

PUMPS (BELL & GOSSETT)										
MARK	MAX. CAP., GPM	MIN. CAP., GPM	HEAD, FT. H2O	HP	MAX BHP	SIZE	SERIES	SYSTEM / AREA SERVED		VOLTAGE, V
BP-1	70	70	5	0.5			110	BOILER CIRCULATION		120
CDP-1	430	0	65	15		1510	1510	CONDENSER LOOP DUTY		480
CDP-2	430	0	65	15		1510	1510	CONDENSER LOOP STANDBY		480
CTP-1	430	0	40	0		1510	1510	COOLING TOWER LOOP DUTY		480
CTP-2	430	0	40	0		1510	1510	COOLING TOWER LOOP STANDBY		480

AIR DISTRIBUTION TERMINAL DEVICE SCHEDULE					
MARK	MANUFACTURER	MODEL	DESCRIPTION	DAMPER	FINISH
A	PRICE	SMDA	LAY-IN	OBD	WHITE
B	PRICE	70	SURFACE	OBD	WHITE
C	PRICE	70	SURFACE	---	WHITE
D	PRICE	RCG	SURFACE	OBD	WHITE
E	PRICE	SMDA	SURFACE	PC	WHITE
F	PRICE	SDS	(2) 1" SLOTS	PC	WHITE
G	PRICE	SDS	(3) 1" SLOTS	PC	WHITE
H	PRICE		SURFACE	OBD	STAINLESS

FANS											
MARK	CAPACITY, CFM	STATIC PRESSURE, IN. H2O	MAX. DAMPER PRESSURE DROP, IN. H2O	INLET dBA	MOTOR HP	MAX. BHP	MANUF.	MODEL NO.	LOCATION	SERVICE	QTY.
F-CLINIC	240	0.25	.08		15	0.1	GREENHECK	G-080-VG	ROOF	CLINIC EXHAUST	1
F-DW	232	0.00			0		GREENHECK	CUBE-200-			0
F-KIT	0	0.00			0		GREENHECK	CUBE-200-			0

GLYCOL FEEDER			
MARK	TANK STORAGE CAPACITY, GAL.	PUMP CAPACITY, GPH	DISCHARGE PRESSURE, PSI

COOLING TOWER										
MARK	MANUFACTURER	MODEL	OUTDOOR TEMP., °F WB	APPROACH, °F	COOLING RANGE, °F	FLOW RATE, GPM	PRESSURE DROP, PSI	FAN MOTOR HP	MAXIMUM HEIGHT, FT	BASIN HEATERS, KW
CT-1	BAC	XES3E-8518-05G	0			0.0	0.00 psi	0		480

EXPANSION TANKS (BELL & GOSSETT)					
MARK	CAPACITY, GALLONS	ACCEPTANCE VOL., GALLONS	MODEL SERIES B	DIMENSIONS, IN. DIA. x HEIGHT	WET WEIGHT, LBS
ET-1	200			1	1814

DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS									
MARK	MANUFACTURER	MODEL NO.	COOLING CAPACITY, MBH	COOLING (SEER)	AIR FLOW	OUTDOOR UNIT MARK	OUTDOOR UNIT MODEL NO.	OUTDOOR UNIT POWER SUPPLY	QUANTITY
DSS-1	DAIKIN	PKA-A12	12	13.8	290 CFM	DSS-10U	PUY-A12	208/1/60	1
DSS-2	DAIKIN	PKA-A18	18	14.1	290 CFM	DSS-20U	PUY-A18	208/1/60	1
DSS-3	DAIKIN	PKA-A12	12	13.8	290 CFM	DSS-30U	PUY-A12	208/1/60	1
DSS-4	DAIKIN	PKA-A12	12	13.8	290 CFM	DSS-40U	PUY-A12	208/1/60	1

ELECTRIC CABINET UNIT HEATERS					
MARK	CFM	HEATING CAPACITY, WATTS	MOTOR WATTS	ARRGMT	QUANTITY
ECUH-1	2,000	6820.0	0.13	VERTICAL UPFLOW	3

HOT WATER BOILERS							
MARK	MANUFACTURER	MODEL NO.	CAPACITY MBH, NET BR	BURNER FIRING RATE, CFH	WATER VOLUME, GAL	MINIMUM AHRI THERMAL EFF., %	MINIMUM TURNDOWN
B-1	ENDURA	1500	1400.0	1500	0	93.5	11:1
B-2	ENDURA	1500	1400.0	1500	0	93.5	11:1

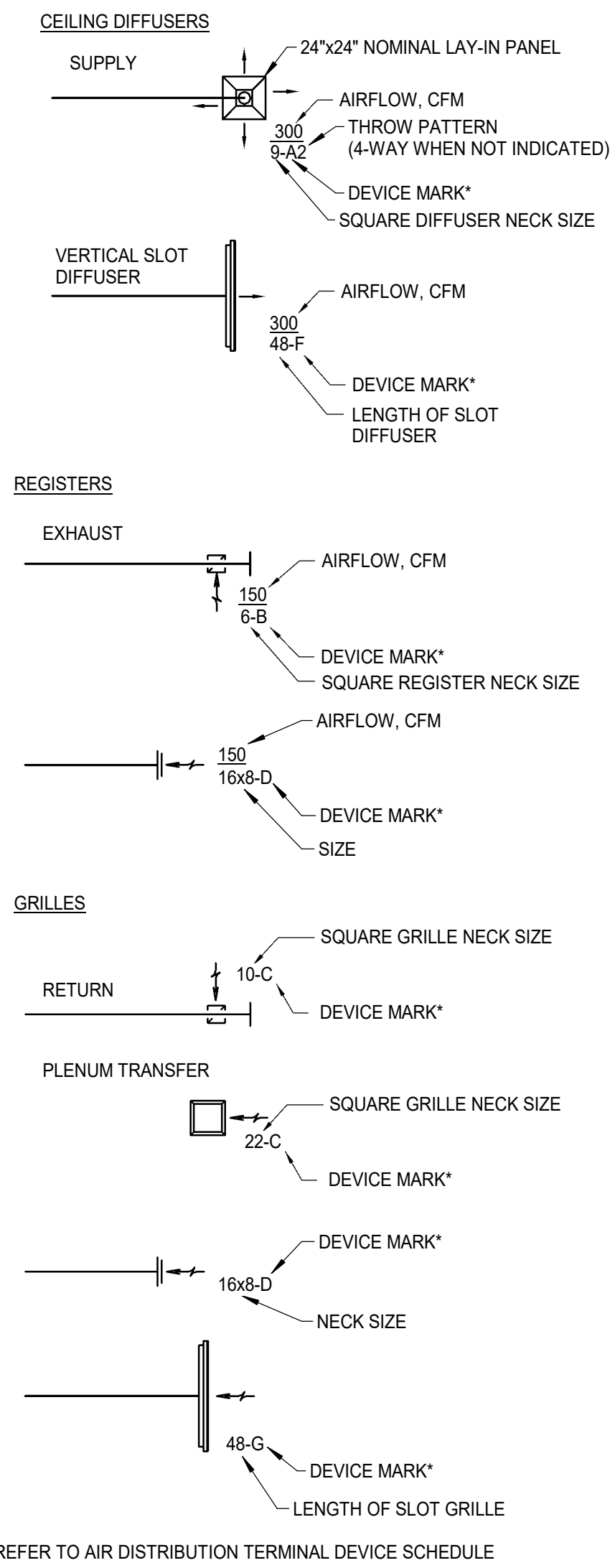
WALL HEATERS					
MARK	MANUFACTURER	HEATING CAPACITY, KW	HEATING CAPACITY, MBH	MODEL NO.	REMARKS
WH-1	MARKEL	2	6.8	3452	RECESSED

