROP (FT H <sub>2</sub> O)	MCA	MOC	Ø	VOLTAGE	NOTES
UV-101	MAGICAIRE	MAUVF3	1000 CFM	370 CFM	37.4	25.6	80 °F	67 °F	56 °F	54 °F	44 °F	55 °F	7.0 GPM	12.7	63.7	50	107	180 °F	160 °F	7.0 GPM	3.9	2.90	15.0 A	1	120 V	ALL
UV-102A	MAGICAIRE	MAUVF2	750 CFM	170 CFM	30.6	20.8	80 °F	67 °F	54 °F	53 °F	44 °F	54 °F	6.0 GPM	7.7	47.3	50	105.7	180 °F	160 °F	6.0 GPM	1.8	2.50	15.0 A	1	120 V	ALL
UV-102B	MAGICAIRE	MAUVF2	750 CFM	170 CFM	30.6	20.8	80 °F	67 °F	54 °F	53 °F	44 °F	54 °F	6.0 GPM	7.7	47.3	50	105.7	180 °F	160 °F	6.0 GPM	1.8	2.50	15.0 A	1	120 V	ALL

**NOTES:**

- MERV 8 FILTER.
- ECM SUPPLY FAN MOTOR.
- FACTORY-INSTALLED INTERNAL DISCONNECT SWITCH.
- CHILLED WATER PERFORMANCE BASED ON 30% PROPYLENE GLYCOL.
- OPERATE DURING OCCUPIED HOURS VIA TIMECLOCK.
- PROVIDE FILLER SECTIONS TO CONCEAL HORIZONTAL PIPING.
- STAND-ALONE, LOCAL CONTROLS. PROVIDE BACNET CARD FOR FUTURE INTEGRATION INTO FUTURE BAS.

23-EXHAUST FAN SCHEDULE													
MARK	MANUFACTURER	MODEL	SERVICE	EXHAUST FAN			ELECTRICAL CHARACTERISTICS						
				TYPE	AIRFLOW	EXTERNAL STATIC PRESSURE	RPM	WATTS	FLA	MOC	Ø	VOLTAGE	NOTES
EF-102	GREENHECK	CSF-A1050-VG	EXHAUST	INLINE, DIRECT DRIVE	835 CFM	0.50 in-wg	1212	197	4.8 A	15.0 A	1	120 V	ALL

**NOTES:**

- FAN SHALL OPERATE DURING OCCUPIED HOURS VIA TIMECLOCK TO MATCH UNIT VENTS.
- INTEGRAL BACKDRAFT DAMPER.

23-AIR DEVICE SCHEDULE											
MARK	BASIS OF DESIGN			DIFFUSER TYPE	MAXIMUM AIRFLOW	MAXIMUM PRESSURE DROP	MAXIMUM SOUND	BLADE SPACING	DIFFUSER PATTERN	CONNECTION SIZE (INCH)	FACE SIZE (INCH)
	MANUFACTURER	MODEL	PRICE								
ECG-2			80	EGG GRATE GRILLE	1070 CFM	0.085 in-wg	22	1/2" X 1/2"	0	22" X 10"	24" X 12"

23-MECHANICAL/ELECTRICAL COORDINATION SCHEDULE													
MARK	SPECIFICATION SECTION	TYPE	STARTING MEANS		LOCATION	TYPE	DISCONNECTING MEANS		LOCATION	ELECTRICAL			
			PROVIDED BY	INSTALLED BY			PROVIDED BY	INSTALLED BY		VOLTS	POLES	AMPS	MOC
EF-102	DIV. 23	N/A	N/A	N/A	N/A	MRTS	DIV. 26	DIV. 26	NEAR UNIT	120 V	1	4.8 A	15.0 A
UV-101	DIV. 23	CONTROL PANEL	DIV. 23	DIV. 23	INTEGRAL TO UNIT	MRTS	DIV. 23	DIV. 23	INTEGRAL TO UNIT	120 V	1	2.9 A	15.0 A
UV-102A	DIV. 23	CONTROL PANEL	DIV. 23	DIV. 23	INTEGRAL TO UNIT	MRTS	DIV. 23	DIV. 23	INTEGRAL TO UNIT	120 V	1	2.9 A	15.0 A
UV-102B	DIV. 23	CONTROL PANEL	DIV. 23	DIV. 23	INTEGRAL TO UNIT	MRTS	DIV. 23	DIV. 23	INTEGRAL TO UNIT	120 V	1	2.9 A	15.0 A

**ASHRAE Standard 62.1-2004-2010**  
By SHP

**ASHRAE Standard 62.1-2004-2010**  
By SHP

**System Ventilation Requirements**

AHU Location	Description	$\sum V_{pz}$ cfm	$P_s$ People	$\sum P_z$ People	D Ps / $\sum P_z$	Vou cfm	Vps cfm	Xs	Ev	Vot cfm	%OA Vot / Vps
<b>Alternative 1</b>											
Zone	101 Classroom	Cooling 1,022	29	29	1.00	362	1,022	0.354	0.354	362	35.4
		Heating 362	29	29	1.00	362	362	1.000	1.000	362	100.0
Zone	102 Innovation Lab	Cooling 1,425	23	23	1.00	330	1,425	0.231	0.460	330	23.1
		Heating 427	23	23	1.00	330	427	0.771	1.000	330	77.1

\* Apply Single Zone Ventilation Calculation

**Ventilation Parameters**

System Zone Room	Occupancy Category	Rp cfm / p	Pz People	Ra cfm/ft²	Std 170		Cooling		Heating	
					Az ft	Vbz cfm	Min OA ach	Ez cfm	Voz cfm	Ez Voz cfm
<b>Alternative 1</b>										
101 Classroom	Classrooms (age 9 plus)	10.00	29.00	0.12	601	362	1.00	362	1.00	362
UV-101		10.00	29.00	0.12	601	362		362		362
102 Innovation Lab	Classrooms (age 9 plus)	10.00	23.00	0.12	831	330	1.00	330	1.00	330
UV-102		10.00	23.00	0.12	831	330		330		330

**Ventilation Calculations for Cooling Design**

System Zone Room	Box Type	Vpz cfm	Vfan cfm	Vdz cfm	Vpz-min cfm	Voz-htg cfm	Zd	Ep	Er	Fa	Fb	Fc	Evz
<b>Alternative 1</b>													
101 Classroom	None	1,022	1,022	1,022	362	362	1.000	1.00	0.00	1.00	1.00	1.00	0.354
UV-101		1,022	1,022	1,022	362	362							0.354
102 Innovation Lab	None	1,425	1,425	1,425	427	330	0.771	1.00	0.00	1.00	1.00	1.00	0.460
UV-102		1,425	1,425	1,425	427	330							0.460

Project Name: NDA,TRC

TRAC6@700 #6.3.3 calculated at 10:57 AM on 05/06/2025  
Dataset Name: NDA,TRC  
Alternative - 1: ASHRAE Standard 62.1-2004/2007 Report Page 1 of 2

Project Name: NDA,TRC

TRAC6@700 #6.3.3 calculated at 10:57 AM on 05/06/2025  
Dataset Name: NDA,TRC  
Alternative - 1: ASHRAE Standard 62.1-2004/2007 Report Page 2 of 2

**Ventilation Calculations for Heating Design**

System Zone Room	Box Type	Vpz cfm	Vfan cfm	Vdz cfm	Vpz-min cfm	Voz-htg cfm	Zd	Ep	Er	Fa	Fb	Fc	Evz
<b>Alternative 1</b>													
101 Classroom	None	362	362	362	362	362	1.000	1.00	0.00	1.00	1.00	1.00	1.000
UV-101		362	362	362	362	362							1.000
102 Innovation Lab	None	427	427	427	427	330	0.771	1.00	0.00	1.00	1.00	1.00	1.000
UV-102		427	427	427	427	330							1.000

**ABBREVIATIONS**

ACU	AIR CONDITIONING UNIT	LL	LOW LIMIT
ACH	AIR CHANGES PER HOUR	LON	LOCAL OPERATING NETWORK
AFUE	ANNUAL FUEL EFFICIENCY RATIO	LP	LOW PRESSURE
AHU	AIR HANDLING UNIT	LRA	LOCKED ROTOR AMPS
AI	ANALOG INPUT	LWB	LEAVING WET BULB TEMPERATURE
AD	ANALOG OUTPUT	LWT	LEAVING WATER TEMPERATURE
B	BOILER	M&V	MEASUREMENT AND VERIFICATION
BACNET	COMMUNICATION PROTOCOL FOR BUILDING AUTOMATION NETWORKS	MA	MIXED AIR
BS	BUILDING AUTOMATION SYSTEM	MAT	MIXED AIR TEMPERATURE
BI	BINARY INPUT	MCC	MOTOR CONTROL CENTER
BO	BINARY OUTPUT	MUA	MAKE-UP AIR UNIT
BTU	BRITISH THERMAL UNIT	MZ	MULTI-ZONE
BTUH	BRITISH THERMAL UNITS / HOUR	NC	NORMALLY CLOSED
CAV	CONSTANT AIR VOLUME	NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
CDD	COOLING DEGREE DAYS	NO	NORMALLY OPEN
CFC	CHLOROFLUOROCARBON	NPSH	NET POSITIVE SUCTION HEAD
CFM	CUBIC FEET PER MINUTE	OA	OUTSIDE AIR
CH	CHILLER	OAP	OUTSIDE AIR PERCENTAGE
CHW	CHILLED WATER	OAT	OUTSIDE AIR TEMPERATURE
CHWP	CHILLED WATER PUMP	OOP	OPEN DRIP PROOF
CFU	CHILLED WATER RETURN	OWS	OPERATOR WORK STATION
CHWR	CHILLED WATER RETURN TEMPERATURE	PC	PERFORMANCE CONTRACTING
CHWS	CHILLED WATER SUPPLY TEMPERATURE	PE	PROFESSIONAL ENGINEER
CHWT	CHILLED WATER SUPPLY TEMPERATURE	PH	PRE-HEAT
COP	COEFFICIENT OF PERFORMANCE	PID	PROPORTIONAL INTEGRAL DERIVATIVE
CRAC	COMPUTER ROOM AIR CONDITIONER	PRV	PRESSURE RELIEF VALVE
CT	COOLING TOWER	PRV	PRESSURE REDUCING VALVE
CV	CONSTANT VOLUME	PTAC	PACKAGED TERMINAL AIR CONDITIONER
CWP	CONDENSER WATER PUMP	RA	RETURN AIR
CWRT	CONDENSER WATER RETURN	RA	RETURN AIR
CWRT	CONDENSER WATER RETURN TEMPERATURE	RF	RE-FAN
CWS	CONDENSER WATER SUPPLY	RH	REHEAT
CWS	CONDENSER WATER SUPPLY TEMPERATURE	RH	RELATIVE HUMIDITY
DATE	DISCHARGE AIR TEMPERATURE	RM	REVOLUTIONS PER MINUTE
DB	DRY BULB	RTD	RESISTANCE TEMPERATURE DETECTOR
DB	DEMAND CONTROLLED VENTILATION	RTU	ROOF TOP UNIT
DCC	DIRECT DIGITAL CONTROL	SA	SUPPLY AIR
DCH	DUCT HEATER	SAT	SUPPLY AIR TEMPERATURE
DH	DIFFERENTIAL PRESSURE	SEER	SEASONAL ENERGY EFFICIENCY RATIO
DX	DIRECT EXPANSION	SF	SUPPLY FAN
EAT	ENTERING AIR TEMPERATURE	SHR	SENSIBLE HEAT RATIO
ECM	ELECTRONICALLY COMMUTATED MOTOR	SP	SET POINT
EDH	ELECTRIC DUCT HEATER	SP	STATIC PRESSURE
EER	ENERGY EFFICIENCY RATIO	T	THERMOSTAT
EF	EXHAUST FAN	TEV	THERMOSTATIC EXPANSION VALVE
EHS	ELECTRIC HEATER	TOD	TIME OF DAY
EMS	ENERGY MANAGEMENT SYSTEM	TXV	THERMOSTATIC EXPANSION VALVE
ESCO	ENERGY SERVICE COMPANY	UH	UNIT HEATER
EUH	ELECTRIC UNIT HEATER	UL	ULTRAVIOLET
EWT	ENTERING WATER TEMPERATURE	UV	UNIT VENTILATOR
FCU	FAN COIL UNIT	VAV	VARIABLE AIR VOLUME
FMA	FULL LOAD AMPS	VD	VOLUME DAMPER
FMS	FACILITY MANAGEMENT SYSTEM	VFD	VARIABLE FREQUENCY DRIVE
FFM	FEET PER MINUTE	VSD	VARIABLE SPEED DRIVE
FW	FEED WATER	VSP	VARIABLE SPEED PUMPING
GFW	GALLONS PER MINUTE	WB	WET BULB
GUI	GRAPHICAL USER INTERFACE	WC	WATER COLUMN
HCFC	HYDROCHLOROFUROCARBON	YTD	YEAR TO DATE
HEPA	HIGH EFFICIENCY PARTICULATE ARRESTING		
HFC	HYDROFLUOROCARBON		
HHPW	HEATING HOT WATER PUMP		
HHRW	HEATING HOT WATER RETURN		
HRWS	HEATING HOT WATER SUPPLY		
HL	HIGH LIMIT		
HR	HEAT RECOVERY		
HRR	HEAT RECOVERY UNIT		
HRV	HEAT RECOVERY VENTILATOR		
HSFP	HEATING SEASONAL PERFORMANCE FACTOR		
HVAC	HEATING VENTILATION AND AIR CONDITIONING		
HWP	HOT WATER PUMP		
HWR	HOT WATER RETURN		
HWS	HOT WATER SUPPLY		
HWT	HOT WATER RETURN TEMPERATURE		
HWST	HOT WATER SUPPLY TEMPERATURE		
HX	HEAT EXCHANGER		
IO	INPUT OUTPUT		
IAQ	INDOOR AIR QUALITY		
IR	INFRARED		
LAV	LEAVING AIR TEMPERATURE		
LHT	LOWER HEATING VALUE		

**SYMBOLS AND ABBREVIATIONS LEGEND**  
(THERE MAY BE SYMBOLS LISTED IN THIS LEGEND THAT ARE NOT USED IN THIS SET OF DRAWINGS)

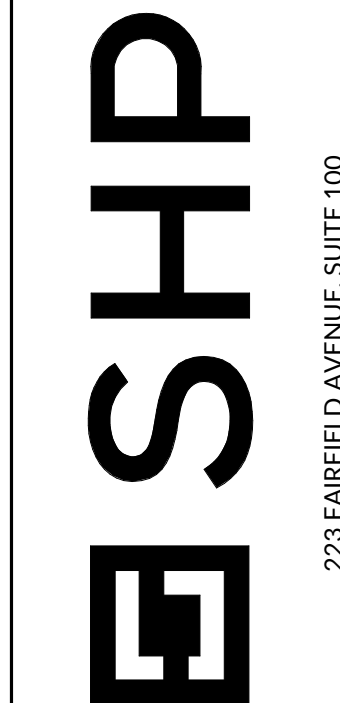
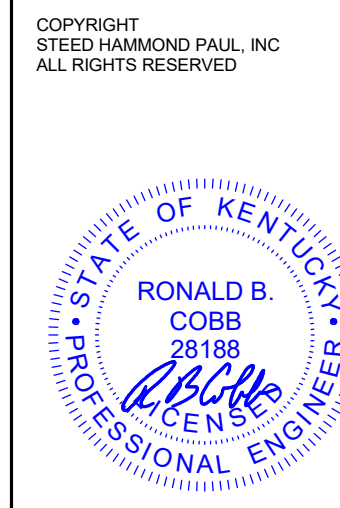
PIPING SYMBOLS	DESCRIPTION
	HHWS - HEATING HOT WATER SUPPLY PIPING
	HHRW - HEATING HOT WATER RETURN PIPING
	CHWS - CHILLER WATER SUPPLY PIPING
	CHWR - CHILLER WATER RETURN PIPING
	CWS - CONDENSER WATER SUPPLY PIPING
	CWR - CONDENSER WATER RETURN PIPING
	GLS - GEO-THERMAL LOOP SUPPLY PIPING
	GLR - GEO-THERMAL LOOP RETURN PIPING
	COND - CONDENSATE DRAIN PIPING
	RS/L - REFRIGERANT SUCTION/LIQUID PIPING
	⊕ - BALL VALVE
	⊕ - BUTTERFLY VALVE
	⊕ - PLUG VALVE
	⊕ - CIRCUIT BALANCING VALVE
	⊕ - CHECK VALVE
	PRV-# - PRESSURE REDUCING VALVE
	⊕ - 3-WAY VALVE
	⊕ - MOTORIZED CONTROL VALVE
	⊕ - MOTORIZED 3-WAY CONTROL VALVE
	⊕ - SOLENOID VALVE
	⊕ - STRAINER
	⊕ - PIPE CONTINUATION
	⊕ - POINT OF REMOVAL/CONNECTION
	⊕ - KEYNOTE NOTE

**DUCTWORK SYMBOLS**

	LINEAR DIFFUSER
	SUPPLY DIFFUSER
	RETURN GRILLE
	EXHAUST GRILLE
	VAV BOX (WITH CLEARANCE BOX SHOWN)
	BALANCING DAMPER
	BACKDRAFT DAMPER
	SMOKE DAMPER
	FIRE DAMPER
	MOTORIZED CONTROL DAMPER
	INTERNALLY LINED DUCTWORK
	FABRIC DUCTWORK
	FLEXIBLE DUCTWORK

**CONTROL SYMBOLS**

	THERMOSTAT
	TEMPERATURE SENSOR
	CARBON DIOXIDE SENSOR
	HUMIDITY SENSOR
	VOC SENSOR
	COMBINATION THERMOSTAT / HUMIDITY SENSOR
	CARBON MONOXIDE SENSOR