WATER SOURCE HEAT PUMP (OFCI)														
MARK	SUPPLY AIRFLOW (CFM)	ESP (IN. H2O)	FAN SPEED	COOLING CAPACITY - TOTAL (MBH)	COOLING CAPACITY - SENSIBLE (MBH)	COOLING ENTERING AIR TEMP. °F DB	COOLING ENTERING AIR TEMP. °F WB	HEATING CAPACITY (MBH)	HEATING ENTERING AIR TEMP. °F DB	COMPRESSOR INPUT MAX KW	WATER SIDE FLOW (GPM)	WATER SIDE PD (FT H2O)	ARRANGEMENT	COUNT
HP-1	600	0.39	HIGH	18.0	26.5	67	75	21.2	70		4.5	10	HORIZONTAL	2
HP-2	800	0.21	HIGH	24.2	17.6	75	63	28.4	70	1.63	6.0	6.14	VERTICAL	4
HP-3	835	0.15	HIGH	28.3	20.1	75	63	33.8	70	1.99	7.0	8.98	VERTICAL	2
HP-4	1,200	0.20	HIGH	37.0	26.7	75	63	40.9	70	2.44	9.0	12.05	VERTICAL	1
HP-5	1,600	0.42	HIGH	47.8	26.5	67	75	60.1	70		12.0	10	HORIZONTAL	4
HP-6	1,600	0.42	HIGH	47.8	32.9	75	63	60.1	70	3.33	12.0	10	VERTICAL	3
HP-7	1,600	0.42	HIGH	47.8	32.9	75	63	60.1	70	3.33	12.0	9.65	VERTICAL	15

ELECTRIC UNIT HEATERS									
MARK	CFM	HEATING CAPACITY, WATTS	MBH	MOTOR HP	ARRGMT	MANUFACTURER	MODEL	VOLTAGE, V	ACCESSORIES
EUH-1	400	4,000	13.6	0.01	VERTICAL	TRANE	5103	480	

PACKAGED ROOFTOP WITH ENERGY RECOVERY																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
MARK	TOTAL AIR CFM	OUTDOOR AIR CFM	IEER	MOP, A	VOLTAGE, V	SUPPLY FAN				GAS FURNACE				COOLING COIL				HOT GAS REHEAT COIL CAP., MBH.	TOTAL ENERGY RECOVERY WHEEL				EXHAUST FAN			RETURN AIR FILTER	OUTDOOR AIR FILTER	MAX. WEIGHT, LBS.	MANUFACTURER	MODEL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
						EXT. S.P., IN. H ₂ O	HP	MAX BHP	MAX RPM	AIRFLOW, CFM	ENT. AIR, °F	INPUT, MBH	OUTPUT, MBH	MODULATION	CAPACITY, MBH	ENTERING AIR, °DB	ENTERING AIR TEMP., °WB		LEAVING AIR TEMP., °DB	LEAVING AIR TEMP., °WB	ENTERING AIR, °DB	ENTERING AIR TEMP., °WB	SUPPLY LAT °DB	AIRFLOW, CFM	EXT. S.P., IN. H ₂ O						HP	TOTAL MAX BHP	MAX RPM	TYPE	EFFICIENCY	TYPE	EFFICIENCY																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

DIFFUSER, REGISTER & GRILLE LEGEND



STANDARD ABBREVIATIONS

Ø	DIAMETER	HP	HORSEPOWER
AK	FLAT WALL	HR	HOURLY
ABV	ABOVE	HZ	HERTZ
AFF	ABOVE FINISHED FLOOR	IN	INCHES
APD	AIR PRESSURE DROP	KW	KILOWATTS
ARRGMT	ARRANGEMENT	LA	LEAVING AIR
AUTO	AUTOMATIC	LBS	POUNDS
AAV	AUTOMATIC AIR VENT	LVD	LOW VOLTAGE MOTOR
AUX	AUXILIARY	MAV	MANUAL AIR VENT
BEL	BELOW	MOD	MOTOR OPERATED DAMPER
BTU	BRITISH THERMAL UNIT	LWT	LEAVING WATER
BTUH	BTU PER HOUR	MAX	MAXIMUM
CFM	CUBIC FEET PER MINUTE	MBH	THOUSAND BTU
CMU	CONCRETE MASONRY UNIT	PER HOUR	PER HOUR
CO	CLEANOUT	MECH	MECHANICAL
CONC	CONCRETE	MFG	MANUFACTURER
CONN	CONNECT	MIN	MINIMUM
CONT	CONTINUATION	MOD	MOTOR OPERATED DAMPER (LINE VOLTAGE)
CR	CONTROL RELAY	MP SW	MOTOR PROTECTIVE SWITCH
CRD	CEILING RADIATION DAMPER	MTD	MOUNTED DAMPER
CTR	CURRENT RELAY	MTD	MANDAL VOLUME DAMPER
CW	COLD WATER	NC	NORMALLY CLOSED
DB	DRY BULB	NIC	NOT IN CONTRACT
dB	DECIBEL	NO	NORMALLY OPEN
DDC	DIRECT DIGITAL CONTROL	NTS	NOT TO SCALE
DIM	DIMENSIONS	OA	OUTSIDE AIR
DISC	DISCONNECT SWITCH	OAT	OUTSIDE AIR TEMPERATURE
DP	DOUBLE POLE	OBD	OPPOSED BLADE DAMPER
DN	DOWN	SDR	DUCT SMOKE DETECTOR
EXST	EXISTING	SDRP	SMOKE DAMPER
EA	EACH	SS	STAINLESS STEEL
EAT	ENTERING AIR TEMPERATURE	S/S	START-STOP DAMPER
ELEC	ELECTRIC	SUSP	SUSPENDED
EQUIP	EQUIPMENT	SW	SWITCH
ENT	ENTERING	TEMP	TEMPERATURE </td
EW	ENTERING WATER TEMP	TYP	TYPICAL
ESP	EXTERNAL STATIC PRESSURE	V	VOLT
ETR	EXISTING TO REMAIN	VERT	VERTICAL
F	FAHRENHEIT	W	WATTS
FA	FIRE ALARM	WB	WET BULB
FDPR	FIRE DAMPER	WC	WATER COLUMN
FS	FIRE STOP	WG	WATER GAUGE
FSR	FINISHED FLOOR	WS	WATER STOP
FL	FLOOR	WT	WEIGHT
FL	FULL LOAD AMPS	W	WITH
FP	FREEZE PROTECTION		
FR	FROM OF FAN RELAY		
FT	FEET		
GAL	GALLONS		
GPM	GALLONS PER MINUTE		
H2O	WATER COLUMN or WATER GAUGE		
HOA	HAND-OFF-AUTOMATIC		

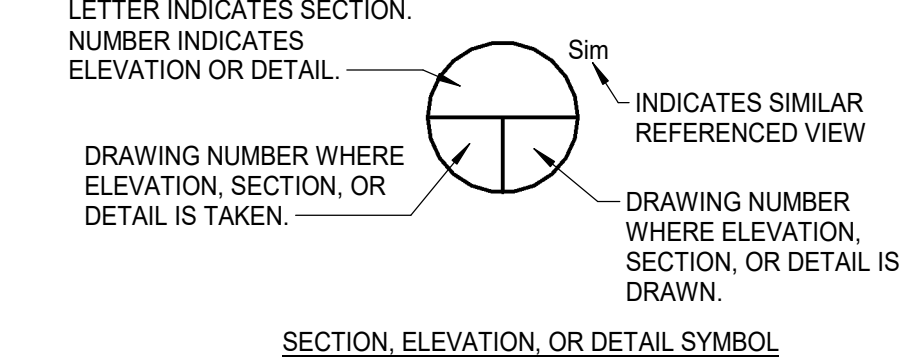
COORDINATION NOTE

ALL DUCTWORK AND PIPES SHALL BE COORDINATED WITH OTHER DUCTS, PIPES, LIGHTS, STRUCTURAL SYSTEM, CEILING SUPPORTS AND FRAMING BEFORE INSTALLATION. MINOR DUCT OFFSETS AND TRANSITIONS SHALL BE PROVIDED AS REQUIRED. WHERE TRANSITIONS ARE REQUIRED, CROSS SECTIONAL AREA OF DUCT SHALL NOT BE REDUCED. MEASUREMENTS FOR VERTICAL CLEARANCES OF DUCTWORK SHALL BE TAKEN AT THE JOB SITE BEFORE FABRICATION OF ANY DUCTWORK.