2025 FARMERS AVENUE SUITE 400  
BELLEVILLE, KY 40023-8592-2024

NOTRE DAME ACADEMY  
**CLASSROOM RENOVATION**  
1699 Hilton Dr., Park Hills, KY 41011

**ISSUANCES**

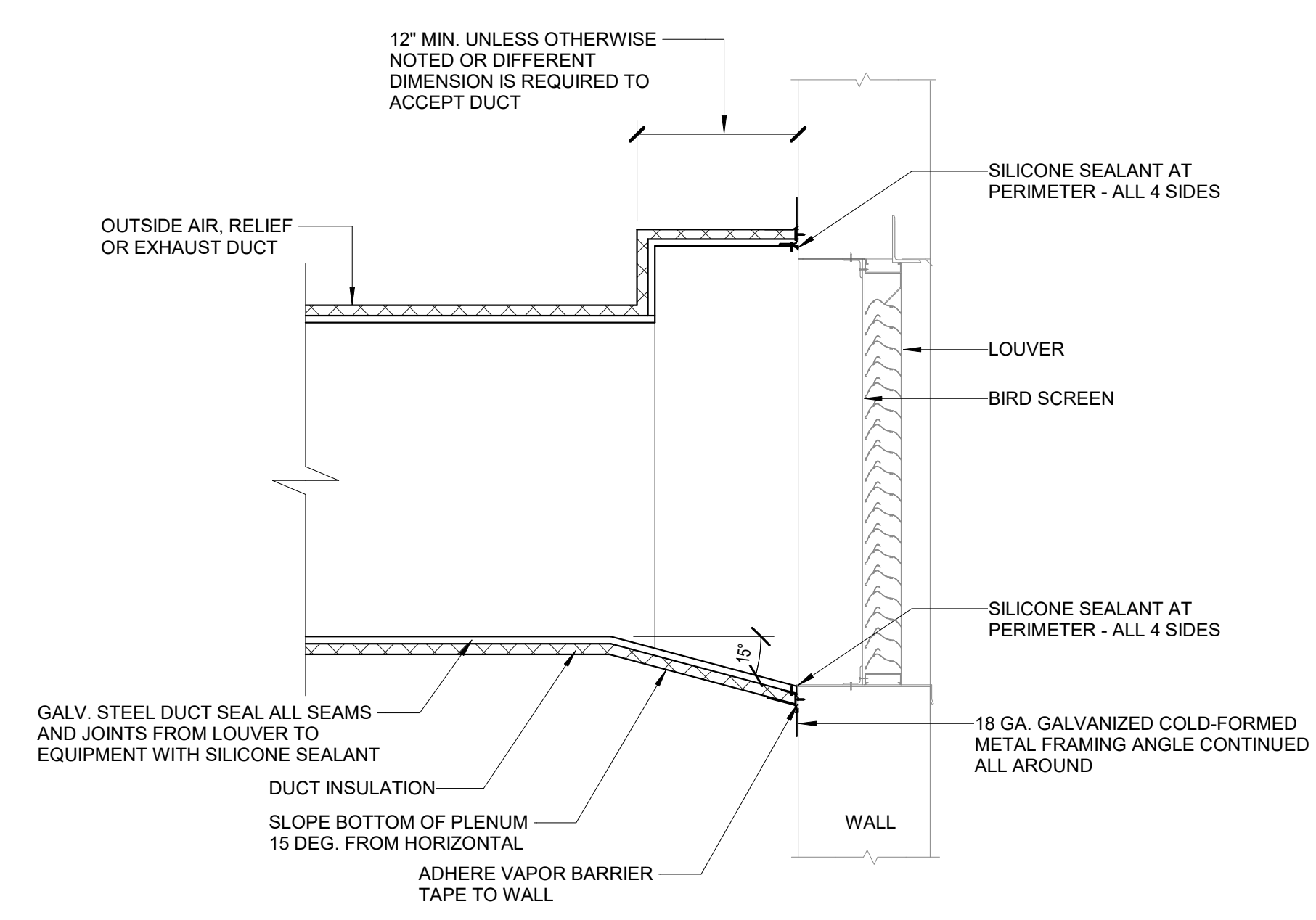
ISSUANCES	
A	05-09-25 PERMIT SET

MECHANICAL SCHEDULES AND DETAILS

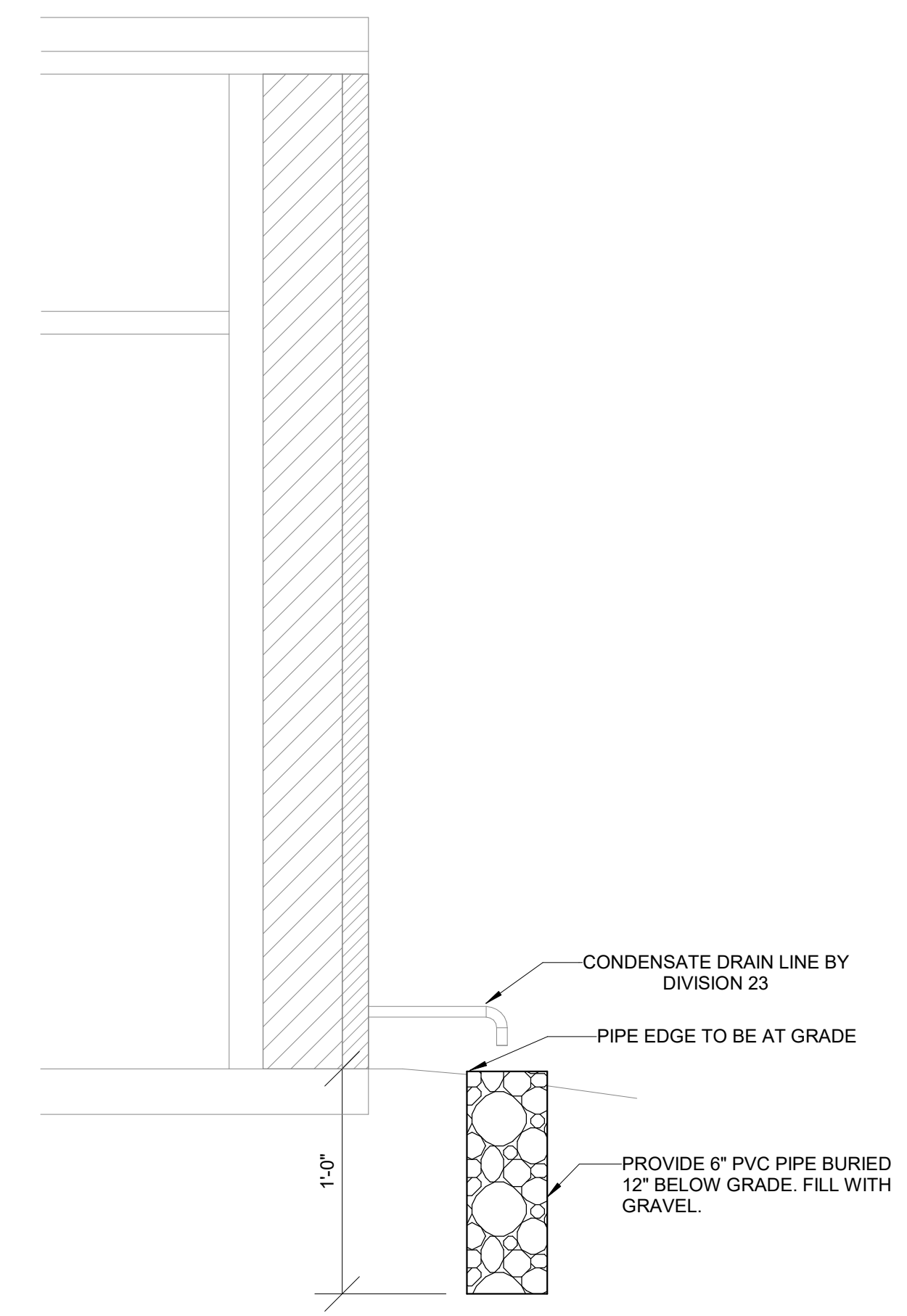
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M002

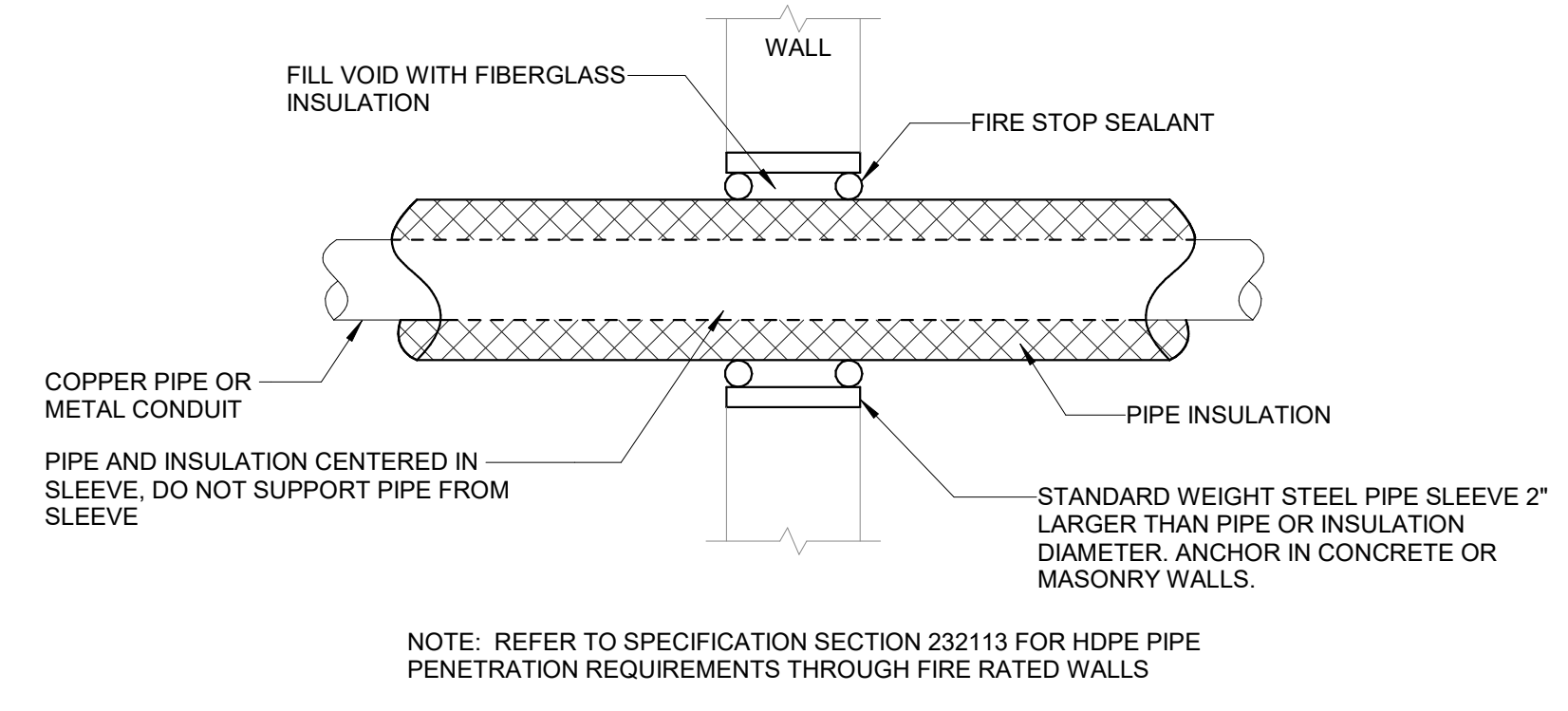
**3 LOUVER DUCTWORK CONNECTION**  
M002 1/8" = 1'-0"



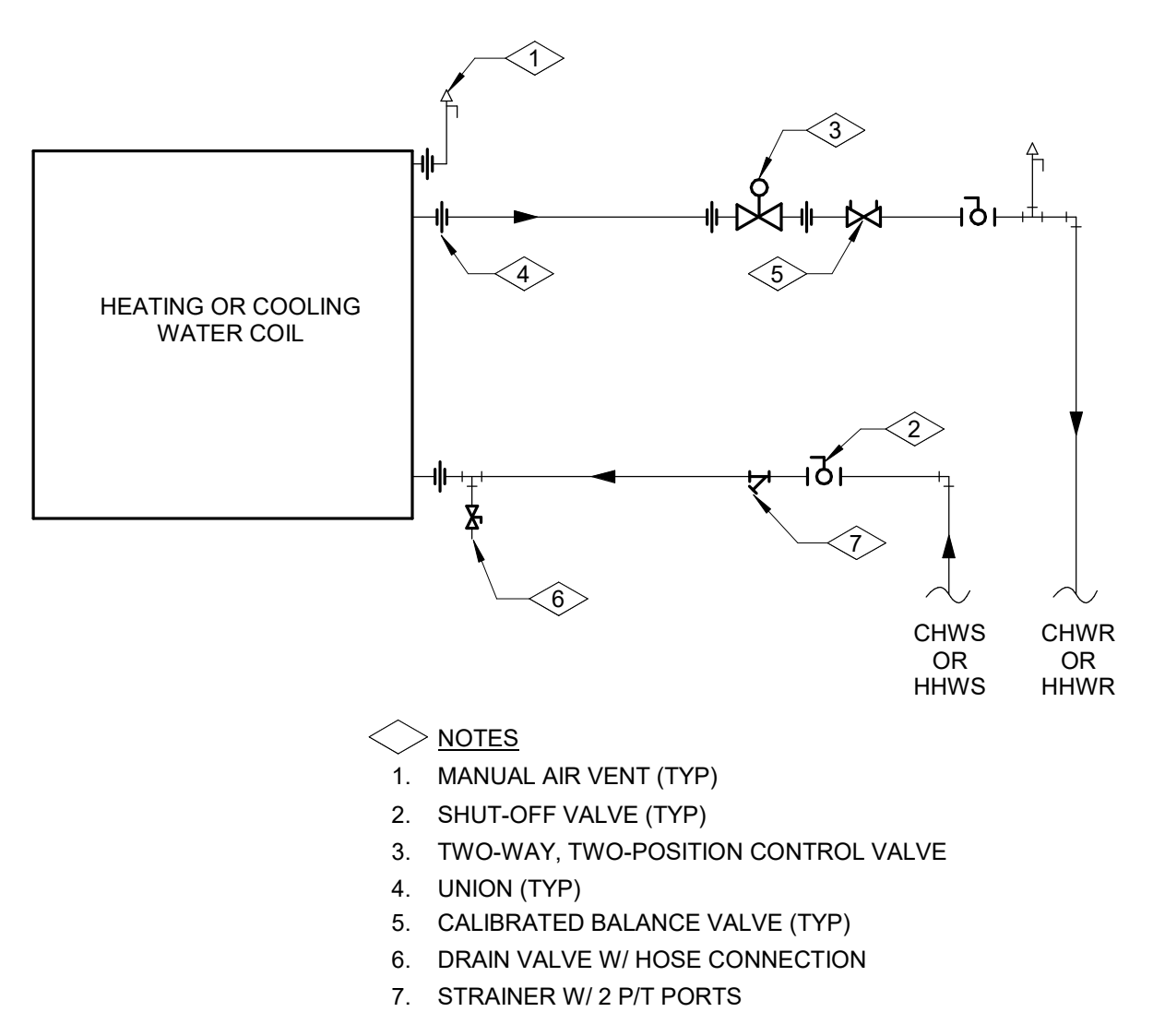
**1 FRENCH DRAIN - FROM BUILDING**  
M002



**2 PIPE PENETRATION THROUGH FIRE RATED WALL**  
M002

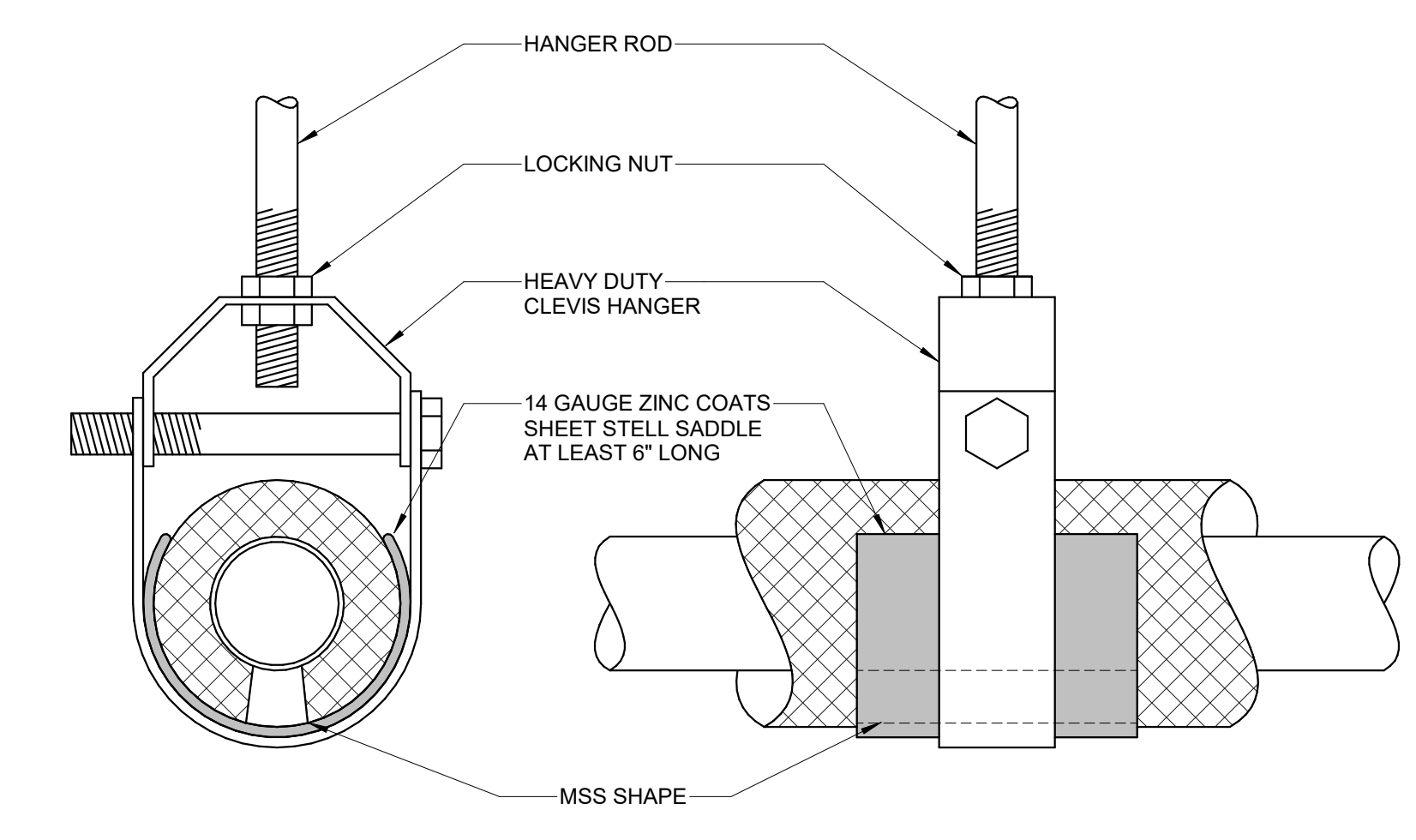


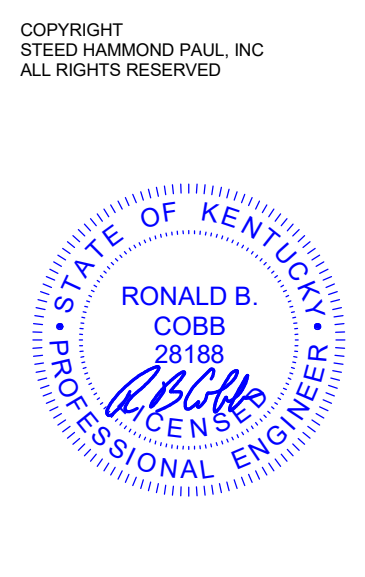
**4 HEATING / COOLING COIL PIPING DETAIL**  
M002



NOTE: IF MULTIPLE COILS USED, PROVIDE COIL CONNECTIONS WITH EITHER REVERSE RETURN PIPING OR MANUAL BALANCING VALVES FOR PROPER COIL BALANCING.

**5 PIPE HANGER (6" AND SMALLER)**  
M002



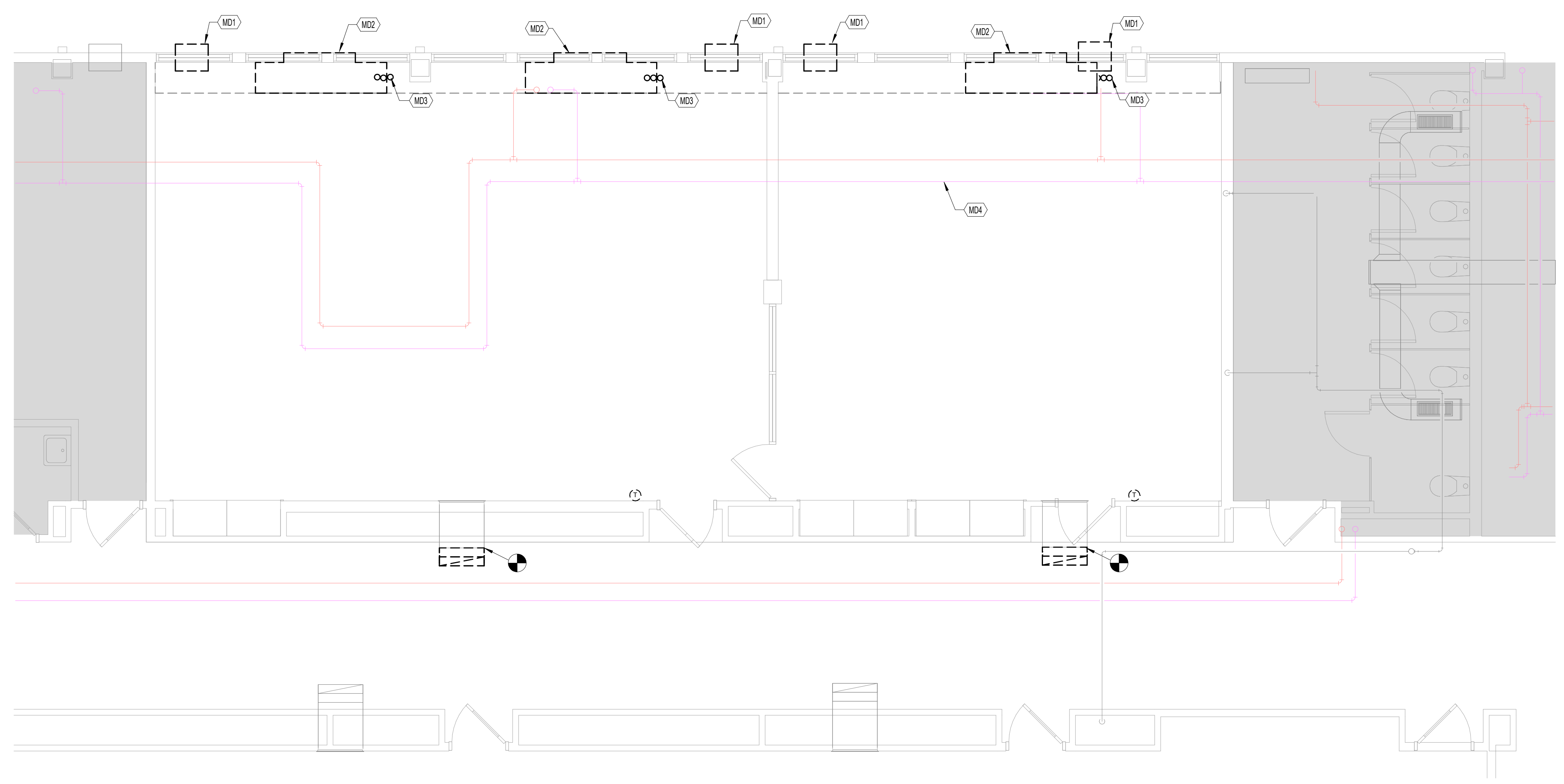


**GENERAL HVAC DEMOLITION NOTES:**

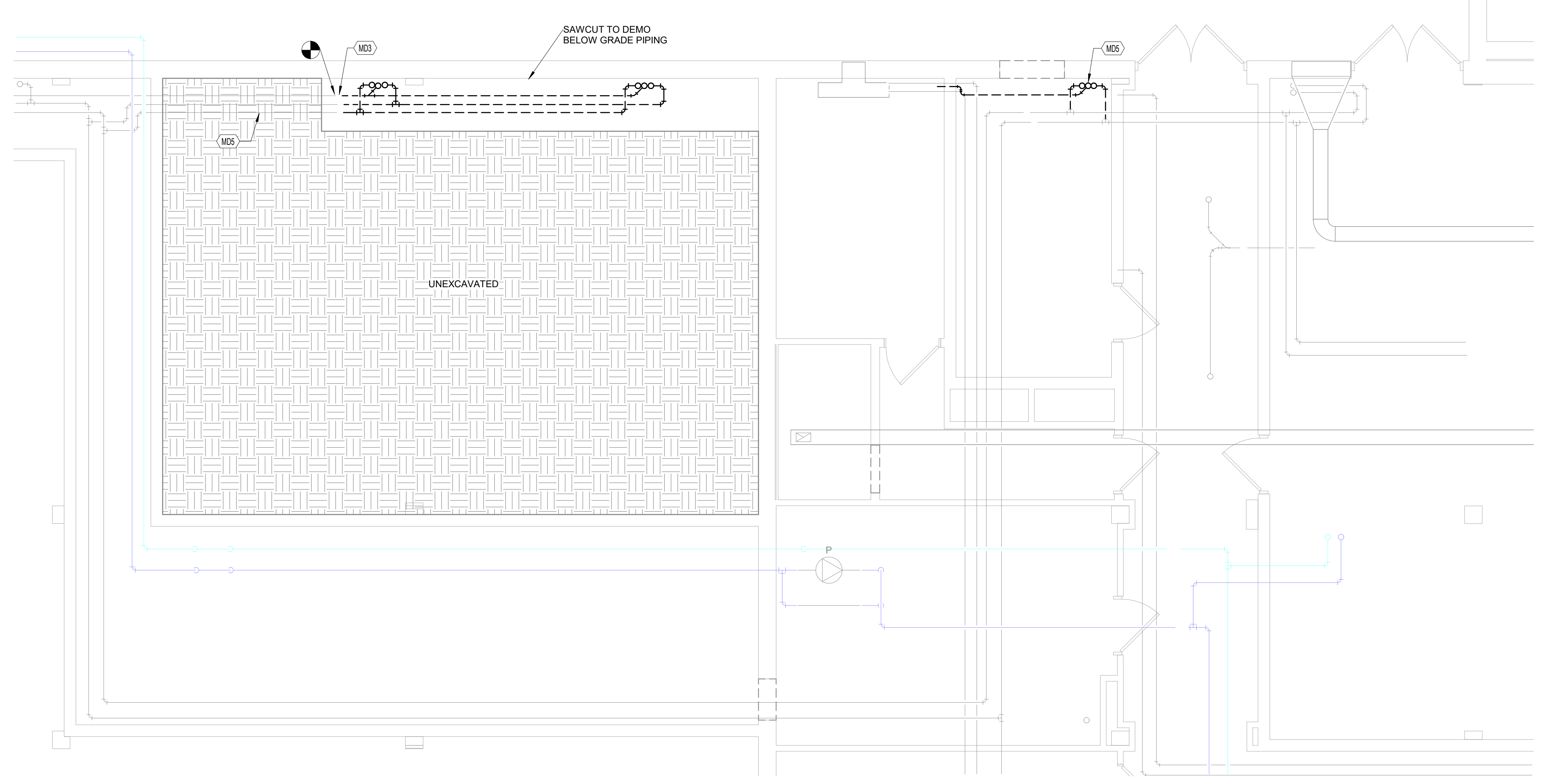
- A. DRAWING IS BASED ON FIELD OBSERVATIONS AND EXISTING DRAWINGS. NOTIFY CM OF DISCREPANCIES DUE TO ACTUAL FIELD CONDITIONS BEFORE PROCEEDING.
- B. DUCTWORK, PIPING, ACCESSORIES, EQUIPMENT, AND ALL OTHER HVAC SCOPE DENOTED BY DASHED LINE TYPE INDICATES DEMOLITION SCOPE.
- C. DUCTWORK, PIPING, ACCESSORIES, EQUIPMENT, AND ALL OTHER HVAC SCOPE DENOTED BY GRAY LINE TYPE INDICATES SCOPE THAT IS EXISTING TO REMAIN.
- D. DEMOLISH ALL EXISTING HVAC NOT REUSED IN NEW DESIGN OR NOTED TO BE ABANDONED IN PLACE.

**KEYNOTES**

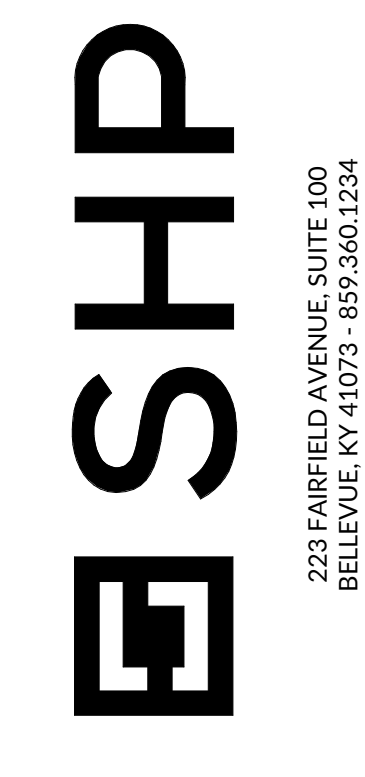
- MD1 REMOVE EXISTING WINDOW UNIT IN ITS ENTIRETY.
- MD2 REMOVE EXISTING UNIT VENTILATOR IN ITS ENTIRETY, INCLUDING EXISTING CONTROLS.
- MD3 CAP EXISTING HWS/R AND CONDENSATE PIPING BELOW GRADE.
- MD4 EXISTING DUAL TEMPERATURE PIPING ROUTES WITHIN CEILING AND SERVES FLOOR ABOVE.
- MD5 REMOVE EXISTING CONDENSATE LINE.