LEGEND

CONDENSER WATER SUPPLY	CDS
CONDENSER WATER RETURN	CDR
COOLING TOWER WATER SUPPLY	CTS
COOLING TOWER WATER RETURN	CTR
CONDENSATE DRAIN	D
GAS	G
REFRIGERANT SUCTION	RS
REFRIGERANT DISCHARGE	RD
REFRIGERANT LIQUID	RL
BOILER BLOW-OFF	BBO
VENT	V
SERVICE VALVE	SV
BALANCING COCK	BC
STRAINER	STR
CHECK VALVE	CV
RELIEF VALVE	RV
GLOBE VALVE	GV
CONTROL VALVE	CV
GAUGE	G
THERMOMETER	TM
DRIP STATION	DS
FILL VALVE	FV
REDUCING VALVE	RV
THERMOSTATIC TRAP	TT
FLOAT AND THERMOSTATIC TRAP	FT
BUCKET TRAP	BT
ELECTRIC THERMOSTAT	ET
DDC SPACE TEMPERATURE SENSOR	STS
DDC COMBINATION SPACE TEMP/HUMIDITY/CO2 SENSOR	CCS
DDC SPACE CO2 SENSOR	SCS
DDC SPACE HUMIDITY SENSOR	SHS
DUCT SMOKE DETECTOR	SDS
DIRECTION OF SLOPE DOWN	SD
DIRECTION OF FLOW	DF
ANCHOR	AN
PIPE GUIDE	PG
ACOUSTIC LINED DUCT (DOUBLE LINE)	ALD
ACOUSTIC DUCT/EQUIPMENT LAGGING	ALD
DUCT TRANSITION	DT
FLEXIBLE DUCT	FD
FLEXIBLE DUCT CONNECTION	FDC
WATERTIGHT DUCT	WD
FABRIC DUCT	FD
CONNECT TO EXISTING	CE
EXTENT OF DEMOLITION	ED
NEW WORK	NW
EXISTING WORK TO REMAIN	EW
EXISTING WORK TO BE REMOVED	EW

IDENTIFICATION KEY



MECHANICAL SHEET INDEX

SHEET NUMBER	SHEET NAME
M-001	MECHANICAL LEGEND, SCHEDULES, DETAILS AND NOTES
MD-101	MECHANICAL DEMOLITION - FIRST FLOOR PLAN AREA A
MD-102	MECHANICAL DEMOLITION - FIRST FLOOR PLAN AREA B
MD-103	MECHANICAL DEMOLITION - SECOND FLOOR FLOOR PLAN AREA A
M-002	HVAC ZONES
M-101	MECHANICAL DUCTWORK - FIRST FLOOR PLAN AREA A
M-102	MECHANICAL DUCTWORK - FIRST FLOOR PLAN AREA B
M-103	MECHANICAL DUCTWORK - SECOND FLOOR PLAN AREA A
M-201	MECHANICAL PIPING - FIRST FLOOR PLAN AREA A
M-202	MECHANICAL PIPING - FIRST FLOOR PLAN AREA B
M-203	MECHANICAL PIPING - SECOND FLOOR PLAN AREA A
M-301	OVERALL MECHANICAL ROOF PLAN
M-401	MECHANICAL SECTIONS AND ENLARGED PLANS
M-501	MECHANICAL DETAILS
M-601	MECHANICAL CONTROLS AND SEQUENCES
M-602	MECHANICAL CONTROLS AND SEQUENCES

PROJECT GLEN COVE ELEMENTARY SCHOOL ADDITIONS AND RENOVATIONS
ROANOKE COUNTY PUBLIC SCHOOLS
5901 COVE RD
ROANOKE, VA

DRAWING MECHANICAL LEGEND, SCHEDULES, DETAILS AND NOTES

SHEET

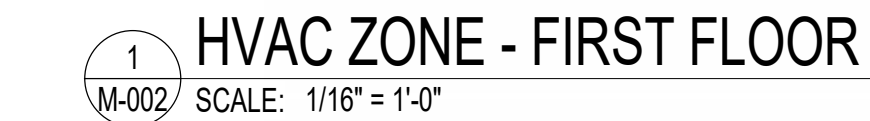
M-001

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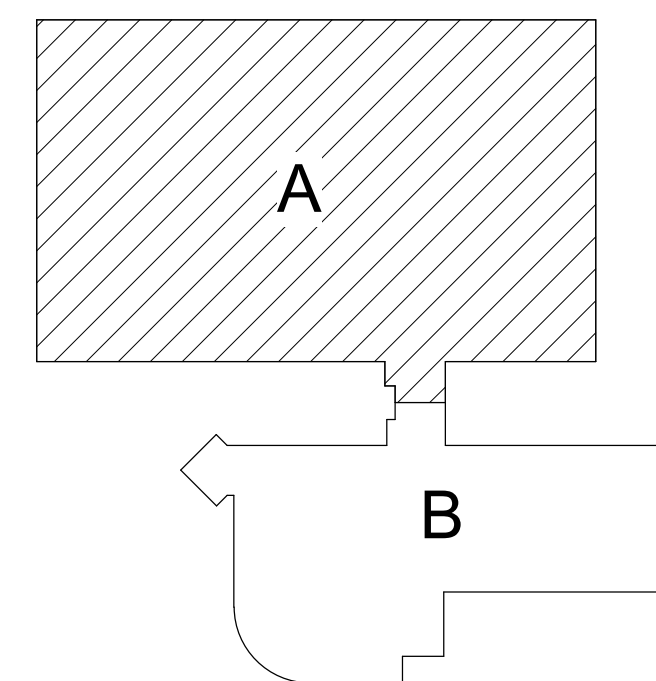
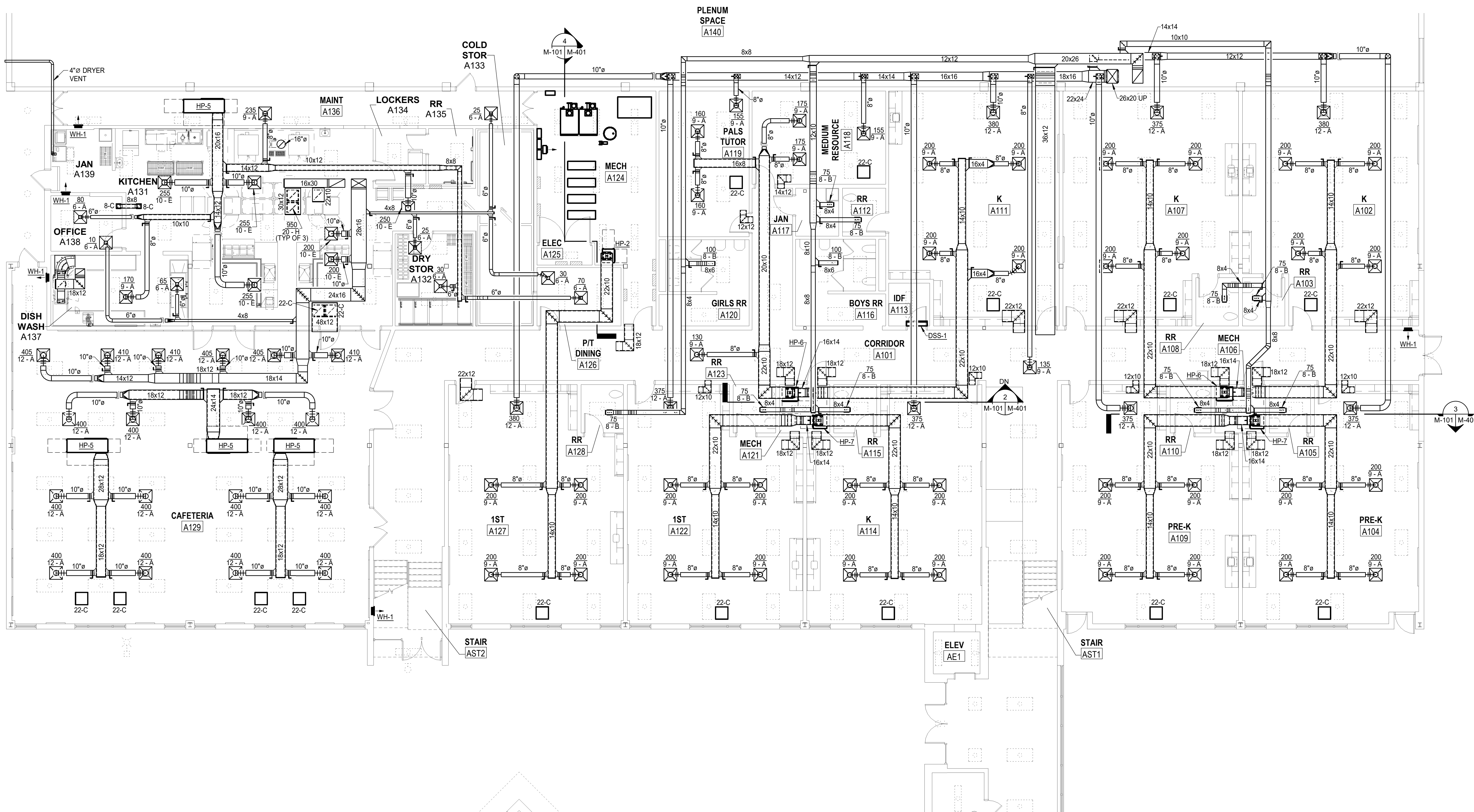
RRMM ARCHITECTS, PC
28 Church Ave SW
Roanoke, Virginia 24011
(540)344-1212

DATE 03/22/2024
PROJECT 23125-02
DESIGNED MHU
DRAWN MHU
CHECKED

ASCENT ENGINEERING GROUP
5208 VALLEYFORD PKWY, SUITE 4
ROANOKE, VIRGINIA 24019
(540)

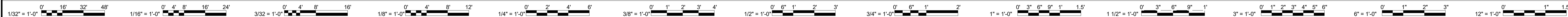


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1 MECHANICAL DUCTWORK PLAN - FIRST FLOOR AREA A
SCALE: 1/8" = 1'-0"

PLAN NORTH
KEY PLAN AREA A
NOT TO SCALE



PROJECT GLEN COVE ELEMENTARY SCHOOL ADDITIONS AND RENOVATIONS
ROANOKE COUNTY PUBLIC SCHOOLS
5901 COVE RD
ROANOKE, VA
DRAWING MECHANICAL DUCTWORK - FIRST FLOOR PLAN AREA A

SHEET
M-101

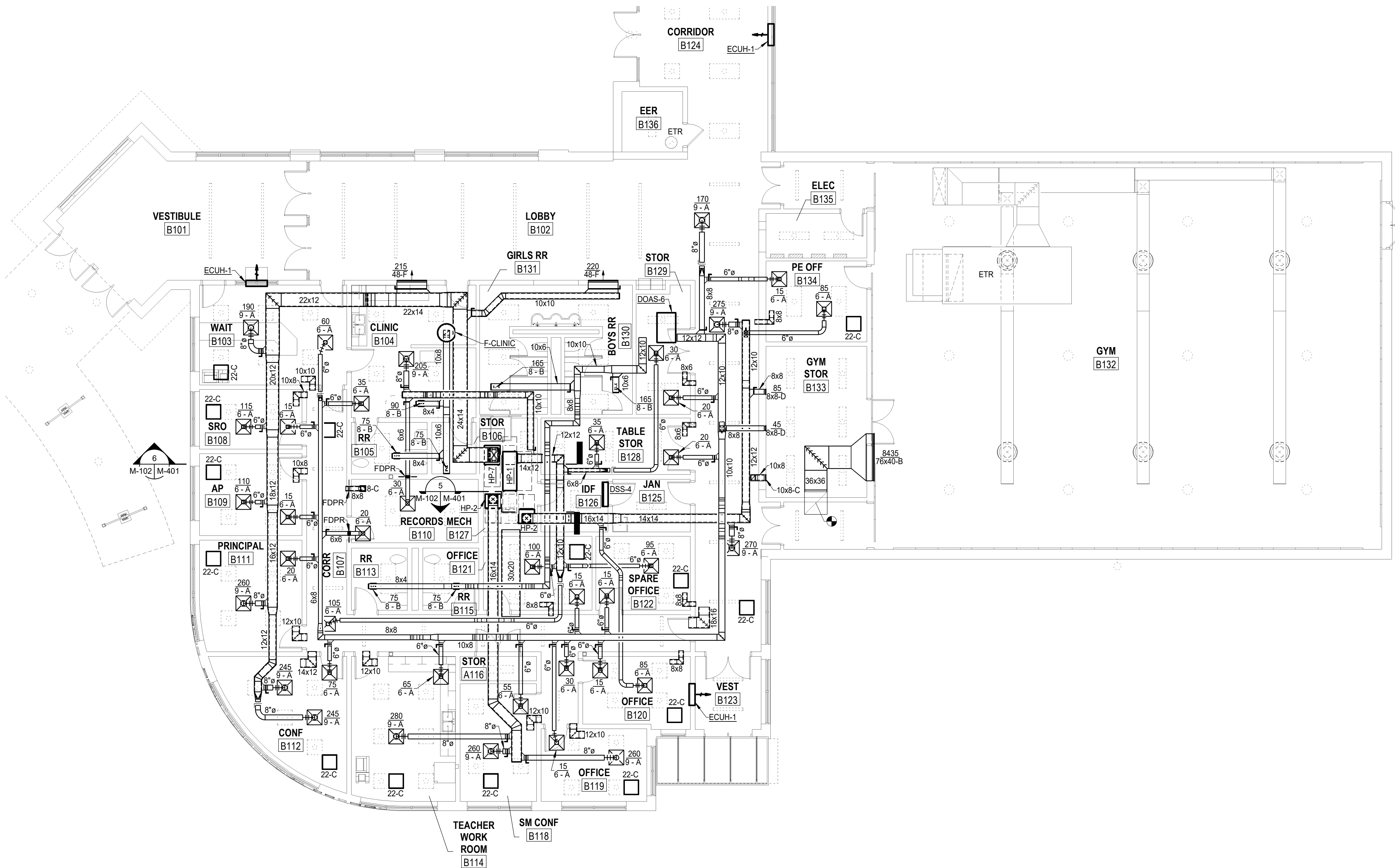
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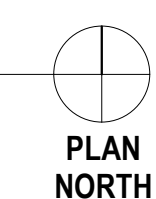
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ENGINEERING GROUP
5228 VALLEYFLORENCE PKWY, SUITE 4
ROANOKE, VIRGINIA 24019
(540) 265-4444
D:MHU 23910 C: ---

DESCRIPTION
BY
MARK DATE
REVISIONS

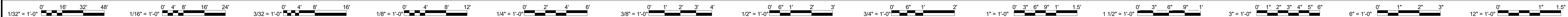
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1 MECHANICAL DUCTWORK PLAN - FIRST FLOOR AREA B
SCALE: 1/8" = 1'-0"