**1 FIRST FLOOR HVAC DEMOLITION PLAN**  
M011 1/4" = 1'-0"



**2 LOWER LEVEL HVAC DEMOLITION PLAN**  
M011 1/4" = 1'-0"



**NOTRE DAME ACADEMY  
CLASSROOM RENOVATION**  
1699 Hilton Dr., Park Hills, KY 41011

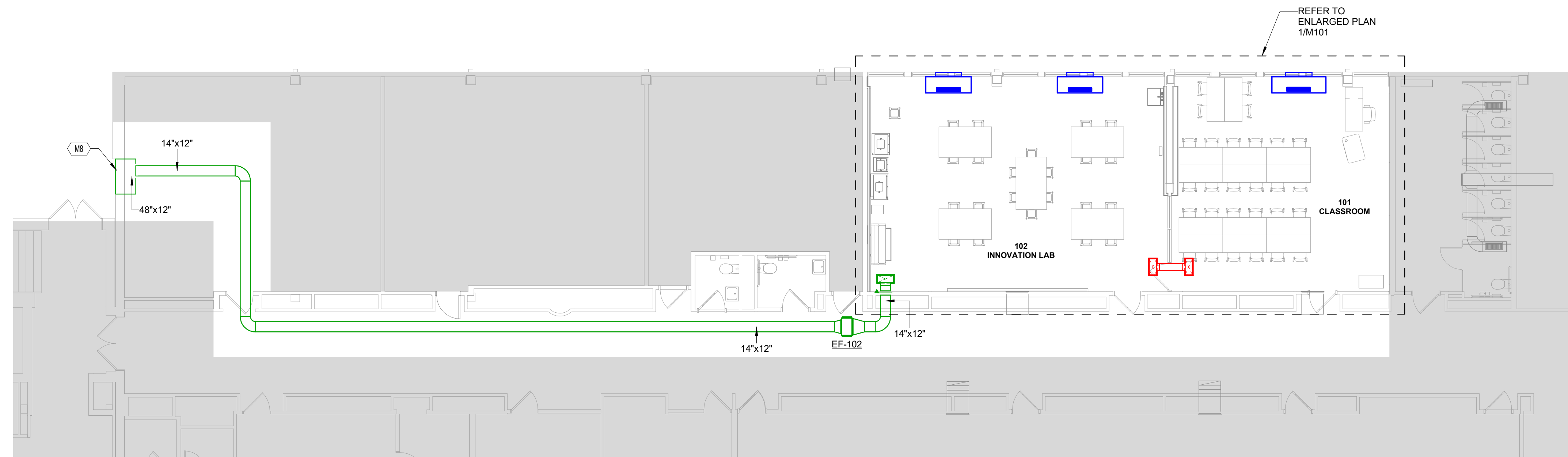
**ISSUANCES**

NO.	DATE	DESCRIPTION
A	05-09-25	PERMIT SET

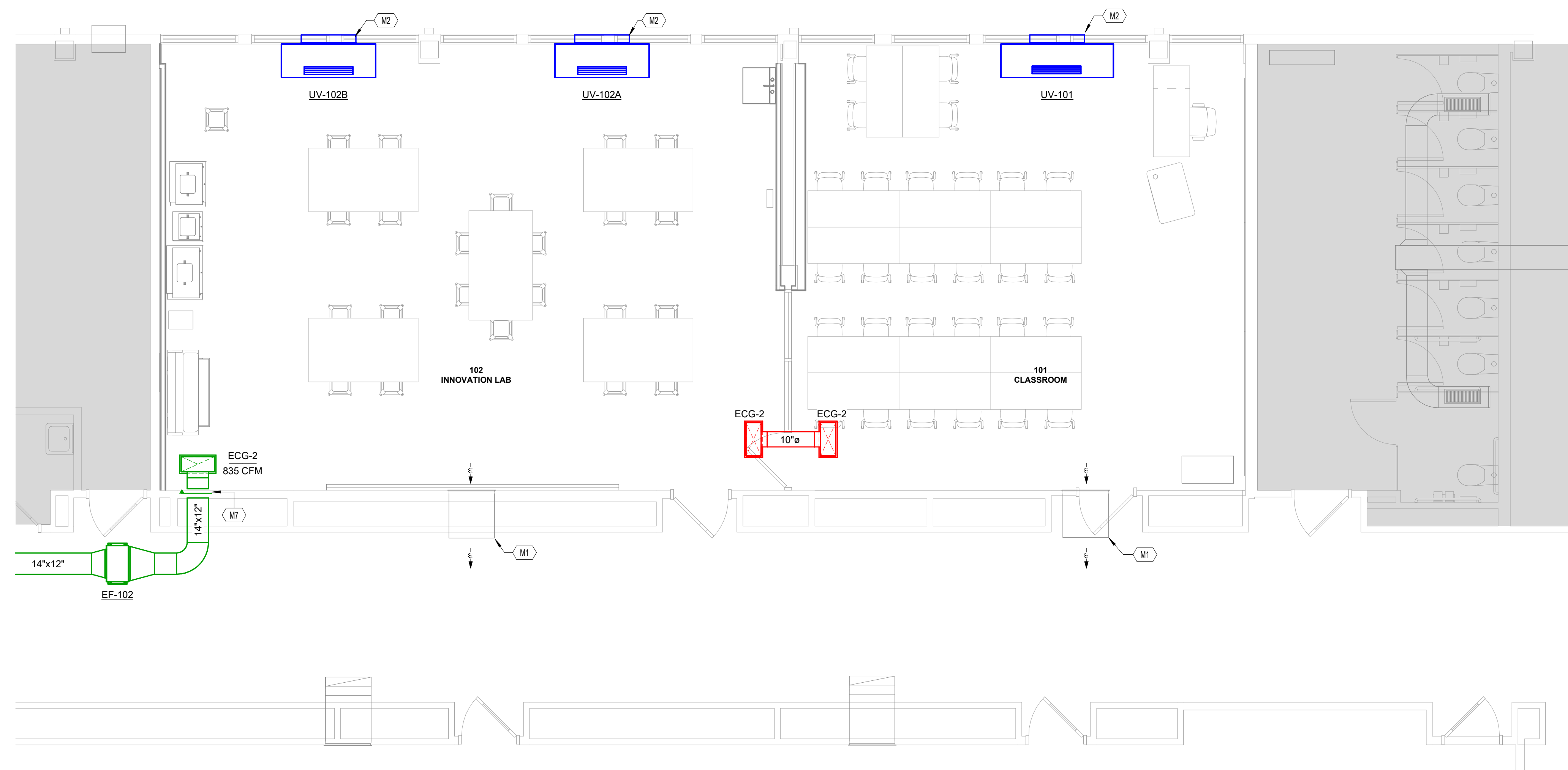
**HVAC  
DEMOLITION  
PLANS**

COMM NO. 2025048.01

**M011**



**2** FIRST FLOOR DUCTWORK PLAN - CLASSROOMS WING  
M101 1/8" = 1'-0"



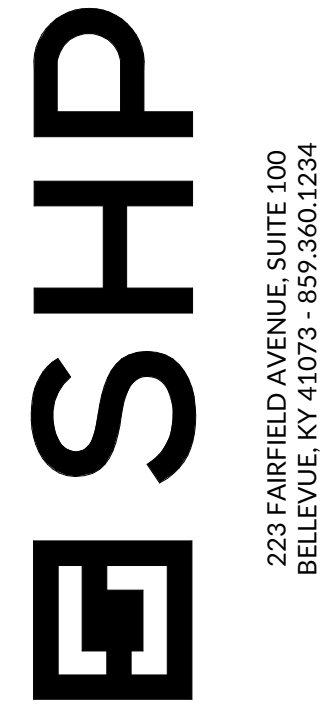
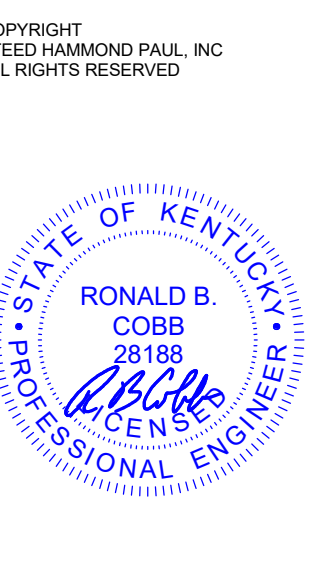
**1** ENLARGED FIRST FLOOR DUCTWORK PLAN - CLASSROOMS  
M101 1/4" = 1'-0"

**GENERAL DUCT PLAN NOTES:**

- A. DO NOT ROUTE DUCTWORK OVER ELECTRICAL EQUIPMENT, THROUGH ELECTRICAL ROOMS, ELEVATOR SHAFTS, OR THROUGH INTERIOR EXIT STAIRWELLS UNLESS OTHERWISE NOTED.
- B. INLET AND DISCHARGE DUCTS CONNECTING TO VAV BOXES ARE TO BE THE SAME SIZE AS VAV BOX INLET AND DISCHARGE RESPECTIVELY UNLESS NOTED OTHERWISE.
- C. DUCTS SERVING DIFFUSERS AND GRILLES ARE TO BE THE SAME SIZE AS DIFFUSER NECK SIZE OR GRILLE FACE UNLESS NOTED OTHERWISE.
- D. VAV BOX CONTROLLER ACCESS IS SHOWN AS A HASHED BOX.
- E. AIR TRANSFER DUCTS ARE 14" X 14" UNLESS NOTED OTHERWISE. CONTRACTOR TO PROVIDE ADDITIONAL TRANSFER OPENINGS ABOVE CEILING AS NEEDED FOR AIR RETURN.
- F. PROVIDE AT LEAST 3 STRAIGHT DUCT DIAMETERS AT INLET OF VAV BOXES.
- G. DO NOT USE FLEXIBLE DUCTWORK AT INLET OF VAV BOX.
- H. PROVIDE VOLUME CONTROL DAMPERS IN RUN-OUT DUCT TO ALL SUPPLY AIR DEVICES.
- I. DUCT DIMENSIONS SHOWN ARE INTERNAL DIMENSIONS.

**KEYNOTES**

- M1 TRANSFER AIR TO DISCHARGE INTO HALLWAY PLENUM.
- M2 TRANSITION INSULATED OUTSIDE AIR DUCT AS REQUIRED TO CONNECT INTO EXISTING OUTSIDE AIR LOUVER. BLANK OFF UNUSED PORTIONS OF OUTSIDE AIR LOUVER.
- M7 DYNAMIC 1.5-HR-RATED FIRE DAMPER EQUAL TO GREENHECK DFD-150X. DAMPER SHALL BE UL 555 RATED WITH A FUSIBLE LINK SET AT 165 DEG F. PROVIDE ACCESS DOOR IN DUCTWORK.
- M8 INSTALL 48 X 12 LOUVER EQUAL TO GREENHECK EHH-401 ADJACENT TO EXISTING LOUVER.



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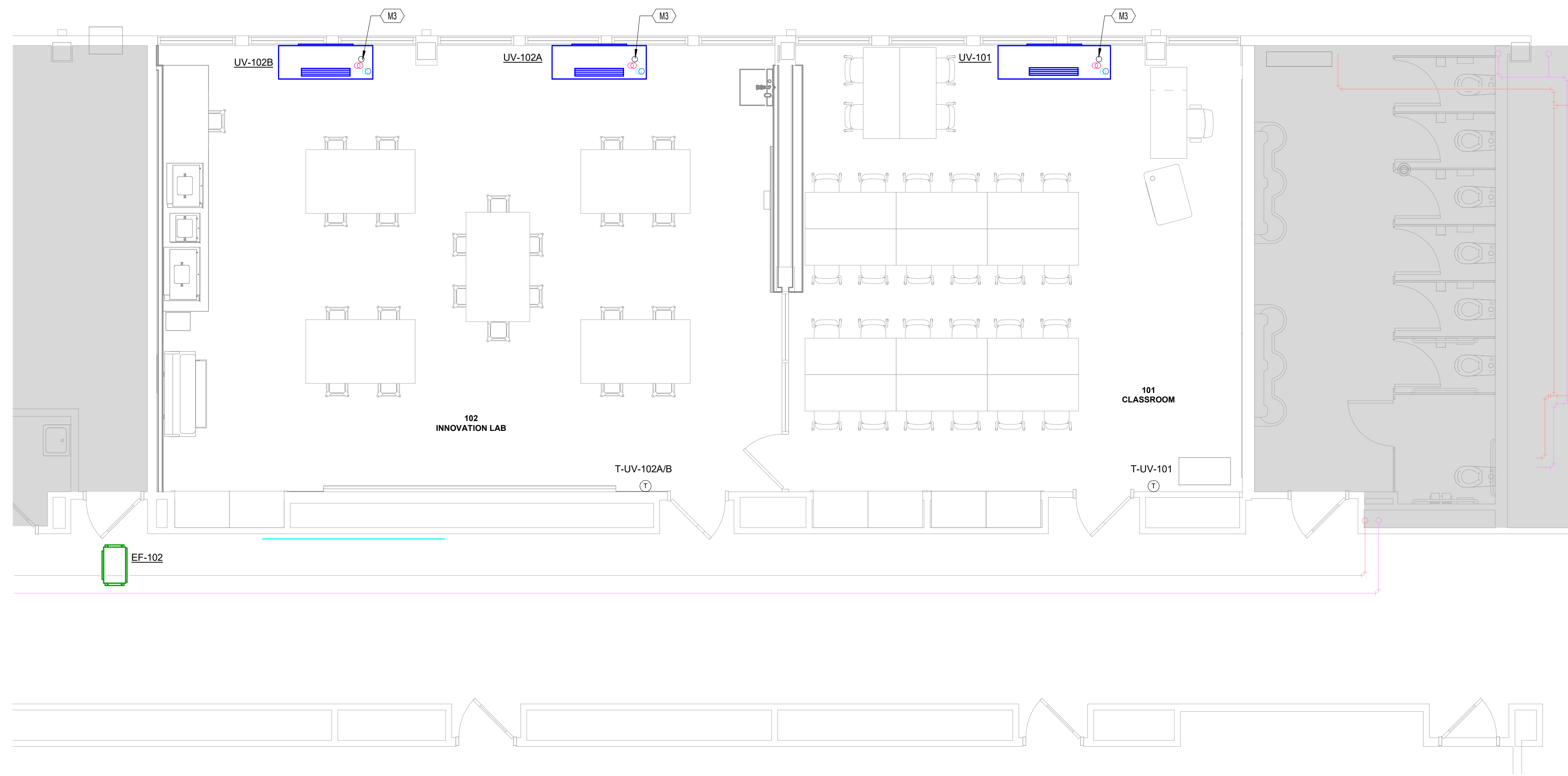
**ISSUANCES**

NO.	DATE	DESCRIPTION
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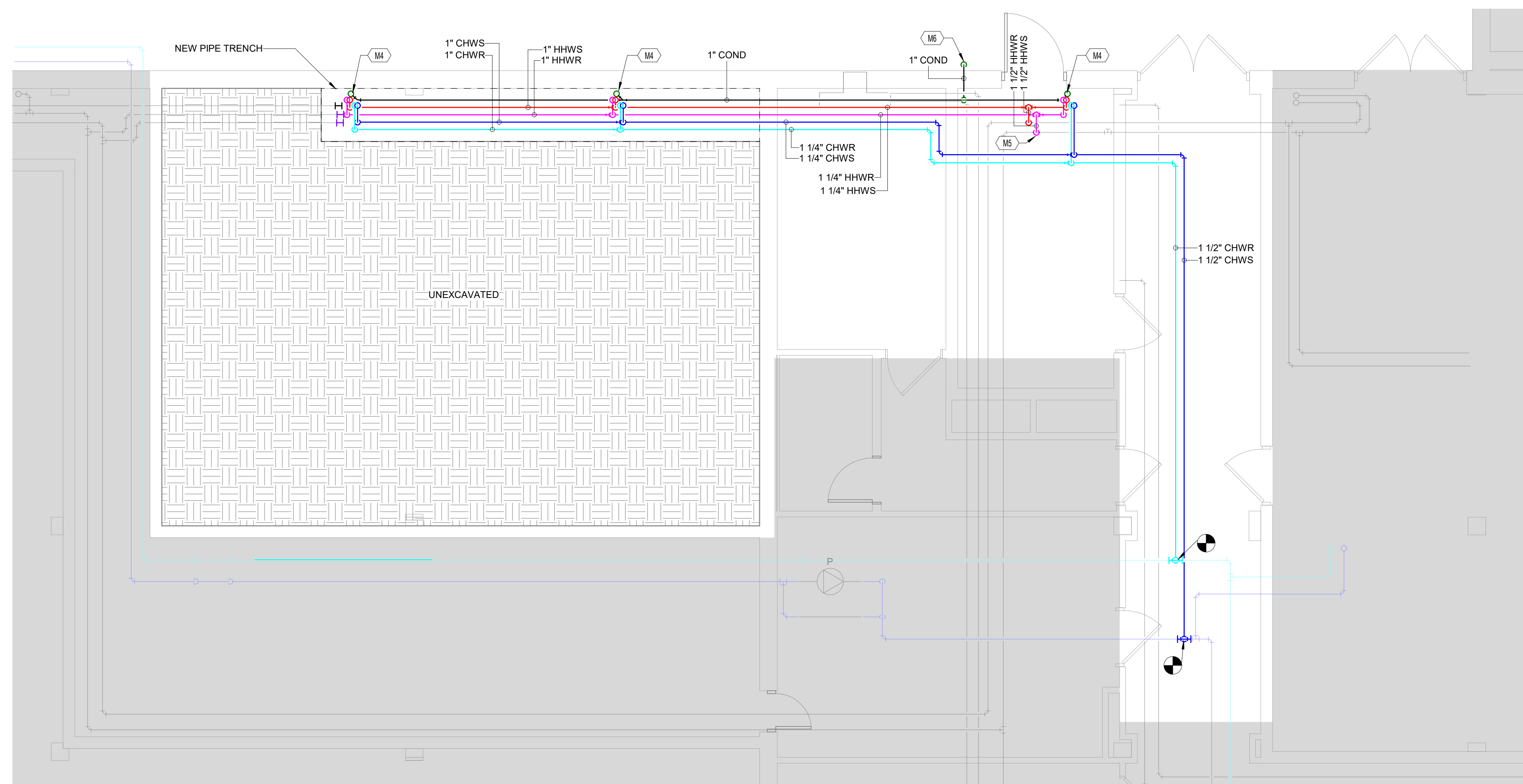
DUCTWORK PLAN - FIRST FLOOR

COMM NO. 2025048.01

M101



**1 FIRST FLOOR HVAC PIPING PLAN**  
 M201 1/4" = 1'-0"



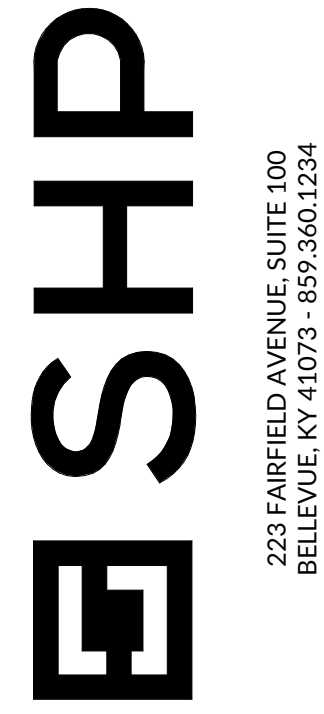
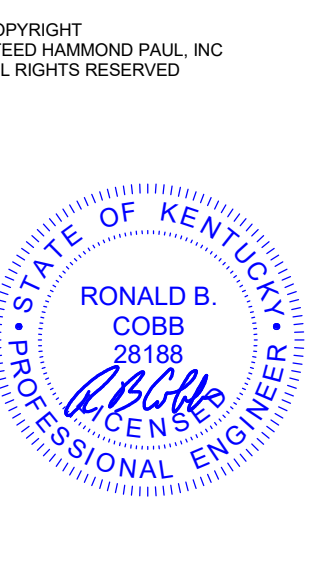
**2 LOWER LEVEL HVAC PIPING PLAN**  
 M201 1/4" = 1'-0"

**GENERAL PIPING PLAN NOTES:**

- A. SUPPLY AND RETURN PIPING IS 3/4" UNLESS NOTED OTHERWISE.
- B. DO NOT ROUTE PIPING OVER ELECTRICAL EQUIPMENT, THROUGH ELECTRICAL ROOMS, ELEVATOR SHAFTS, OR THROUGH INTERIOR EXIT STAIRWELLS UNLESS OTHERWISE NOTED.
- C. CONDENSATE PIPING IS 1" UNLESS NOTED OTHERWISE.

**KEYNOTES**

- M3 ROUTE HWS/R, CHWS/R, AND CONDENSATE PIPE INTO UNIT VENT PIPE CHASE FROM PIPE TRENCH BELOW AND CONNECT TO COIL TRIM PROVIDED WITH UNIT.
- M4 ROUTE HWS/R, CHWS/R, AND CONDENSATE PIPE UP INTO UNIT VENT ABOVE.
- M5 CONNECT NEW HWS INTO EXISTING HWS AND NEW HWR INTO EXISTING HWR
- M6 ROUTE CONDENSATE PIPE DOWN CORNER OF ROOM AND OUT WALL AT 12" ABOVE GRADE. DISCHARGE TO FRENCH DRAIN. REFER TO DETAIL 1/M002.