KEY PLAN AREA B
NOT TO SCALE



PROJECT GLEN COVE ELEMENTARY SCHOOL ADDITIONS AND RENOVATIONS
ROANOKE COUNTY PUBLIC SCHOOLS
5901 COVE RD
ROANOKE, VA

DRAWING MECHANICAL DUCTWORK - FIRST FLOOR PLAN AREA B

SHEET
M-102



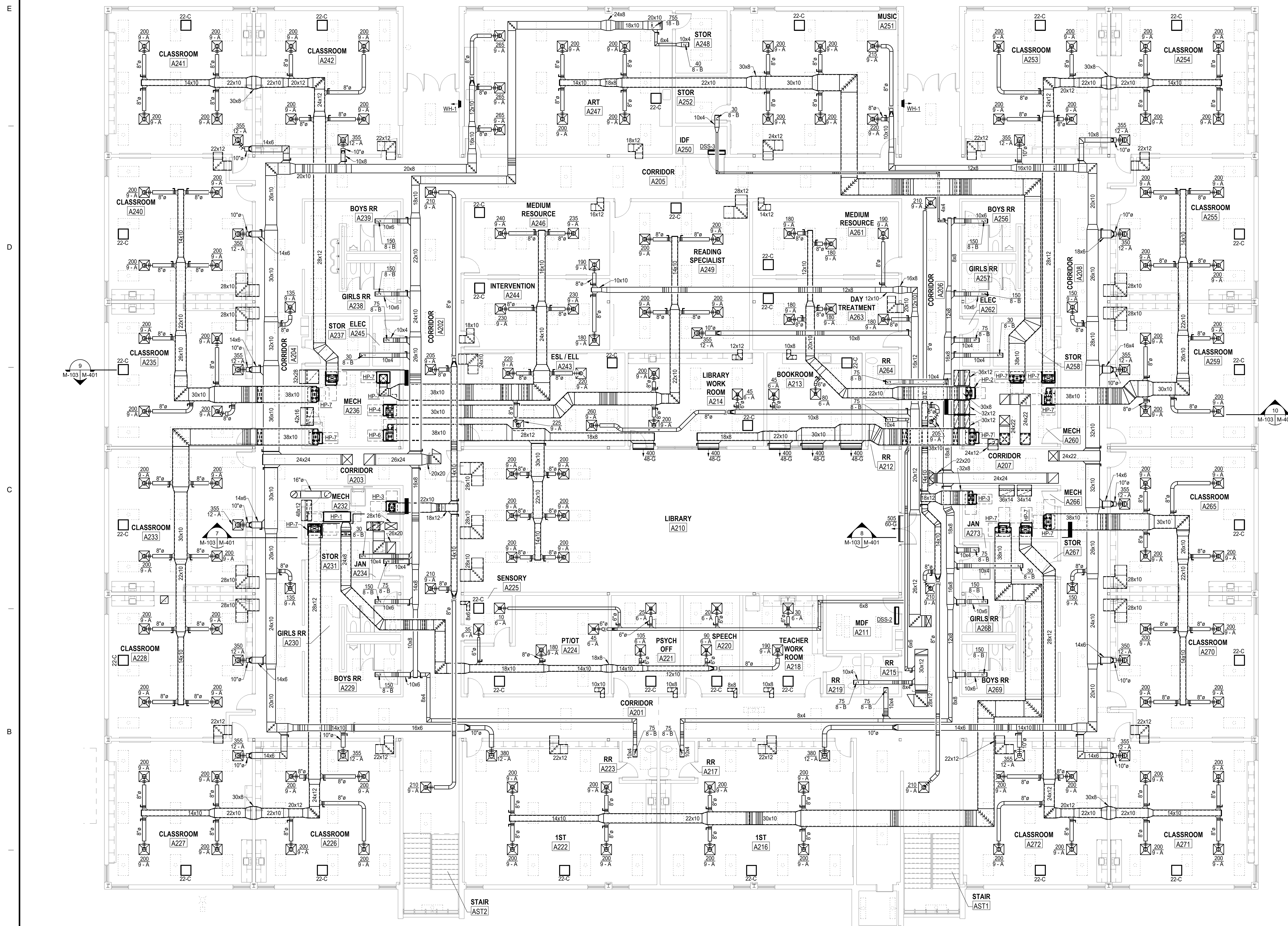
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DATE	PROJECT	DESIGNED	DRAWN	CHECKED
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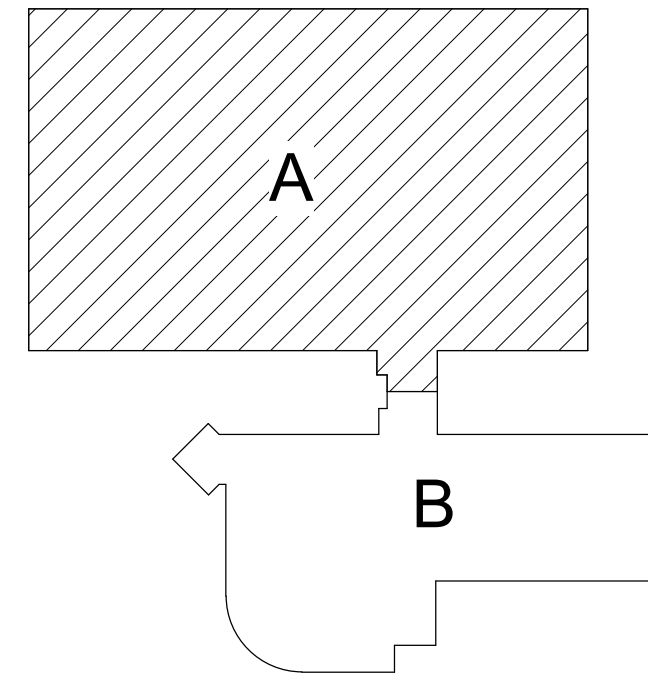
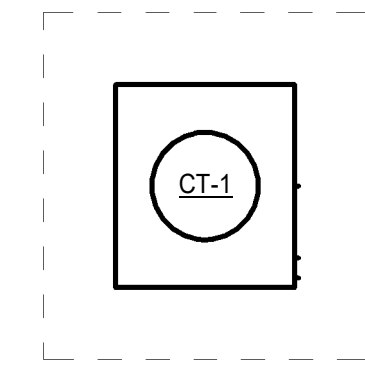
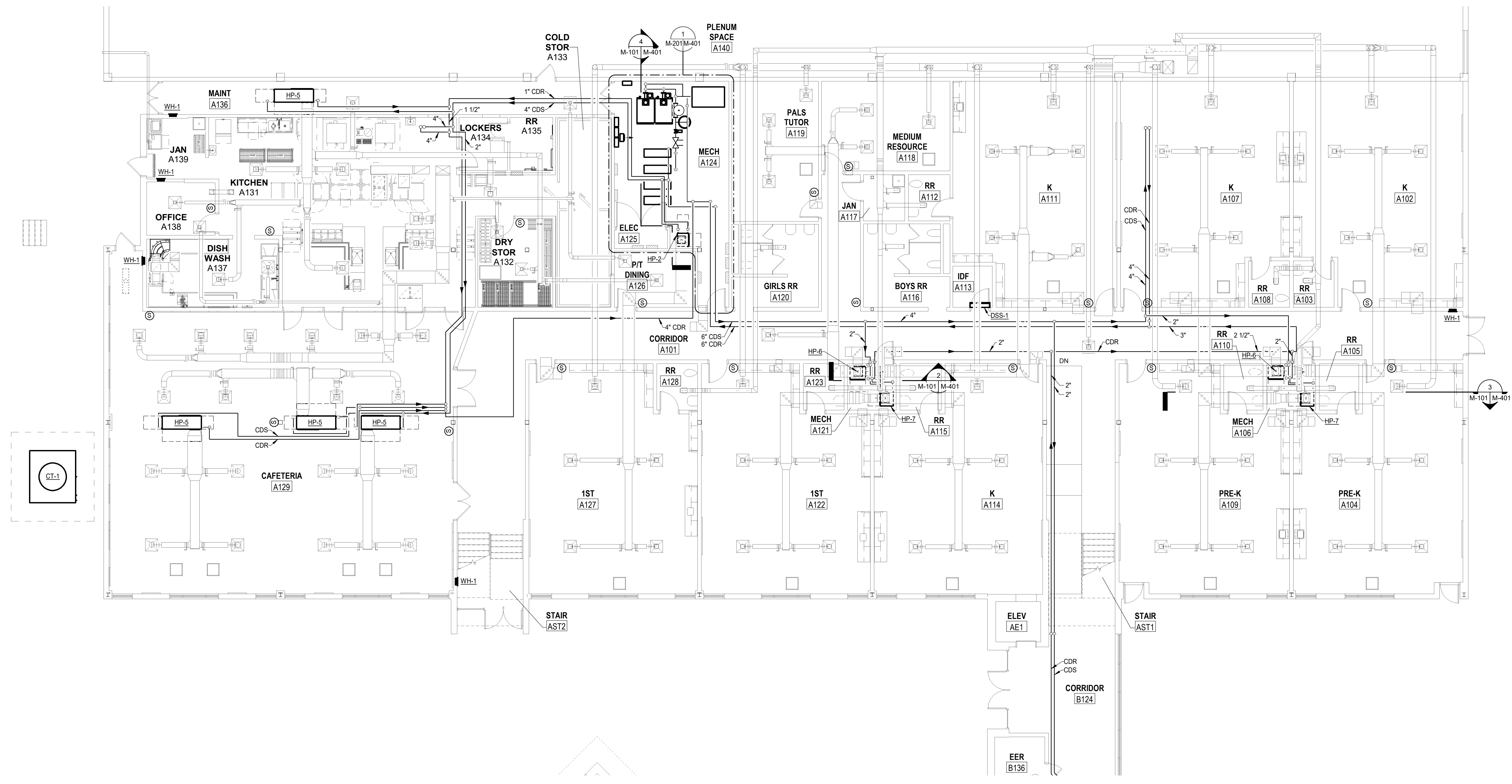
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5228 VALLEYFONTE PKWY, SUITE 4
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1 M-201 MECHANICAL PIPING PLAN - FIRST FLOOR AREA A
SCALE: 1/8" = 1'-0"



KEY PLAN AREA A
NOT TO SCALE



PROJECT GLEN COVE ELEMENTARY SCHOOL ADDITIONS AND RENOVATIONS
ROANOKE COUNTY PUBLIC SCHOOLS
5901 COVE RD
ROANOKE, VA

DRAWING MECHANICAL PIPING - FIRST FLOOR PLAN AREA A

SHEET
M-201

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ENGINEERING GROUP
5228 VALLEYFONTE PKWY, SUITE 4
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(540) 265-4444
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03/22/2024
DATE PROJECT DESIGNED DRAWN CHECKED
23125-02 MHU MHU