NOTRE DAME ACADEMY  
**CLASSROOM RENOVATION**  
 1699 Hilton Dr., Park Hills, KY 41011

**ISSUANCES**

NO.	DATE	DESCRIPTION
A	05-09-25	PERMIT SET

HVAC PIPING PLAN - FIRST FLOOR

COMM NO. 2025048.01

M201

**SECTION 230600 - COMMON WORK RESULTS FOR HVAC**

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

**PART 1 - GENERAL**

- 1.1 SUMMARY
  - A. See Editing Instruction No. 3 in the Evaluations for discussion about how this Section supplements other Division 23 Sections.
  - B. This Section includes the following:
    - 1. Piping materials and installation instructions common to most piping systems.
    - 2. Dielectric fittings.
    - 3. Sleeves.
    - 4. Escutcheons.
    - 5. Equipment installation requirements common to equipment sections.
    - 6. Supports and anchors.
- 1.2 SUBMITTALS
  - A. Retain this Article if procedures for welder certification are retained in "Quality Assurance" Article.
  - B. Welding certificates.
  - 1.3 QUALITY ASSURANCE
    - A. Retain first two paragraphs below for approval of welding and pipe welding are retained in "Pipe Joint Construction" and "Erection of Metal Supports and Anchorage" articles. AWS states that welding qualifications remain in effect indefinitely unless welding personnel have not worked for more than six months or there is a specific reason to question their ability.
    - B. Weld Support Welding: Qualify processes and operators according to AWS D11.1, "Structural Welding Code-Steel."
    - C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
    - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
    - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
  - C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately installed. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

**PART 2 - PRODUCTS**

- 1.1 PIPE, TUBE, AND FITTINGS
  - A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
  - B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- 1.2 RELATED MATERIALS
  - A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
  - B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
  - C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
  - D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAq1, unless otherwise indicated.
  - E. Welding Flux: Comply with AWS D10.12.
- 2.3 DIELECTRIC FITTINGS
  - A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that maintain piping system materials.
  - B. Insulating Material: Suitable for system fluid, pressure, and temperature.
  - C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
  - D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
  - E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 180 deg F.
  - F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
- 3. GALVANIZED-STEEL SHEET: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- 4. STEEL PIPE: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- 5. WALL BRACING SYSTEMS: Comply with Division 5, "Structural Steel Joists and Bracing."
- 6. CAST IRON: ASTM A 124, ductile iron, nonferrous, cast iron, with plain ends and integral waterstop, unless otherwise indicated.
- 7. SLACK SLEEVE FITTINGS: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

**PART 3 - EXECUTION**

- 1.1 PREPARATION
  - A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
  - B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
  - C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
  - D. Install piping in exposed interior piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
  - E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
  - F. Install piping to permit valve servicing.
  - G. Install piping at indicated slopes.
  - H. Install piping free of sags and bends.
  - I. Install piping to permit expansion and branch connections.
  - J. Install piping to allow application of insulation.
  - K. Select system components with pressure rating equal to or greater than system operating pressure.
  - L. Select escutcheons for penetrations of walls, ceilings, and floors.
  - M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1/4-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- 1.2 INSTALLATION
  - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
  - 3. Seal piping by means of sealing elements between pipe and material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
  - 4. Seal piping by means of sealant.
  - 5. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
  - 6. Verify final equipment locations for roughing-in.
  - 7. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 2.3 PIPING JOINT CONSTRUCTION
  - 1. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
  - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  - C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
  - D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
  - E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
  - F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open wells.
  - G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
  - H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on both gaskets.
- 3.3 PIPING CONNECTIONS
  - A. Make connections according to the following, unless otherwise indicated:
    - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
    - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - B. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
  - 4. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS
    - A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
    - B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
    - C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
    - D. Install equipment to allow right of way for piping installed at required slope.
  - 3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES
    - A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
    - B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
    - C. Field Welding: Comply with AWS D11.1.

**END OF SECTION 230600**

**SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

Revise this Section by deleting and inserting text to meet project-specific requirements.

**PART 1 - GENERAL**

- 1.1 SUMMARY
  - A. This Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on air power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- 1.2 COORDINATION
  - A. Refer to other Division 23 Sections to determine if control coordination is required.
  - B. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
    - 1. Motor controllers.
    - 2. Torque, speed, and horsepower requirements of the load.
    - 3. Ratings and characteristics of supply circuit and required control sequence.
    - 4. Ambient and environmental conditions of installation location.
- 2.1 GENERAL MOTOR REQUIREMENTS
  - A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
  - B. Comply with NEMA MG 1 unless otherwise indicated.
  - C. Duty: MOTOR CHARACTERISTICS
    - 1. Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
    - 2. 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.
  - D. POLYPHASE MOTORS
    - A. Description: NEMA MG 1, Design B, medium induction motor.
    - B. Efficiency: Premium efficient, as defined in NEMA MG 1.
    - C. Inclusion-Insert Material for Cold Piping: ASTM C 552, Type I cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
    - D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type I cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
    - E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
    - F. For Clevis or Band Hangers: Insert and shield shall cover 180 degrees of pipe.
    - G. Insert Length: Extend 2 inches beyond metal shield for piping operating under ambient air temperature.
  - 2.4 FASTENER SYSTEMS
    - A. Verify suitability of fasteners in this article for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
    - B. Mechanical-Expansion Anchors: Insert wedge-type, steel anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
    - 2.5 PIPE STANDS
      - A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
        - 1. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
        - 2. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curbs.
      - B. Equipment Supports
        - A. Description: Welded-rod-and-plate equipment support made from structural carbon-steel shapes.

**PART 2 - PRODUCTS**

- 1.1 RELATED DOCUMENTS
  - A. Retain first paragraph below for service factors exceeding NEMA standard for other than open-drip proof motors. If retaining, coordinate with Drawings and other Sections. See "Product Characteristics" Article in the Evaluations for discussion of service factor. A service factor of at least 1.15 is available for most motors, including explosion proof; however, there are exceptions.
  - B. Service Factor: 1.15.
  - C. See "Multispeed and Variable-Speed Considerations" Article in the Evaluations.
- 2. MULTISPEED MOTORS: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- 3. RANDOM-WOUND, OTHER TYPE
  - A. NEMA MG 1 recommends ball bearings for polyphase motors 500 hp and smaller due to their ability to sustain coupling end-play and rotor float. Some smaller integral and fractional polyphase motors might have sleeve bearings for lower cost and quieter operation, especially if direct coupled and not subjected to belt loads. For motor-bearing requirements for specific equipment, specify those requirements in motorized equipment Sections. Coordinate equipment suppliers for bearing types in smaller motors. Specify bearing-life requirements, according to ABMA 9, in motor-driven equipment Sections.
  - B. Bearings: Regreaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- 4. TEMPERATURE RATING: Class F temperature rise; Class H insulation.
  - A. Standard insulation class for general-purpose, open-drip proof motors, of nominal efficiency rating, is Class B; however, many energy- and premium-efficient motors, and those with service factors 1.15 or higher, are built with insulation meeting Class F requirements, especially if designed as "inverter ready" for use with variable frequency controllers. Retain option in first paragraph below unless a higher or lower insulation class is required as a default.
  - H. Insulation: Class F.
    - 1. Code Letter Designation: Starting codes in first subparagraph below are adequate for most variable-torque loads encountered in HVAC applications; 15 hp is a common breakpoint in rating among manufacturers when Code F and Code G apply. Retain both subparagraphs and options unless Project conditions or other Sections specify otherwise.
      - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
      - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- 5. SINGLE-PHASE MOTORS: Class F temperature rise; Class H insulation.
  - A. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
  - B. Motors Used with Variable Frequency Controllers: Retain first paragraph below if Project includes separately connected motors, with controllers specified in Division 26.
  - C. Motors Used with Match-wiring controller requirements for controller with required motor leads: Provide terminals in motor terminal box, suited to control method.
  - D. See "Multispeed and Variable-Speed Considerations" Article in the Evaluations for discussion of motor types used with variable frequency controllers. Retain option in first paragraph below if Project includes separately connected motors, with controllers specified in Division 26.
  - 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)**

- 1.1 RELATED DOCUMENTS
  - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.2 SUMMARY
  - A. Section Includes:
    - 1. Motor controllers and supports.
    - 2. Trapeze pipe hangers.
    - 3. Thermal-hanger shield inserts.
    - 4. Fastener systems.
    - 5. Pipe stands.
    - 6. Equipment supports.
  - B. Related Sections:
    - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
    - 2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
    - 3. Division 23 Section "(e)" Metal Fabrications for duct hangers and supports.
- 1.3 DEFINITIONS
  - A. Retain definitions remaining after this Section has been edited.
  - B. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
  - 1.4 PERFORMANCE REQUIREMENTS
    - A. Retain first paragraph below if Contractor is required to assume responsibility for design.
    - B. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
    - C. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
      - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
      - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
    - C. Continuous threaded rod shall be used wherever possible. An engineered cable support system is acceptable. Chain, wire, or perforated straps shall not be permitted.
    - D. Concrete inserts into poured concrete floor systems are permitted.
    - E. Beam clamps, trapeze hangers, and clevis hangers shall be permitted.
    - F. Supports from roof decking systems are not permitted.
    - G. Concrete inserts into precast concrete plank are permitted.
    - H. Powder activated fasteners are not allowed.
- 1.5 ACTION SUBMITTALS
  - A. Product Data: For each type of product indicated.
  - B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
    - 1. Trapeze pipe hangers.
    - 2. Metal framing systems.
    - 3. Fiberglass strut systems.
    - 4. Pipe stands.
    - 5. Equipment supports.
- 1.6 QUALITY ASSURANCE
  - A. Retain both paragraphs below if shop or field welding is required. If retaining, also retain "Welding certificates" Paragraph in "Informational" Section.
  - A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code-Steel."
  - B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

**PART 2 - PRODUCTS**

- 2.1 METAL PIPE HANGERS AND SUPPORTS
  - A. Carbon-Steel Pipe Hangers and Supports
    - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
    - 2. Galvanized Metallic Coatings: Pregalvanized or hot dip.
    - 3. Nonmetallic Coatings: Epoxy resin. Plastic coatings are not permitted.
    - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
    - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
  - B. Trapeze Pipe Hangers
    - A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
    - B. Metal framing systems in this article require calculating and detailing at each use.
    - C. Framing systems in first paragraph below are made by MFMA members.
- 2.2 THERMAL-HANGER SHIELD INSERTS
  - A. Description: MSS SP-58, Type 50, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
  - B. Metal framing systems in this article require calculating and detailing at each use.
  - C. Framing systems in first paragraph below are made by MFMA members.
- 2.3 FASTENER SYSTEMS
  - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1. Buckaross, Inc.
    - 2. Carpenter and Paterson, Inc.
    - 3. National Pipe Hanger Corporation.
    - 4. Piping Technology & Products, Inc.
    - 5. Rico Manufacturing Co., Inc.
    - 6. Inclusion-Insert Material for Cold Piping: ASTM C 552, Type I cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
    - 7. Inclusion-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type I cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
    - D. For Clevis or Band Hangers: Insert and shield shall cover 180 degrees of pipe.
    - E. Insert Length: Extend 2 inches beyond metal shield for piping operating under ambient air temperature.
  - 2.4 FASTENER SYSTEMS
    - A. Verify suitability of fasteners in this article for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
    - B. Mechanical-Expansion Anchors: Insert wedge-type, steel anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
    - 2.5 PIPE STANDS
      - A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
        - 1. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
        - 2. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curbs.
      - B. Equipment Supports
        - A. Description: Welded-rod-and-plate equipment support made from structural carbon-steel shapes.

**PART 3 - EXECUTION**

- 1.1 PREPARATION
  - A. Retain first paragraph below if manufacturer's name and model number are indicated in schedules or plans on Drawings; delete option and insert manufacturer's name and model number if not included on Drawings.
    - 1. Buckaross, Inc.
    - 2. Carpenter and Paterson, Inc.
    - 3. National Pipe Hanger Corporation.
    - 4. Piping Technology & Products, Inc.
    - 5. Rico Manufacturing Co., Inc.
  - B. Inclusion-Insert Material for Cold Piping: ASTM C 552, Type I cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
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  - D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
  - E. For Clevis or Band Hangers: Insert and shield shall cover 180 degrees of pipe.
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      - A. Description: Welded-rod-and-plate equipment support made from structural carbon-steel shapes.

**PART 3 - EXECUTION (NOT APPLICABLE)**

- 1.1 RELATED DOCUMENTS
  - A. Retain first paragraph below for service factors exceeding NEMA standard for other than open-drip proof motors. If retaining, coordinate with Drawings and other Sections. See "Product Characteristics" Article in the Evaluations for discussion of service factor. A service factor of at least 1.15 is available for most motors, including explosion proof; however, there are exceptions.
  - B. Service Factor: 1.15.
  - C. See "Multispeed and Variable-Speed Considerations" Article in the Evaluations.
- 2. MULTISPEED MOTORS: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- 3. RANDOM-WOUND, OTHER TYPE
  - A. NEMA MG 1 recommends ball bearings for polyphase motors 500 hp and smaller due to their ability to sustain coupling end-play and rotor float. Some smaller integral and fractional polyphase motors might have sleeve bearings for lower cost and quieter operation, especially if direct coupled and not subjected to belt loads. For motor-bearing requirements for specific equipment, specify those requirements in motorized equipment Sections. Coordinate equipment suppliers for bearing types in smaller motors. Specify bearing-life requirements, according to ABMA 9, in motor-driven equipment Sections.
  - B. Bearings: Regreaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- 4. TEMPERATURE RATING: Class F temperature rise; Class H insulation.
  - A. Standard insulation class for general-purpose, open-drip proof motors, of nominal efficiency rating, is Class B; however, many energy- and premium-efficient motors, and those with service factors 1.15 or higher, are built with insulation meeting Class F requirements, especially if designed as "inverter ready" for use with variable frequency controllers. Retain option in first paragraph below unless a higher or lower insulation class is required as a default.
  - H. Insulation: Class F.
    - 1. Code Letter Designation: Starting codes in first subparagraph below are adequate for most variable-torque loads encountered in HVAC applications; 15 hp is a common breakpoint in rating among manufacturers when Code F and Code G apply. Retain both subparagraphs and options unless Project conditions or other Sections specify otherwise.
      - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
      - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- 5. SINGLE-PHASE MOTORS: Class F temperature rise; Class H insulation.
  - A. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
  - B. Motors Used with Variable Frequency Controllers: Retain first paragraph below if Project includes separately connected motors, with controllers specified in Division 26.
  - C. Motors Used with Match-wiring controller requirements for controller with required motor leads: Provide terminals in motor terminal box, suited to control method.
  - D. See "Multispeed and Variable-Speed Considerations" Article in the Evaluations for discussion of motor types used with variable frequency controllers. Retain option in first paragraph below if Project includes separately connected motors, with controllers specified in Division 26.
  - 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)**

- 1.1 RELATED DOCUMENTS
  - A. Retain first paragraph below for service factors exceeding NEMA standard for other than open-drip proof motors. If retaining, coordinate with Drawings and other Sections. See "Product Characteristics" Article in the Evaluations for discussion of service factor. A service factor of at least 1.15 is available for most motors, including explosion proof; however, there are exceptions.
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  - B. Bearings: Regreaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- 4. TEMPERATURE RATING: Class F temperature rise; Class H insulation.
  - A. Standard insulation class for general-purpose, open-drip proof motors, of nominal efficiency rating, is Class B; however, many energy- and premium-efficient motors, and those with service factors 1.15 or higher, are built with insulation meeting Class F requirements, especially if designed as "inverter ready" for use with variable frequency controllers. Retain option in first paragraph below unless a higher or lower insulation class is required as a default.
  - H. Insulation: Class F.
    - 1. Code Letter Designation: Starting codes in first subparagraph below are adequate for most variable-torque loads encountered in HVAC applications; 15 hp is a common breakpoint in rating among manufacturers when Code F and Code G apply. Retain both subparagraphs and options unless Project conditions or other Sections specify otherwise.
      - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
      - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- 5. SINGLE-PHASE MOTORS: Class F temperature rise; Class H insulation.
  - A. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
  - B. Motors Used with Variable Frequency Controllers: Retain first paragraph below if Project includes separately connected motors, with controllers specified in Division 26.
  - C. Motors Used with Match-wiring controller requirements for controller with required motor leads: Provide terminals in motor terminal box, suited to control method.
  - D. See "Multispeed and Variable-Speed Considerations" Article in the Evaluations for discussion of motor types used with variable frequency controllers. Retain option in first paragraph below if Project includes separately connected motors, with controllers specified in Division 26.
  - 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)**

- 1.1 RELATED DOCUMENTS
  - A. Retain first paragraph below for service factors exceeding NEMA standard for other than open-drip proof motors. If retaining, coordinate with Drawings and other Sections. See "Product Characteristics" Article in the Evaluations for discussion of service factor. A service factor of at least 1.15 is available for most motors, including explosion proof; however, there are exceptions.
  - B. Service Factor: 1.15.
  - C. See "Multispeed and Variable-Speed Considerations" Article in the Evaluations.
- 2. MULTISPEED MOTORS: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- 3. RANDOM-WOUND, OTHER TYPE
  - A. NEMA MG 1 recommends ball bearings for polyphase motors 500 hp and smaller due to their ability to sustain coupling end-play and rotor float. Some smaller integral and fractional polyphase motors might have sleeve bearings for lower cost and quieter operation, especially if direct coupled and not subjected to belt loads. For motor-bearing requirements for specific equipment, specify those requirements in motorized equipment Sections. Coordinate equipment suppliers for bearing types in smaller motors. Specify bearing-life requirements, according to ABMA 9, in motor-driven equipment Sections.
  - B. Bearings: Regreaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- 4. TEMPERATURE RATING: Class F temperature rise; Class H insulation.
  - A. Standard insulation class for general-purpose, open-drip proof motors, of nominal efficiency rating, is Class B; however, many energy- and premium-efficient motors, and those with service factors 1.15 or higher, are built with insulation meeting Class F requirements, especially if designed as "inverter ready" for use with variable frequency controllers. Retain option in first paragraph below unless a higher or lower insulation class is required as a default.
  - H. Insulation: Class F.
    - 1. Code Letter Designation: Starting codes in first subparagraph below are adequate for most variable-torque loads encountered in HVAC applications; 15 hp is a common breakpoint in rating among manufacturers when Code F and Code G apply. Retain both subparagraphs and options unless Project conditions or other Sections specify otherwise.
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  - C. Motors Used with Match-wiring controller requirements for controller with required motor leads: Provide terminals in motor terminal box, suited to control method.
  - D. See "Multispeed and Variable-Speed Considerations" Article in the Evaluations for discussion of motor types used with variable frequency controllers. Retain option in first paragraph below if Project includes separately connected motors, with controllers specified in Division 26.
  - 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.