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DESCRIPTION
BY
MARK DATE
REVISIONS

E

□



E

A

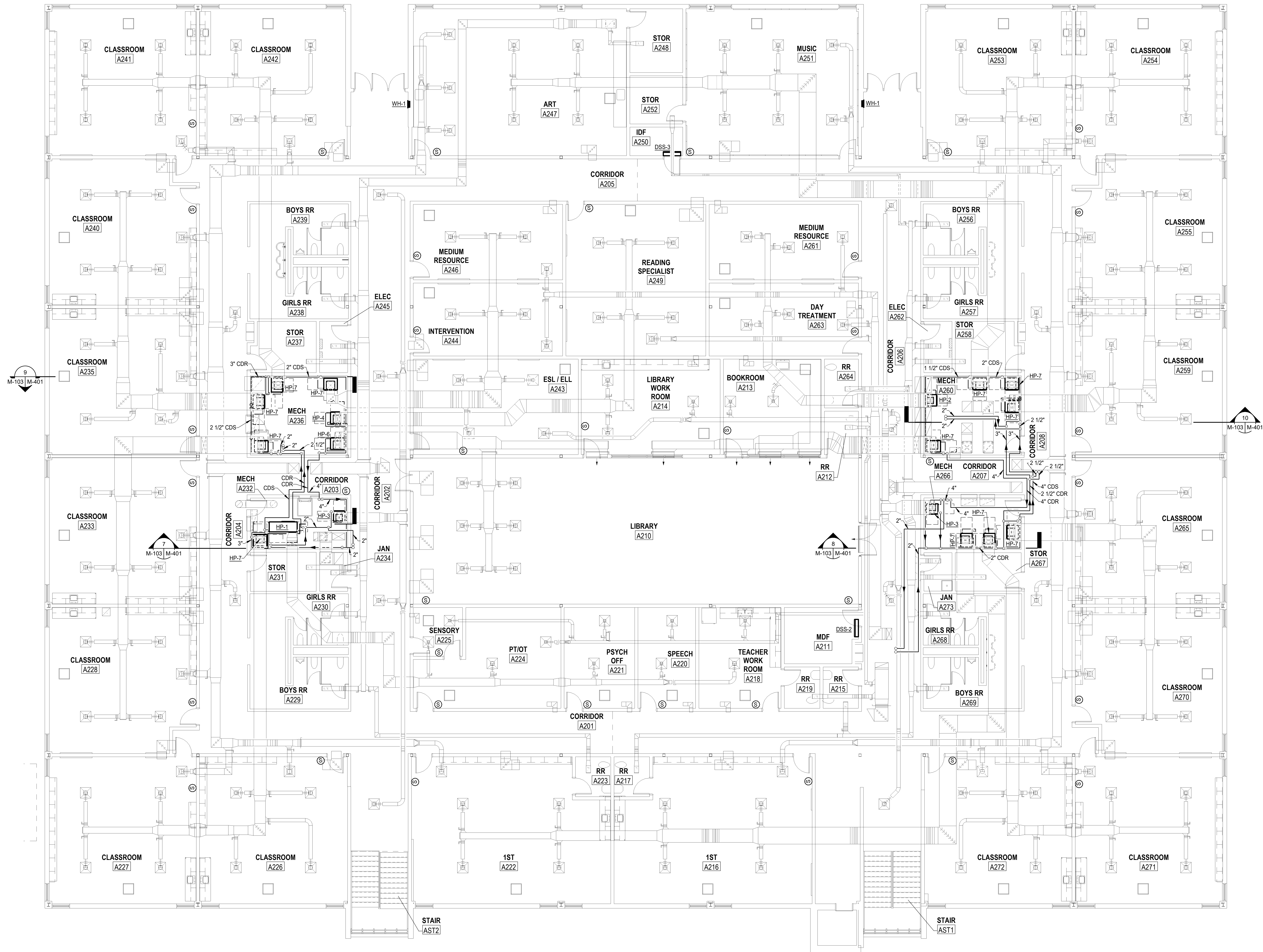
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M-202



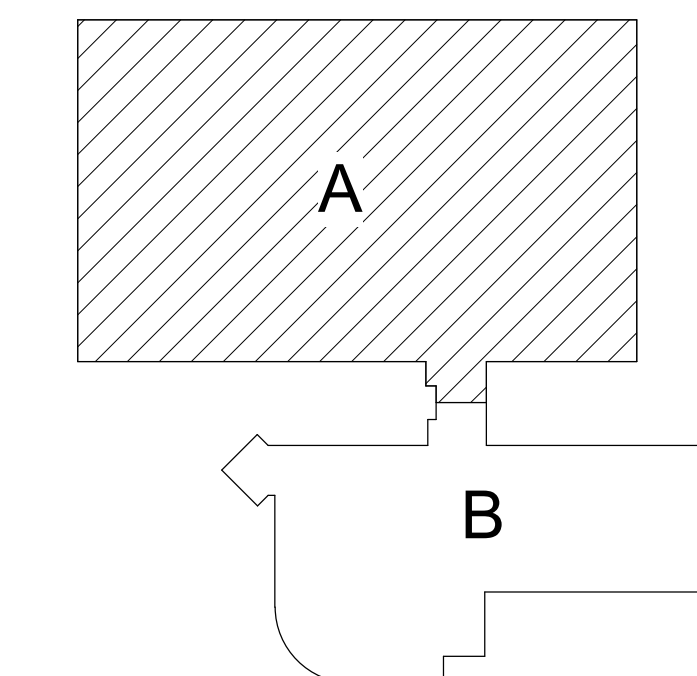
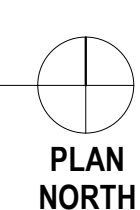
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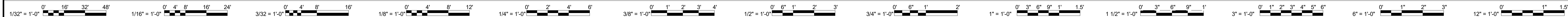
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MECHANICAL PIPING PLAN - SECOND FLOOR
SCALE: 1/8" = 1'-0"



KEY PLAN AREA A
NOT TO SCALE



PROJECT GLEN COVE ELEMENTARY SCHOOL ADDITIONS AND RENOVATIONS
ROANOKE COUNTY PUBLIC SCHOOLS
5901 COVE RD
ROANOKE, VA
DRAWING MECHANICAL PIPING - SECOND FLOOR PLAN AREA A

SHEET
M-203

DATE 03/22/2024
PROJECT 23125-02
DESIGNED MHU
DRAWN MHU
CHECKED

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28 Church Ave SW
Roanoke, Virginia 24011
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ASCENT
ENGINEERING GROUP
5528 VALLEYFLOPPY PKWY, SUITE 4
ROANOKE, VIRGINIA 24019
(540) 265-4444
D:MHU 23910 C: ---

DESCRIPTION
BY
MARK DATE
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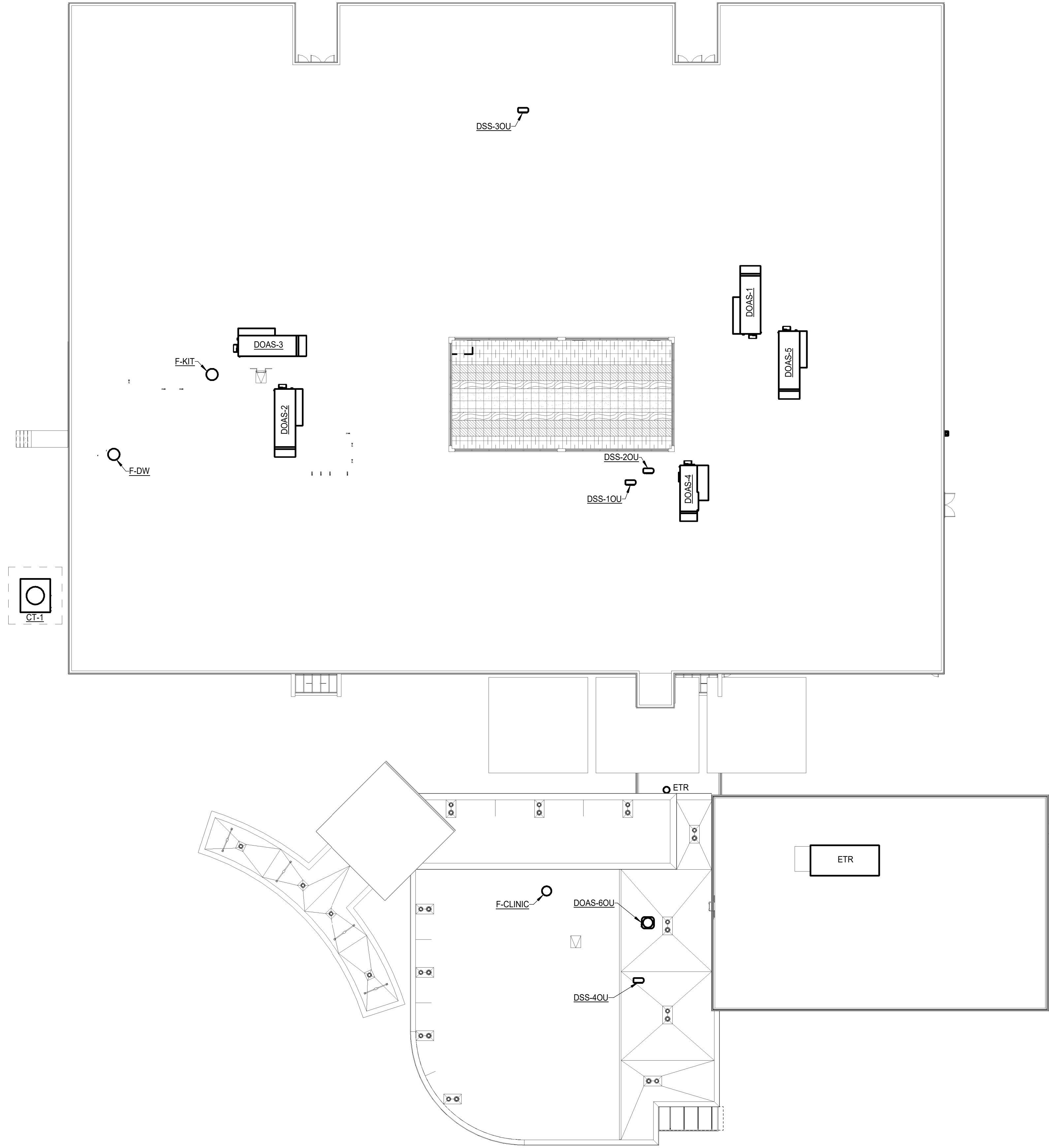
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D

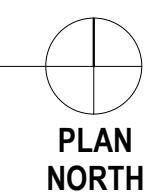
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B

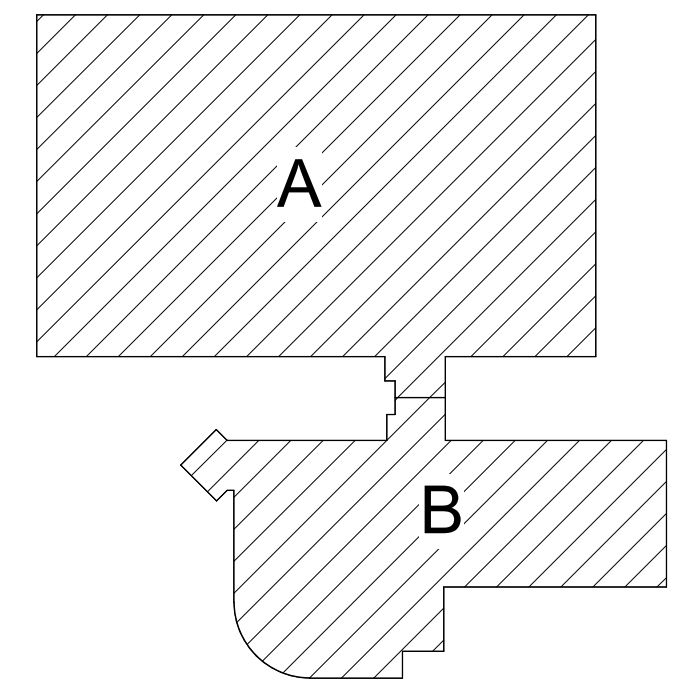
A



1
M-301
MECHANICAL ROOF PLAN
SCALE: 1/16" = 1'-0"



KEY PLAN AREA B
NOT TO SCALE



MARK	DATE	BY	DESCRIPTION

ASCENT
ENGINEERING GROUP
5228 VALLEYFONTE PKWY, SUITE 4
ROANOKE, VIRGINIA 24019
(540) 265-4444
D:MHU 23910 C: ---

DATE	PROJECT	DESIGNED	DRAWN	CHECKED
03/22/2024	23125-02	MHU	MHU	---

RRMM
ARCHITECTS, PC
28 Church Ave SW
Roanoke, Virginia 24011
(540)344-1212



PROJECT GLEN COVE ELEMENTARY SCHOOL ADDITIONS AND RENOVATIONS
ROANOKE COUNTY PUBLIC SCHOOLS
5901 COVE RD
ROANOKE, VA
DRAWING OVERALL MECHANICAL ROOF PLAN