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  - B. Bearings: Regreaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- 4. TEMPERATURE RATING: Class F temperature rise; Class H insulation.
  - A. Standard insulation class for general-purpose, open-drip proof motors, of nominal efficiency rating, is Class B; however, many energy- and premium-efficient motors, and those with service factors 1.15 or higher, are built with insulation meeting Class F requirements, especially if designed as "inverter ready" for use with variable frequency controllers. Retain option in first paragraph below unless a higher or lower insulation class is required as a default.
  - H. Insulation: Class F.
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- 5. SINGLE-PHASE MOTORS: Class F temperature rise; Class H insulation.
  - A. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
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- 3. RANDOM-WOUND, OTHER TYPE
  - A. NEMA MG 1 recommends ball bearings for polyphase motors 500 hp and smaller due to their ability to sustain coupling end-play and rotor float. Some smaller integral and fractional polyphase motors might have sleeve bearings for lower cost and quieter operation, especially if direct coupled and not subjected to belt loads. For motor-bearing requirements for specific equipment, specify those requirements in motorized equipment Sections. Coordinate equipment suppliers for bearing types in smaller motors. Specify bearing-life requirements, according to ABMA 9, in motor-driven equipment Sections.
  - B. Bearings: Regreaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.
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  - A. Standard insulation class for general-purpose, open-drip proof motors, of nominal efficiency rating, is Class B; however, many energy- and premium-efficient motors, and those with service factors 1.15 or higher, are built with insulation meeting Class F requirements, especially if designed as "inverter ready" for use with variable frequency controllers. Retain option in first paragraph below unless a higher or lower insulation class is required as a default.
  - H. Insulation: Class F.
    - 1. Code Letter Designation: Starting codes in first subparagraph below are adequate for most variable-torque loads encountered in HVAC applications; 15 hp is a common breakpoint in rating among manufacturers when Code F and Code G apply. Retain both subparagraphs and options unless Project conditions or other Sections specify otherwise.
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- 5. SINGLE-PHASE MOTORS: Class F temperature rise; Class H insulation.
  - A. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
  - B. Motors Used with Variable Frequency Controllers: Retain first paragraph below if Project includes separately connected motors, with controllers specified in Division 26.
  - C. Motors Used with Match-wiring controller requirements for controller with required motor leads: Provide terminals in motor terminal box, suited to control method.
  - D. See "Multispeed and Variable-Speed Considerations" Article in the Evaluations for discussion of motor types used with variable frequency controllers. Retain option in first paragraph below if Project includes separately connected motors, with controllers specified in Division 26.
  - 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)**

- 1.1 RELATED DOCUMENTS
  - A. Retain first paragraph below for service factors exceeding NEMA standard for other than open-drip proof motors. If retaining, coordinate with Drawings and other Sections. See "Product Characteristics" Article in the Evaluations for discussion of service factor. A service factor of at least 1.15 is available for most motors, including explosion proof; however, there are exceptions.
  - B. Service Factor: 1.15.
  - C. See "Multispeed and Variable-Speed Considerations" Article in the Evaluations.
- 2. MULTISPEED MOTORS: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1

**SECTION 230993 - TESTING, ADJUSTING, AND BALANCING FOR HVAC**

- PART 1 - GENERAL**
- 1.1 RELATED DOCUMENTS**
  - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.2 SUMMARY**
  - A. Section Includes:**
    - Balancing Air Systems:
      - Constant-volume air systems.
      - Balancing Hydronic Piping Systems:
        - Constant-flow hydronic systems.
- 1.3 DEFINITIONS**
  - A. AABC: Associated Air Balance Council.
  - B. NEBB: National Environmental Balancing Bureau.
  - C. TAB: Testing, adjusting, and balancing.
  - D. TABB: Testing, Adjusting, and Balancing Bureau.
  - E. TAB Specialist: An entity engaged to perform TAB Work.
- 1.4 INFORMATION SUBMITTALS**
  - A. Qualification Data: Submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
  - B. Contract Documentation Report: Submit the Contract Documents review report as specified in Part 3.
  - C. Strategies and Procedures Plan: Submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
  - D. Certified TAB reports.
  - E. Sample report forms.
  - F. Instrumentation reports, to include the following:
    - Instrument type and make.
    - Serial number.
    - Application.
    - Dates of use.
    - Dates of calibration.
- 1.5 QUALITY ASSURANCE**
  - A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB:
    - TAB Field Supervisor: Must be certified by AABC or NEBB.
    - TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.
  - B. TAB Conference: Meet with Engineer, Construction Manager, and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

- Coordinate requirements in subparagraphs below with Section 013100 "Project Management and Coordination."**
  - The Contract Documents examination report.
  - The TAB plan.
  - Coordination and cooperation of trades and subcontractors.
  - Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:**
  - Review data reports to validate accuracy of data and to prepare certified TAB reports.
  - Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms:** Use standard TAB contractor's forms approved by Engineer.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration:** As described in ASHRAE 111, Section 5, "Instrumentation." Retain "ASHRAE Compliance" Paragraph below for LEED Prerequisite IEQ 1, which requires compliance with ASHRAE 62.1.
- F. ASHRAE Compliance:** Retain "Air Balancing" Paragraph below for LEED Prerequisite EA 2, which requires compliance with ASHRAE/IESNA 90.1.
- G. ASHRAE/IESNA Compliance:** Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

**1.6 COORDINATION**

- A. Notice:** Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.**
- PART 2 - PRODUCTS (Not Applicable)**
- PART 3 - EXECUTION**
- 3.1 EXAMINATION**
  - See** Editing Instruction No. 2 in the Evaluations for discussion of the Contract Documents review.
  - Examine the Contract Documents familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
  - Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
  - Examine the approved submittals for HVAC systems and equipment.
  - See** "Design Data" Article in the Evaluations.
  - Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
  - Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 2331.13 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
  - Examine equipment performance data including fan and pump curves:
    - Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
    - Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment. To calculate system effects for air systems, use tables and charts in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
  - Examine system and equipment installations and verify that field quality-control testing, clearing, and adjusting specified in individual Sections have been performed.
  - Examine test reports specified in individual system and equipment Sections.
  - Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
  - Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
  - Examine strainers. Verify that strainer screens are replaced by permanent screens with indicated perforations.
  - Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
  - Examine heat-transfer coils for correct piping connections and for clean and straight fins.
  - Examine system pumps to ensure absence of entrained air in the suction piping.
  - Examine operating safety interlocks and controls on HVAC equipment.
  - Identify deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

- 3.2 PREPARATION**
  - Prepare a TAB plan that includes strategies and step-by-step procedures.
  - Complete system-readiness checks and prepare reports. Verify the following:
    - Permanent electrical-power wiring is complete.
    - Hydronic systems are filled, clean, and free of air.
    - Automatic temperature-control systems are operational.
    - Equipment and duct access doors are securely closed.
    - Balance, smoke, and fire dampers are open.
    - Isolating and balancing valves are open and control valves are operational.
    - Ceilings are installed in critical areas where air-patten adjustments are required and access to balancing devices is provided.
    - Windows and doors can be closed to isolated conditions for system operation.
- 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING**
  - A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
  - LEED Prerequisite IEQ 1 requires compliance with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing." ASHRAE 62.1 requires that ventilation systems be balanced according to ASHRAE 111 or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing," or equivalent at least to extent necessary to verify compliance with the standard.
  - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

- B. Calibration:** Ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures. Retain one of first two subparagraphs below.
  - After testing and balancing, patch test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
  - After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories." Do not install joint new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and HVAC piping according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "Finch Insulation."
  - Remove equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
  - Take and report testing and balancing measurements in inch-pounds (IP) units.
- 3.6 TESTING, ADJUSTING, AND BALANCING**
  - A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
    - Fans and ventilators.
    - Unit ventilators.

- 3.7 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS**
  - A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
  - B. Prepare schematic diagrams of systems' "as-built" duct layouts:
    - For variable-air-volume systems, develop a plan to simulate diversity.
    - Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
    - Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
    - Locate start-stop and disconnect switches, electrical interlocks, and the motor starters.
    - Verify that motor starters are equipped with properly sized thermal protection.
    - Check dampers for proper position to achieve desired airflow path.
    - Check for airflow blockages.
    - Check condensate drains for proper connections and functioning.
    - Check for proper sealing of air-handling-unit components.
    - Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

- 3.8 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS**
  - A. Adjust fans to deliver total indicated airflow within the maximum allowable fan speed listed by fan manufacturer.
    - Measure total airflow:
      - Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total air flow.
      - Measure fan static pressure: Measure fan static pressure at a point downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      - Measure static pressure directly at the fan outlet or through the flexible connection.
        - Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
      - Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
    - Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      - Report the cleanliness status of filters and the time static pressures are measured.
    - Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
    - Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Make adjustments, as needed, to accommodate actual conditions.

- See** Evaluations for discussion of fan-speed adjustments.
  - Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Maintain maximum fan motor amperage to ensure that no overload will occur. Measure fan motor amperage in full-loading, full-heating, economizer, and any other operating mode to determine the maximum airflow brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflow within specified tolerances.**
  - Measure airflow of submain and branch ducts:
    - Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  - Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
    - Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
  - Measure air outlets and inlets without making adjustments.
    - Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
    - Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
      - Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations specified by the Contract Documents.
    - Adjust patterns of adjustable outlets for proper distribution without drafts.

**3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS**

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch circuit flows against total flow. Correct variations that exceed plus or minus 5 percent.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
  - Open all manual valves for maximum flow.
  - Check liquid level in expansion tank.
  - Check makeup water-station pressure gage for adequate pressure for highest vent.
  - Check flow-control valves for specified sequence of operation, and set as indicated flow.
  - Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
  - Set system controls so automatic valves are wide open to heat exchangers.
  - Check air vents for a forceful liquid flow exiting from when manually operated.

- 3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS**
  - A. Measure water flow rate. Use the following procedures except for positive-displacement pumps:
    - Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      - If impeller sizes must be adjusted to achieve pump performance, obtain approval from Engineer and comply with requirements in Section 232123 "Hydronic Pumps."
    - Check system resistance. With all valves wide open, measure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
      - Monitor motor performance during procedures and do not operate motors in overload conditions.
    - Verify pump-brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
      - Report flow rates that are not within plus or minus 10 percent of design.
    - Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are operating as designed.
    - Set calibrated balancing valves, if installed, at calculated presettings.
    - Measure flow at all stations and adjust, where necessary, to obtain final balance.

**3.9 ADJUSTING AND BALANCING**

- A. Measure flow rates that are not within plus or minus 10 percent of design.
  - Determine the balancing station with the highest percentage over indicated flow.
  - Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
  - Record settings and mark balancing devices.
  - Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
  - Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
  - Check settings and operation of each safety valve. Record settings.
- PROCEDURES FOR MOTORS**
  - A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
    - Manufacturer's name, model number, and serial number.
    - Motor horsepower rating.
    - Motor rpm
    - Efficiency rating.
    - Nameplate and measured voltage, each phase.
    - Nameplate and measured amperage, each phase.
    - Starter thermal-protection-element rating.
  - B. Motors Driven by Variable-Frequency Drives: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.
- TOLERANCES**
  - A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
    - Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
    - Air Outlets and Inlets: Plus or minus 5 percent.
    - Hydronic Flow Rate: Plus or minus 5 percent.
- 3.11 FINAL REPORT**
  - A. Prepare a certified written report, tabulate and divide the report into separate sections for tested systems and balanced systems.
    - Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer, with contact information for AABC or NEBB standard forms.
    - Include a list of instruments used for procedures, along with proof of calibration.
  - B. Final Report Contents: In addition to certified field-report data, include the following:
    - Pump curves.
    - Fan curves.
    - Manufacturers' test data.
    - Field test reports prepared by system and equipment installers.
    - Other information relative to equipment performance; do not include Shop Drawings and product data.
  - C. General Report Data: In addition to form titles and entries, include the following data:
    - Tab page.
    - Name and address of the TAB contractor.
    - Project name.
    - Project location.
    - Armstrong - Armco, Inc. Division SA for exterior applications.
    - Armco - AP Amfast/FX for interior applications.
    - Clad WT, USA, Clad WT Sheer of AL Sheet.
    - Elastomeric Co.
    - Thermal Conductivity: 75 deg F mean temperature, 0.25 per ASTM C 177
    - Water Vapor Permeability: 0.05 per ASTM E 96, Procedure A
    - Water Absorption, % by Volume: 0.2% or less per ASTM C 209.
    - Product shall be tested for mold, fungi and bacterial resistance, passing value, per UL181, ASTM G21 and ASTM G22.
    - Weatherability: Excellent per ASTM D4047.
    - Durability: Excellent per ASTM D1036.
    - Use range of 180 deg F to -297 deg F per ASMET C534.
  - 3. Factory applied jacket for exterior applications; Embossed laminate surface, where required, requiring no painting, puncture resistant, UV resistant, minimum 12 mil thick.
    - a. Color: White or aluminum.

- 2.2 ADHESIVES**
  - A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
      - Eagle Bridges - Marathon Industries; 225.
      - Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-6085-70.
      - Mon-Eco Industries, Inc.; 22-25.
  - B. Elastomeric Co.
    - a. Thermal Conductivity: 75 deg F mean temperature, 0.25 per ASTM C 177
    - b. Water Vapor Permeability: 0.05 per ASTM E 96, Procedure A
    - c. Water Absorption, % by Volume: 0.2% or less per ASTM C 209.
    - d. Product shall be tested for mold, fungi and bacterial resistance, passing value, per UL181, ASTM G21 and ASTM G22.
    - e. Weatherability: Excellent per ASTM D4047.
    - f. Durability: Excellent per ASTM D1036.
    - g. Use range of 180 deg F to -297 deg F per ASMET C534.
- 2.3 ADHESIVES**
  - A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
      - Eagle Bridges - Marathon Industries; 225.
      - Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-6085-70.
      - Mon-Eco Industries, Inc.; 22-25.
  - B. Elastomeric Co.
    - a. Thermal Conductivity: 75 deg F mean temperature, 0.25 per ASTM C 177
    - b. Water Vapor Permeability: 0.05 per ASTM E 96, Procedure A
    - c. Water Absorption, % by Volume: 0.2% or less per ASTM C 209.
    - d. Product shall be tested for mold, fungi and bacterial resistance, passing value, per UL181, ASTM G21 and ASTM G22.
    - e. Weatherability: Excellent per ASTM D4047.
    - f. Durability: Excellent per ASTM D1036.
    - g. Use range of 180 deg F to -297 deg F per ASMET C534.

- 2.4 SEALANTS**
  - A. FSK and Metal Jacket Flashing Sealants:
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      - Eagle Bridges - Marathon Industries; 405.
      - Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
      - Mon-Eco Industries, Inc.; 22-02.
  - B. Materials shall be compatible with insulation materials, jackets, and substrates.
    - Fire- and water-resistant, flexible, elastomeric sealant.
    - Service Temperature Range: Minus 40 to plus 260 deg F.
    - Color: White.
- 2.5 FIELD-APPLIED OUTDOOR JACKETS**
  - A. Jacketing:
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - Alumaguard; All-Weather.
      - 3M VentureClad; 1529CW.
      - FlexClad; FlexClad 400.
      - Victory Clad; VC 600 Plus Series.
  - B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-8030-90.
      - Venoco Corporation, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-8030-90.
  - C. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - D. Service Temperature Range: Minus 20 to plus 180 deg F.
  - E. Solids Content: ASTM D 1644, 56 percent by volume and 70 percent by weight.
  - F. Color: White.

- 2.6 TAPES**
  - A. FSK and PSK Tapes: Foli-face for FSK, white face for PSK, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - ASB Tape Division; 491 AW FSK.
      - Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      - Compac Corporation; 110 and 111.
      - Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  - B. Width: 3 inches.
  - C. Thickness: 6.5 mils.
  - D. Adhesion: 90 ounces force/inch in width.
  - E. Elongation: 2 percent.
  - F. Tensile Strength: 40 lb/inch in width.
  - G. FSK Tape Disks and Squares: Proud disks or squares of FSK tape.
- 2.7 SECUREMENTS**
  - A. Aluminum Bands: ASTM B 209, Alloy 3003, 3015, or 5005; Temp-H 14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - ITW Insulation Systems; Gerrard Strapping and Seals.
      - RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
  - B. Insulation Pins and Hangers:
    - Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position including when self-locking washer is in place. Comply with the following requirements:
      - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
        - AGM Industries, Inc.; Tactco Perforated Base Insul-Hangers.
        - GEMCO; R-150.
        - Midwest Fasteners, Inc.; SpinDle.
    - Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick with 2 inches square.
    - Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.100-inch-diameter shank, length to suit depth of insulation indicated.
  - C. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

- 3.12 INSPECTIONS**
  - A. Final Inspection:
    - Initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Authority.
    - The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.
    - Commissioning Authority, documentation, documents, and equipment required for the inspection shall be provided in the final report. Retesting shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
    - Retests: Retests yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
    - If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing is considered incomplete and shall be rejected.
  - B. TAB Work will be considered defective if it does not pass final inspection. If TAB Work fails, proceed as follows:
    - Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes, resubmit the final report, and request a second final inspection.
    - If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- C. END OF SECTION 230993**

**SECTION 230713 - DUCT INSULATION**

- PART 1 - GENERAL**
- 1.1 SUMMARY**
  - A. Section includes insulation and jacketing for the following duct services:
    - Exhaust and outdoor air duct.
    - Related Sections:
      - Division 23 Section "HVAC Equipment Insulation."
      - Division 23 Section "HVAC Piping Insulation."
      - Division 23 Section "Metal Ducts" for duct liners.
- 1.2 ACTION SUBMITTALS**
  - A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
  - B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
    - Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
    - Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
    - Detail application at knock-outs of control devices.
- 1.3 INFORMATIONAL SUBMITTALS**
  - A. Qualification Data: For qualified installer.
- 1.4 QUALITY ASSURANCE**
  - A. All duct insulation and jacketing systems shall comply with SMACNA Standards.
  - B. All duct insulation systems shall comply with Midwest Insulation Contractors Association (MICA), National Commercial and Industrial Insulation Standards, 7th Edition.
  - C. All duct insulation shall comply with the requirements of ASHRAE Standard 90.1.
  - D. Work shall be performed at the temperatures and humidity recommended by the product manufacturers.
  - E. 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.
    - Insulation Installed Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
    - Insulation Installed Indoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
  - F. Installer Qualification: Only installers who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- 1.5 COORDINATION**
  - A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
  - B. Coordinate clearance requirements with duct installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- 1.6 SCHEDULING**
  - A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- 1.7 DELIVERY AND STORAGE OF MATERIALS**
  - A. Delivery: Deliver materials in manufacturer's original packaging.
  - B. Storage: Store and protect products in accordance with the manufacturer's instructions. Store in a dry indoor location. Protect insulation materials from moisture and soiling.
  - C. Do not install insulation that has been damaged or wet. Remove it from the jobsite.

- PART 2 - PRODUCTS**
- 2.1 INSULATION MATERIALS**
  - A. Comply with the requirements listed in "Detail Installation Schedule" in this specification.
  - B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
  - C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM E 971.
  - D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
  - E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type III, to maximum service temperature of 220 deg F.
  - F. Fiberglass Insulation: Closed-cell, expanded-rubber materials. Comply with ASTM C 534, Type I for sheet materials. Insulation shall be provided with or without pressure sensitive adhesive in sheet or roll form.
- 2.2 PRODUCTS**
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include:
    - Certain Teed Corp.; SoftTouch Duct Wrap.
    - Johns Manville; Microflex PSK or Microflex PSK.
    - Knauf Insulation; Atmosphere Duct Wrap.
    - Owens Corning; SoRr Duct Wrap FRK or White PSK.
  - 2. The duct wrap insulation shall consist of a blanket of glass or mineral fibers factory-laminated to a foil reinforced (FRK) or white poly scrim kraft (PSK) vapor-retarder facing with a 2 inch (min) stapling edge and taping flange on one edge.
    - Insulating ability:
      - 0.75 lb/cu ft, 1.5-inch-thick insulation shall have a minimum unit-of-packing R value of R-5.1.
    - Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB.
- 2.3 PRODUCTS**
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - Certain Teed Corp.; Commercial Board.
    - Johns Manville; 800 Series Spinal.
    - Knauf Insulation; Fiberglas 70 Series.
    - Owens Corning; Insulation 100 Series.
  - 2. Flexible Elastomeric Adhesive: Closed-cell, expanded-rubber materials. Comply with ASTM C 534, Type I for sheet materials. Insulation shall be provided with or without pressure sensitive adhesive in sheet or roll form.
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - Armco - Armco Insulation SA for exterior applications only.
      - Armco - AP Amfast/FX for interior applications.
      - Clad WT, USA, Clad WT Sheer of AL Sheet.
      - Elastomeric Co.
      - Thermal Conductivity: 75 deg F mean temperature, 0.25 per ASTM C 177
      - Water Vapor Permeability: 0.05 per ASTM E 96, Procedure A
      - Water Absorption, % by Volume: 0.2% or less per ASTM C 209.
      - Product shall be tested for mold, fungi and bacterial resistance, passing value, per UL181, ASTM G21 and ASTM G22.
      - Weatherability: Excellent per ASTM D4047.
      - Durability: Excellent per ASTM D1036.
      - Use range of 180 deg F to -297 deg F per ASMET C534.
- 2.4 PRODUCTS**
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - Eagle Bridges - Marathon Industries; 225.
    - Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-6085-70.
    - Mon-Eco Industries, Inc.; 22-25.
  - 2. Elastomeric Co.
    - a. Thermal Conductivity: 75 deg F mean temperature, 0.25 per ASTM C 177
    - b. Water Vapor Permeability: 0.05 per ASTM E 96, Procedure A
    - c. Water Absorption, % by Volume: 0.2% or less per ASTM C 209.
    - d. Product shall be tested for mold, fungi and bacterial resistance, passing value, per UL181, ASTM G21 and ASTM G22.
    - e. Weatherability: Excellent per ASTM D4047.
    - f. Durability: Excellent per ASTM D1036.
    - g. Use range of 180 deg F to -297 deg F per ASMET C534.

- 2.5 PRODUCTS**
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - Certain Teed Corp.; Commercial Board.
    - Johns Manville; 800 Series Spinal.
    - Knauf Insulation; Fiberglas 70 Series.
    - Owens Corning; Insulation 100 Series.
  - 2. Flexible Elastomeric Adhesive: Closed-cell, expanded-rubber materials. Comply with ASTM C 534, Type I for sheet materials. Insulation shall be provided with or without pressure sensitive adhesive in sheet or roll form.
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - Armco - Armco Insulation SA for exterior applications only.
      - Armco - AP Amfast/FX for interior applications.
      - Clad WT, USA, Clad WT Sheer of AL Sheet.
      - Elastomeric Co.
      - Thermal Conductivity: 75 deg F mean temperature, 0.25 per ASTM C 177
      - Water Vapor Permeability: 0.05 per ASTM E 96, Procedure A
      - Water Absorption, % by Volume: 0.2% or less per ASTM C 209.
      - Product shall be tested for mold, fungi and bacterial resistance, passing value, per UL181, ASTM G21 and ASTM G22.
      - Weatherability: Excellent per ASTM D4047.
      - Durability: Excellent per ASTM D1036.
      - Use range of 180 deg F to -297 deg F per ASMET C534.
- 2.6 PRODUCTS**
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - Eagle Bridges - Marathon Industries; 225.
    - Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-6085-70.
    - Mon-Eco Industries, Inc.; 22-25.
  - 2. Elastomeric Co.
    - a. Thermal Conductivity: 75 deg F mean temperature, 0.25 per ASTM C 177
    - b. Water Vapor Permeability: 0.05 per ASTM E 96, Procedure A
    - c. Water Absorption, % by Volume: 0.2% or less per ASTM C 209.
    - d. Product shall be tested for mold, fungi and bacterial resistance, passing value, per UL181, ASTM G21 and ASTM G22.
    - e. Weatherability: Excellent per ASTM D4047.
    - f. Durability: Excellent per ASTM D1036.
    - g. Use range of 180 deg F to -297 deg F per ASMET C534.

- 2.7 PRODUCTS**
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - Certain Teed Corp.; Commercial Board.
    - Johns Manville; 800 Series Spinal.
    - Knauf Insulation; Fiberglas 70 Series.
    - Owens Corning; Insulation 100 Series.
  - 2. Flexible Elastomeric Adhesive: Closed-cell, expanded-rubber materials. Comply with ASTM C 534, Type I for sheet materials. Insulation shall be provided with or without pressure sensitive adhesive in sheet or roll form.
    - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - Armco - Armco Insulation SA for exterior applications only.
      - Armco - AP Amfast/FX for interior applications.
      - Clad WT, USA, Clad WT Sheer of AL Sheet.
      - Elastomeric Co.
      - Thermal Conductivity: 75 deg F mean temperature, 0.25 per ASTM C 177
      - Water Vapor Permeability: 0.05 per ASTM E 96, Procedure A
      - Water Absorption, % by Volume: 0.2% or less per ASTM C 209.
      - Product shall be tested for mold, fungi and bacterial resistance, passing value, per UL181, ASTM G21 and ASTM G22.
      - Weatherability: Excellent per ASTM D4047.
      - Durability: Excellent per ASTM D1036.
      - Use range of 180 deg F to -297 deg F per ASMET C534.
- 2.8 PRODUCTS**
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - Eagle Bridges - Marathon Industries; 225.
    - Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-6085-70.
    - Mon-Eco Industries, Inc.; 22-25.
  - 2. Elastomeric Co.
    - a. Thermal Conductivity: 75 deg F mean temperature, 0.25 per ASTM C 177
    - b. Water Vapor Permeability: 0.05 per ASTM E 96, Procedure A
    - c. Water Absorption, % by Volume: 0.2% or less per ASTM C 209.
    - d. Product shall be tested for mold, fungi and bacterial resistance, passing value, per UL181, ASTM G21 and ASTM G22.
    - e. Weatherability: Excellent per ASTM D4047.
    - f. Durability: Excellent per ASTM D1036.
    - g. Use range of 180 deg F to -297 deg F per ASMET C534.

- 2.9 PRODUCTS**
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - Eagle Bridges - Marathon Industries; 225.
    - Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-6085-70.
    - Mon-Eco Industries, Inc.; 22-25.

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1.1 RELATED DOCUMENTS Retain or delete this article in all Sections of Project Manual. A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 ACTION SUBMITTALS A. Product Data: For each type of product indicated, include thermal conductivity, vapor permeance thickness, and jackets (both factory and field applied if any).

1.3 ACTION SUBMITTALS A. Product Data: For each type of product indicated, include thermal conductivity, vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 INFORMATIONAL SUBMITTALS Coordinate first paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as supplemented in "Quality Assurance" Article.

1.5 QUALITY ASSURANCE Retain first paragraph below if available at Project location. Apprenticeship programs are usually associated with union shops. Other craft training programs are available.

1.6 DELIVERY, STORAGE, AND HANDLING Retain this article to require shipping container markings. Container marking is an option in ASTM standards; default condition does not include the marking in this article unless specified in the Contract.

1.7 COORDINATION A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment".

1.8 SCHEDULING A. Schedule installation and concealment of plastic materials as rapidly as possible in each area of construction.

2. PRODUCTS 2.1 INSULATION MATERIALS If retaining more than one type of insulation in this article, indicate where each type applies in insulation system schedules.

2.2 INSULATING CEMENTS Mineral-fiber insulating cement is suitable for temperatures from 100 to 1600 deg F (38 to 871 deg C). Vermiculite insulating cement is suitable for temperatures from 100 to 1800 deg F (38 to 982 deg C).

2.3 ADHESIVES A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

2.4 TAPE A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

2.5 ADHESIVES A. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.6 ADHESIVES A. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.7 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.8 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.9 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.10 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.11 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.12 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.13 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.14 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.15 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.16 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.17 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.18 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.19 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.20 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.21 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.22 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.23 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

F. PVC Jacket Adhesive: Compatible with PVC jacket. 1. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

2.4 MASTICS Retain or delete this article in all Sections of Project Manual. A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2.5 ADHESIVES A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

2.6 ADHESIVES A. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.7 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.8 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.9 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.10 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.11 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.12 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.13 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.14 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.15 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.16 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.17 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.18 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.19 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.20 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.21 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.22 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.23 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.24 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

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2.26 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.27 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.28 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.29 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.30 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.31 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.32 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.33 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.34 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

SECTION 232113 - HYDRONIC PIPING PART 1 - GENERAL 1.1 RELATED DOCUMENTS A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY A. Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following: 1. Hot-water heating piping.

1.3 ACTION SUBMITTALS A. Product Data: For each type of the following: 1. Plastic pipe and fittings with solvent cement.

1.4 ACTION SUBMITTALS A. Product Data: For each type of the following: 1. Plastic pipe and fittings with solvent cement.

1.5 QUALITY ASSURANCE A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.6 DEFINITIONS Retain abbreviations that remain after this Section has been edited.

2. PRODUCTS See "Writing Guide" in the Evaluations. 2.1 COPPER TUBE AND FITTINGS A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

2.2 COPPER TUBE AND FITTINGS A. Drawn-Temper Copper Tubing: ASTM B 88, Type L. Type K (A) soft temper in paragraph below is applicable for belowground installations.

2.3 JOINING MATERIALS A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

2.4 GROOVED MECHANICAL-JOINT FITTINGS, COUPLINGS, AND SPECIALTIES A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2.5 JOINING MATERIALS A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

2.6 GROOVED MECHANICAL-JOINT FITTINGS, COUPLINGS, AND SPECIALTIES A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2.7 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.8 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.9 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.10 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.11 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.12 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.13 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.14 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

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2.24 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.25 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.26 FIELD QUALITY CONTROL A. Prepare hydronic piping according to ASME B31.9 and as follows:

2.7 AIR CONTROL DEVICES See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. Retain one of two paragraphs and list of manufacturers below. See Division 01 Specification Sections for requirements.

2.8 AIR CONTROL DEVICES See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. Retain one of two paragraphs and list of manufacturers below. See Division 01 Specification Sections for requirements.

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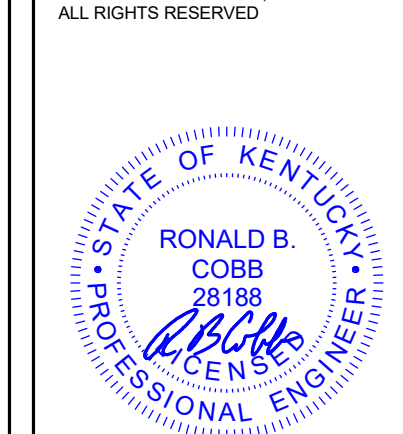
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ESHP 2925 FOREBROOK AVENUE SUITE 400 BELLEVILLE, KY 40303-2824

NOTRE DAME ACADEMY CLASSROOM RENOVATION 1699 Hilton Dr., Park Hills, KY 41011

ISSUANCES table with columns for date and permit set number.

HVAC SPECIFICATIONS

COMM NO. 2025048.01

M602

REFERENCE LINE

SECTION 233113 - METAL DUCTS

- PART 1 - GENERAL
1.1 RELATED DOCUMENTS
1.2 SUMMARY
A. Section Includes
1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

- 1.4 ACTION SUBMITTALS
A. Product Data: For each type of the following products:
1. Liners and adhesives.
2. Sealants and gaskets.
3. Welding certificates.
3. Field quality-control reports.
1.6 QUALITY ASSURANCE
A. Welding Qualifications: Quality procedures and personnel according to the following:
1. AWS D1.1D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D15.1MDS.1, "Sheet Metal Welding Code," for duct joint and seam welding.

- PART 2 - PRODUCTS
2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

- 2.3 SHEET METAL MATERIALS
A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.
2.4 SEALANT AND GASKETS
A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723, certified by an NRTL.

- 2.5 HANGERS AND SUPPORTS
A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

- PART 3 - EXECUTION
3.1 DUCT INSTALLATION
Coordinate duct layout and duct accessory arrangement with Drawings.
A. Drawing Plans, Schematics, and Diagrams: Indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations.
3.2 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.

- 3.3 HANGER AND SUPPORT INSTALLATION
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

SECTION 233300 - AIR DUCT ACCESSORIES

- PART 1 - GENERAL
1.1 RELATED DOCUMENTS
1.2 SUMMARY
A. Section Includes:
1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Flexible connection.
4. Duct accessory hardware.
1.3 ACTION SUBMITTALS
A. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

- 2.2 MATERIALS
A. 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.
B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14, with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
C. Maximum Air Velocity: 2000 fpm.

- 2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Air Balance Inc., a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nalor Industries Inc.
4. Ruskin Company.

- 2.4 MANUAL VOLUME DAMPERS
A. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
a. Ruskin Company.
b. Gernco.
c. Greenheck.
d. Nalor.
e. Potluff.

- 2.5 FLEXIBLE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Ductmate Industries, Inc.
2. Duro Dyno, Inc.
3. Egan Manufacturing.
4. Ventifabrics, Inc.
5. Ward Industries, Inc., a division of Hart & Cooley, Inc.

- 2.6 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.

- 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.
C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
D. Control dampers serving exhaust, outside, or relief air systems exposed to the outdoors shall be insulated.
E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

- 3.2 FIELD QUALITY CONTROL
A. Tests and Inspections:
1. Operate dampers to verify full range of movement.

SECTION 233423 - HVAC POWER VENTILATORS

- PART 1 - GENERAL
1.1 SUMMARY
A. Section Includes:
1. In-line centrifugal fans.
1.2 SUBMITTALS
A. Product Data: For each type of product indicated:
1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Fan speed controllers.

- 2.2 MATERIALS
A. 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.
B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14, with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
C. Maximum Air Velocity: 2000 fpm.

- 2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Air Balance Inc., a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nalor Industries Inc.
4. Ruskin Company.

- 2.4 MANUAL VOLUME DAMPERS
A. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
a. Ruskin Company.
b. Gernco.
c. Greenheck.
d. Nalor.
e. Potluff.

- 2.5 FLEXIBLE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Ductmate Industries, Inc.
2. Duro Dyno, Inc.
3. Egan Manufacturing.
4. Ventifabrics, Inc.
5. Ward Industries, Inc., a division of Hart & Cooley, Inc.

- 2.6 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.

- 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.
C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
D. Control dampers serving exhaust, outside, or relief air systems exposed to the outdoors shall be insulated.
E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

- 3.2 FIELD QUALITY CONTROL
A. Tests and Inspections:
1. Operate dampers to verify full range of movement.

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

- PART 1 - GENERAL
1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
1.2 SUMMARY
A. Section Includes:
1. Registers and grilles.
B. Related Sections:
1. Section 08000 "Louvers and Vents" for adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Section 23300 "Air Duct Accessories" for fire dampers and volume-control dampers not integral to diffusers, registers, and grilles.

- 2.2 MATERIALS
A. 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.
B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14, with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
C. Maximum Air Velocity: 2000 fpm.

- 2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Air Balance Inc., a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nalor Industries Inc.
4. Ruskin Company.

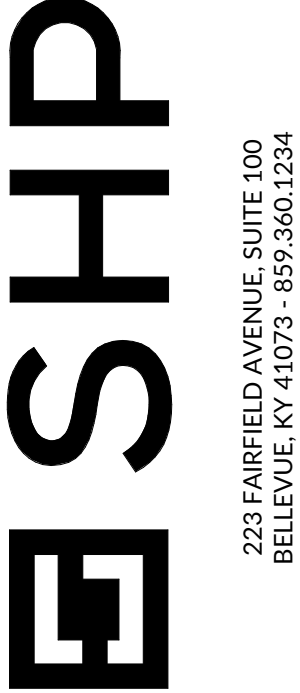
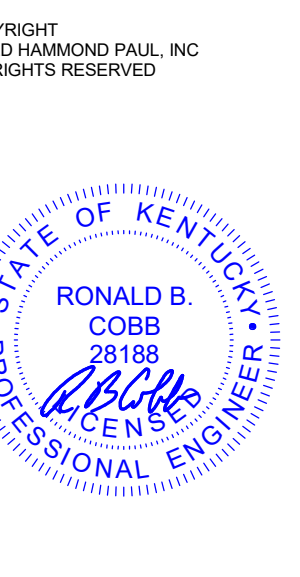
- 2.4 MANUAL VOLUME DAMPERS
A. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
a. Ruskin Company.
b. Gernco.
c. Greenheck.
d. Nalor.
e. Potluff.

- 2.5 FLEXIBLE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Ductmate Industries, Inc.
2. Duro Dyno, Inc.
3. Egan Manufacturing.
4. Ventifabrics, Inc.
5. Ward Industries, Inc., a division of Hart & Cooley, Inc.

- 2.6 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.

- 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.
C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
D. Control dampers serving exhaust, outside, or relief air systems exposed to the outdoors shall be insulated.
E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

- 3.2 FIELD QUALITY CONTROL
A. Tests and Inspections:
1. Operate dampers to verify full range of movement.



NOTRE DAME ACADEMY CLASSROOM RENOVATION
1699 Hilton Dr., Park Hills, KY 41011

Table with 2 columns: Date, Description. Includes entry for 05-09-25 PERMIT SET.

Table with 2 columns: Date, Description. Includes entry for 05-09-25 PERMIT SET.

HVAC SPECIFICATIONS
M603

SECTION 238223 - UNIT VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes unit ventilators and accessories with the following heating and cooling features:

- 1. Hydronic heating/cooling coil.

B. This Section includes special quality control requirements.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration, including unit ventilator, metal casework, sheet-metal chases, pipe enclosures, custom relief enclosure, and relief air shutter assembly/components.
1. Include metal thickness (or gauge) for all sheet metal components including housings, cabinets, metal casework, pipe covers, and other sheet metal work, if not included in manufacturer's literature include as part of shop drawings.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. NOTE: shop drawings will not be reviewed until manufacturer qualifications data is received; see "Qualifications Data" paragraphs below.
1. Plans, elevations, sections, and details.
2. Details of anchorages and attachments to structure and to supported equipment.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Include specific shop drawings of metal casework, pipe covers, metal chases, and relief enclosure showing dimensioned plans and sections of each:
a. Show relationship to adjacent work.
b. Furnish large-scale details (1-1/2-inch equals a foot minimum size) of assembly joints, of connections to adjacent components and assemblies, and of attachment to walls, floors and other in-place construction.
c. Indicate locations of hardware, grilles, louvers, catches and keepers, locks (if any).
d. Indicate locations of blocking and reinforcements required for installing items.
e. Include details of utility spaces showing supports for piping.
f. Indicate locations of and clearances from adjacent walls, windows, other building components, and other equipment.
E. Field quality-control test reports.
D. Operation and maintenance data. Data submitted shall include filter size, thickness, and MERV rating.
E. Pressure test reports: Manufacturer shall provide pressure test reports for hydronic coils and piping package pressure tests.
F. Qualification Data: NOTE - qualifications data must be submitted concurrent with or in advance of shop drawing submittals; shop drawings will not be reviewed until qualifications data is received.
1. For qualified manufacturer.
a. Include separate qualifications data for metal casework manufacturer if such items are to be produced by a secondary provider under sub-contract.
2. For qualified installer, according to provisions in Quality Assurance article.
G. Samples for Finish Selection: For each type of metal with factory-applied color finishes.
1. Provide actual panel-material samples of all colors available, approximately 2- by 3-inches minimum size, free of burrs and rough edges. Color representations of color are not acceptable.
2. Include similar samples of trim and accessories involving color selection if selection range differs from panel selections.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: One of the manufacturers specified in Part 2 who is responsible for the entire production and assembly of the products and Work of this Section.
B. Fabricator Qualifications: Fabricator of metal casework and other custom components, enclosures and the like shall have a minimum 10 years continuous successful experience in producing metal casework and the other required components similar in type and extent to those indicated for this Project; and must have furnished such assemblies for at least 5 projects in the last 10 years with a record of successful in-service performance. Include 3 references and contact numbers to verify.
C. Installer Qualifications: Installer shall be a company specializing in the installation of metal casework and other custom components, enclosures and the like required by this Project with a minimum 10 years successful experience. The specific foreman supervising the installation Work for this Project shall have a minimum 10 years experience installing assemblies similar to those required by this project and must have successfully completed at least 5 projects in the last three years. Include 3 references and contact numbers to verify for installation company and for project foreman.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
E. Comply with NFPA 70.
F. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including structural analysis, preconstruction testing, field testing, and in-service performance.
1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.5 COORDINATION

- A. Coordinate size and location of wall sleeves for outdoor-air intake and relief dampers.
1.6 EXTRA MATERIALS
A. Furnish touch-up paint to match unit ventilator color, packaged for storage and identified with label describing contents.
B. Furnish touch-up paint to for casework to match casework color, packaged for storage and identified with label describing contents.
1.7 PROJECT CONDITIONS
A. Field Measurements: Verify actual locations and conditions of adjacent surfaces by field observation and measurements before installation to verify tolerances are acceptable.
B. Notify Construction Manager and Architect of any non-conformance in other's work that interfaces this work, with sufficient advance of planned installation to allow corrections to interfacing work to occur.
1.8 WARRANTY
A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of units that do not comply with requirements or that fall in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Structural failures including, but not limited to, excessive deflection.
b. Noise or vibration caused by thermal movements.
c. Deterioration of metals and other materials beyond normal weathering.
d. Water leakage through louvers and wall openings.
e. Failure of operating components.
2. Warranty Period: Two years from date of Contract Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

Retain one of three paragraphs below. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation.
2. AAF HermanNelson / McQuay. (Basis of Design)
3. Trane
4. MagicAir
2.2 MANUFACTURED UNITS
A. Description: Factory-packaged and -tested units rated according to ARI 840, ASHRAE 33, and UL 1995, including finished cabinet, filter, cooling/heating coil, drain pan, supply-air fan and motor in draw-through configuration, and hydronic cooling/heating coil.

2.3 CABINETS - FLOOR MOUNTED UNITS

- A. Insulation: Minimum 1-inch thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
2. The interior areas of the unit ventilator shall be insulated for sound attenuation and to provide protection against condensation or moisture on or within the unit. The unit shall be provided with an ultra-quiet sound package consisting of acoustically matched low speed fans to fan housing, sound barrier insulation material (non-fiberglass) adhered to the bottom underside of the unit top panel, sides of the fan section and sound absorbing insulation (non-fiberglass) material applied to the unit front panel.
B. Drain Pan: Insulated stainless steel or polymer formed plastic as required by ASHRAE 62.1-2004 with drain pan outlet on both ends of the pan, field reversible to opposite end.
C. Cabinet Frame and Access Panels: Welded-steel frame with 16-gauge removable panels fastened with hex-head tamperproof fasteners and key-operated control and valve access doors.
1. Steel components exposed to weather shall be hot-dip galvanized after fabrication.
D. Cabinet Finish: Baked enamel, color(s) as selected by Architect from manufacturer's full range of standard colors.
E. Integral pipe tunnel: Cabinet shall have integral pipe tunnel for crossover of piping.
F. Indoor-Supply-Air Grille: Steel, adjustable multi-directional linear bar.
G. Return-Air Inlet: Front toe space.
Retain first paragraph below if unit ventilators are freestanding.

H. End Panels: Matching material and finish of unit ventilator.

- I. Extended End Pocket: Provide 12" extended end pocket for each unit ventilator to house piping package components, constructed of same material, finish, and color as the unit ventilator.
J. Filler Section: Provide extended filler section constructed of same material, finish, and color as the unit ventilator. Length shall be verified during submittals and field-cut to exact fit.
K. Removable End Panel: Constructed of same material, finish, and color as the unit ventilator.

2.4 FILTERS

A. Each unit ventilator shall be equipped with a one-piece filter located to provide filtration of the return air/outdoor air mixture. The filter shall be easily accessible from the front, and removable in one piece without removal of the unit return air damper stop.

2.5 COILS

- A. Test and rate unit ventilator coils according to ASHRAE 33.
B. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

2.6 INDOOR FAN

- A. Fan and Motor Board: Removable.
1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Fan Shaft and Bearings: Hollow steel shaft with permanently lubricated, resiliently mounted bearings.
3. Motor: Permanently lubricated, multispeed, resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
4. Wiring Termination: Connect motor to chassis wiring with plug connection.

2.7 DAMPERS

- A. All damper actuators shall be housed in the unit ventilator end compartment opposite of the coil piping connection side of the unit.
B. Return-Air Dampers: Galvanized-steel or aluminum blades with edge and end seals and nylon bearings; with electric actuator.
C. Outdoor-Air Dampers: Galvanized-steel or aluminum blades with edge and end seals and nylon bearings; with electric actuator. The outdoor air damper shall be a double-wall thermally broken damper with 1/2" thick, 1 1/2 lb density glassfiber insulation encapsulated between the welded blade halves.
D. Face and Bypass Dampers: Galvanized-steel or aluminum blades with edge and end seals and nylon bearings; with electric actuator.

2.8 ACCESSORIES

- Verify availability of additional features for unit ventilators specified.
A. Custom Filler Section: Painted metal top, with front panel and kick plate to match unit ventilator in construction and finish. Provide where indicated on drawings or otherwise required.
B. Subbase: Sheet metal floor-mounting base with leveling screws and baked enamel finish. Field verify quantity, location and height of sub-bases required.
C. Pipe enclosures and Sheet Metal Chases: Custom fabricated sheet metal fabricated to match shapes and profiles indicated on the drawings and as required to enclose piping.
1. Match material, type, thickness and finish of unit ventilators.
2. Form metal and / or provide reinforcing to avoid deformed surfaces and oil-canning.
3. Provide accessory brackets and mounting devices necessary for secure and movement-free installation.
4. Provide concealed fasteners except where exposed fasteners are unavoidable; where exposed fasteners are required provide with tamper-proof heads.
5. All finished exposed components, including screws, pins, washers, and the like must match finished chase color.
6. Chase and enclosure shall join with casework, filler section, or equipment with neatly custom fit flange type connection.
a. Caulking shall not be acceptable.
b. Exposed edges of metal shall be hemmed.
D. Insulated false back with gasket seals on wall and outdoor-air plenum.
1. Insulation: Minimum 1/2-inch thick matte-finish, closed-cell foam complying with ASTM C 1071 and attached adhesive complying with ASTM C 916.
a. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
E. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 8 MERV.
F. Unit mounted electrical disconnect safety switch.
G. Condensate overflow switch.

2.9 FACTORY HYDRONIC PIPING PACKAGE (factory assembled, shipped lose, field installed)

- A. Piping: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet. Crossover piping, NPS 1-1/2 with shut-off valves. Provide an extended end pocket to house piping components.
B. Control Valves: Electric actuators compatible with terminal controller and building controls.
1. Two-way, two-position control valve for dual-temperature-water coil.
C. Isolation Valves, Strainers, Unions, and Balance Valves.
1. Two-Piece Ball Valves: Bronze body with stainless-steel ball and stem and galvanized-steel lever handle for each supply and return connection. If balancing device is combination shutoff type with memory stop, isolation valve may be omitted on the return.
2. Calibrated-Office Balancing Valves: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
3. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
4. Wrought-Copper Unions: ASME B16.22.

D. All piping and accessories, including all piping package components, in the end pocket of the unit, extended unit sections, and filler sections, shall be insulated. Insulation system shall comply with requirements in Division 23 Section 230719, HVAC Piping Insulation. Piping and associated components shall be field insulated by the installing contractor.

2.10 BASIC UNIT CONTROLS

- A. Control devices are specified in Division 23 Sections "Instrumentation and Control for HVAC."
B. Reference Specification 220903 - "Sequence of Operations for HVAC Controls" for unit ventilator control sequences.
C. Unit Ventilators shall be programmed by the unit ventilator manufacturer or local representative. Retain paragraph above and delete first paragraph and subparagraphs below if controls are part of overall temperature-control system.
D. Basic Unit Controls (provided by FCC):
1. Control voltage transformer.
2. Local User Interface with the following features:
a. Digital LED display with touch pad
b. Operating Mode States
1) Heat
2) Cool
3) Fan Only
4) Auto
c. Fan Functions
1) High
2) Medium
3) Low
4) Auto
d. Room setpoint temperature
e. Current room temperature
f. Fault codes
3. Wall-mounting temperature sensor for field mounting with the following features.
a. Setpoint adjustment: +/- 2 F
b. Concealed setpoint.
c. Tenant override capability.

E. DDC Terminal Controller (provided by FCC): Controller shall allow for integration of unit ventilator with Building Automation System (BAS) and be BACnet or LON open protocol. The unit controller shall monitor room conditions, and automatically adjust unit operations (fan speed, temperatures, etc.) to maintain pre-programmed temperature setting selection ranges and ventilation requirements. The control sequence shall be on the basis of ASHRAE Cycle II for normal classroom locations. The fan speeds shall be high constant, medium constant, low constant and auto, which shall vary the air flow in direct relation to the room load. The fan shall not change speeds in less than ten minutes in any one mode.

F. Temperature Sensors (provided by unit ventilator manufacturer):
1. A discharge air temperature sensor shall be factory located to constantly sense unit discharge air temperatures. The unit's discharge air temperature sensor shall work in conjunction with the room temperature sensor to provide for stable discharge air temperatures, even in the event of rapid changes in outdoor air quantities.
2. An outdoor air temperature sensor shall be factory located in the outside air stream prior to the outside air damper to continually sense outdoor air temperature.

G. Humidity Sensors (provided by unit ventilator manufacturer): Unit mounted, utilizing a 0-100% RH, 0 VDC capacitive humidity sensor to be used with outdoor air enthalpy economizer. Provide sensor factory mounted in the outside air stream.

- H. Actuators (provided by unit ventilator manufacturer):
1. Face and Bypass Damper Actuator
2. Mixed Air Damper (MAD) Actuator:
a. Direct-coupled, floating-point, with spring return upon loss of power for positive close-off.
3. 2-Position End-of-Cycle Valve Actuator
a. Spring return, normally open.

I. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive unit ventilators for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in for piping and electrical connections to verify actual locations before unit ventilator installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install unit ventilators to comply with NFPA 90A.
B. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 54 inches above finished floor.
Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.
C. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to unit ventilator factory hydronic piping package.
3. Connect condensate drain to indirect waste.
D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
F. Replace temporary filters used during construction and testing, with new, clean filters. Install new filters in each unit ventilator within 2 weeks after Substantial Completion.

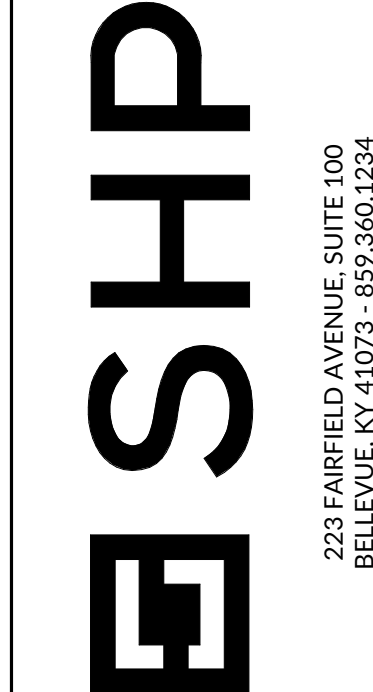
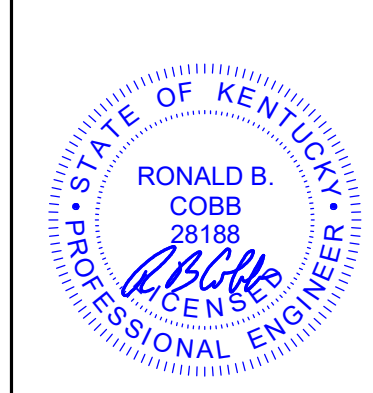
3.3 INSTALLATION OF CABINETS

- A. Install level, plumb, and true; shim as required, using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:
1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet.
2. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet.
3. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch.
B. Attachment: Fasten cabinets to utility-space framing, walls or reinforcements in partitions with fasteners spaced not more than 24 inches o.c. Bolt adjacent cabinets together with joints flush, light, and uniform.
C. Remove metal burrs, sharp and cutting edges and corners. Touch-up finish in a manner acceptable to architect or replace as a defective component.
3.4 STARTUP
A. Engage a factory-authorized representative to assist contractor in startup service as required.
B. Do not operate fan unit filters (temporary or permanent) are in place.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
B. Remove and replace malfunctioning units and reset as specified above.
3.6 PROTECTION AND CLEANING
A. After testing and adjusting units for proper operation, protect units and finishes from damage for remainder of construction period.
B. Just before inspection for substantial completion remove protective coverings and thoroughly clean units, cabinets, enclosures and all surfaces.
C. Replace dented, scratched or otherwise damaged elements. Replace exposed fasteners that are damaged or have a finish not matching adjacent colors.
D. Touch-up finish in a manner acceptable to architect or replace as a defective component.

END OF SECTION 238223



NOTRE DAME ACADEMY CLASSROOM RENOVATION 1699 Hilton Dr., Park Hills, KY 41011

ISSUANCES

A (05-09-25) PERMIT SET

HVAC SPECIFICATIONS

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