SHEET
M-301

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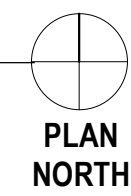
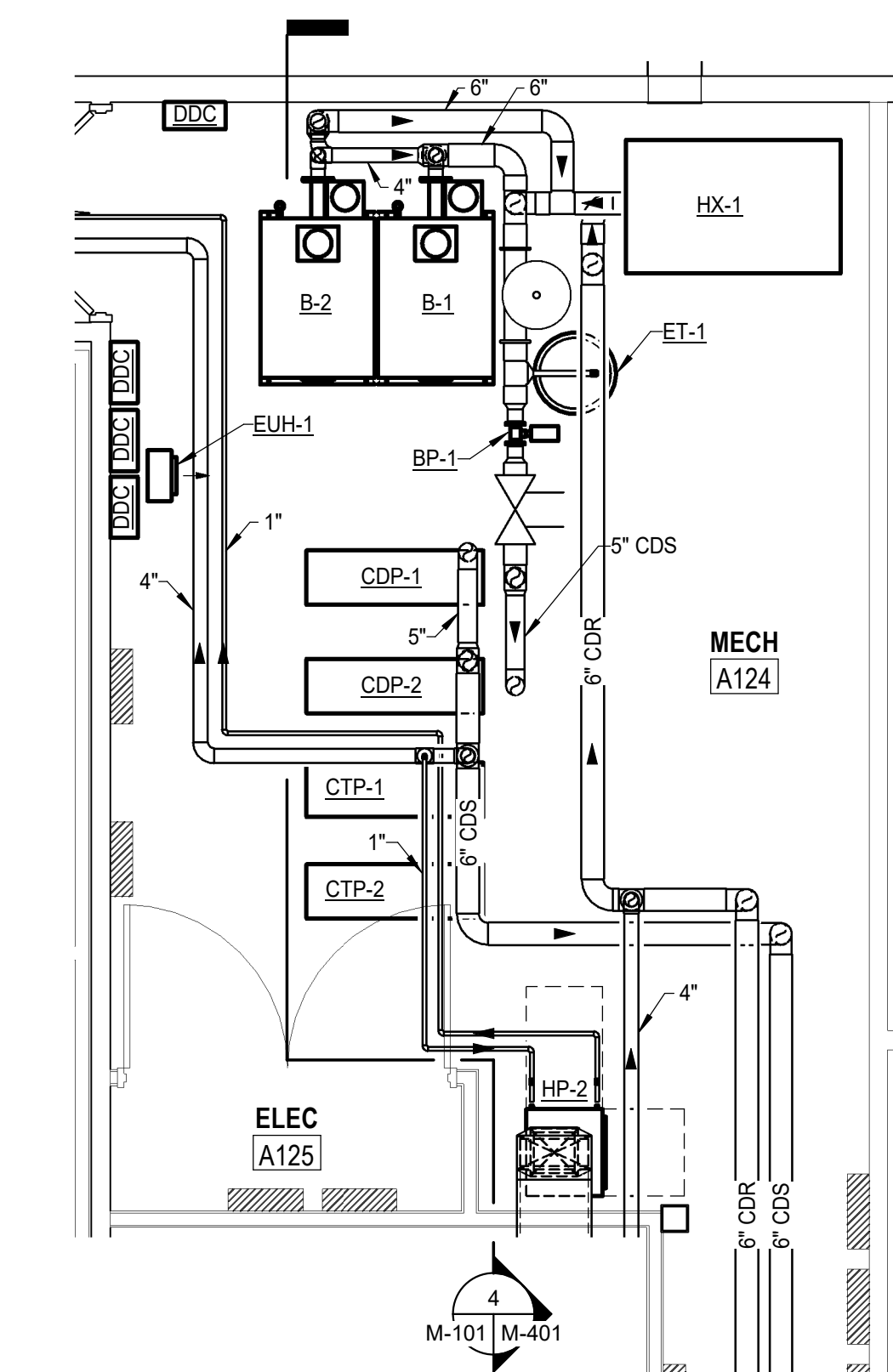
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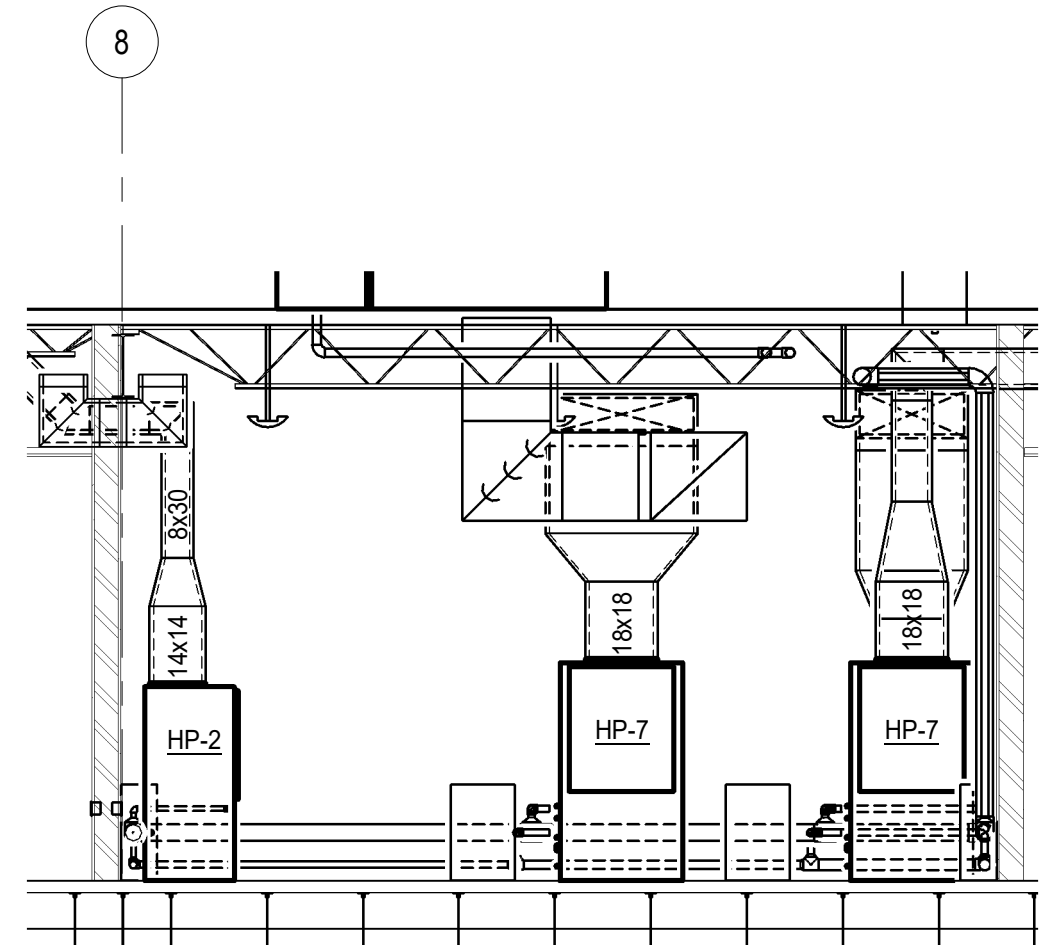
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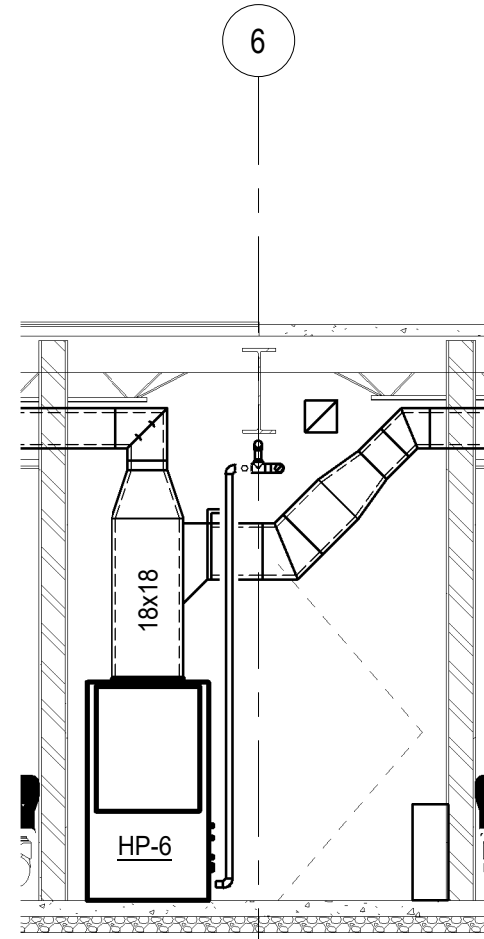
1 ENLARGED MECHANICAL ROOM PLAN
M-201 M-401 1/4" = 1'-0"



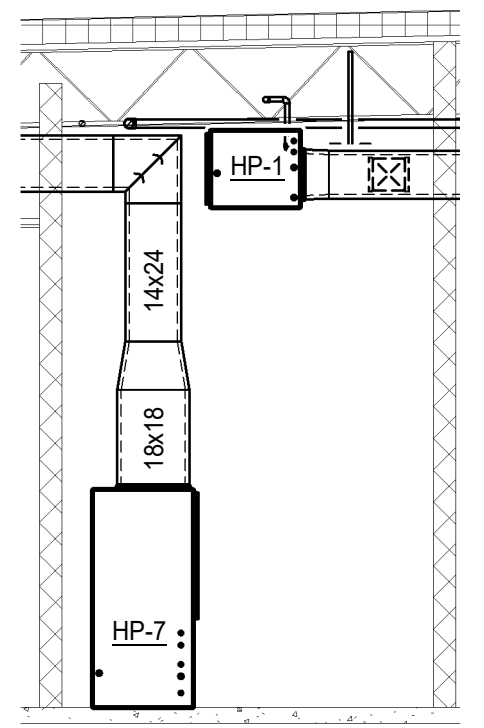
10 MECH A260 SECTION
M-103 M-401 1/4" = 1'-0"



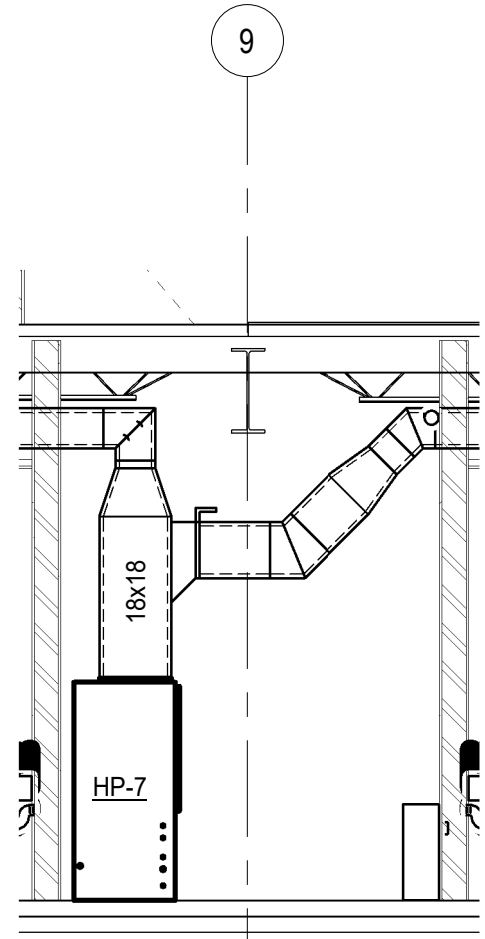
2 MECH A121 SECTION
M-101 M-401 1/4" = 1'-0"



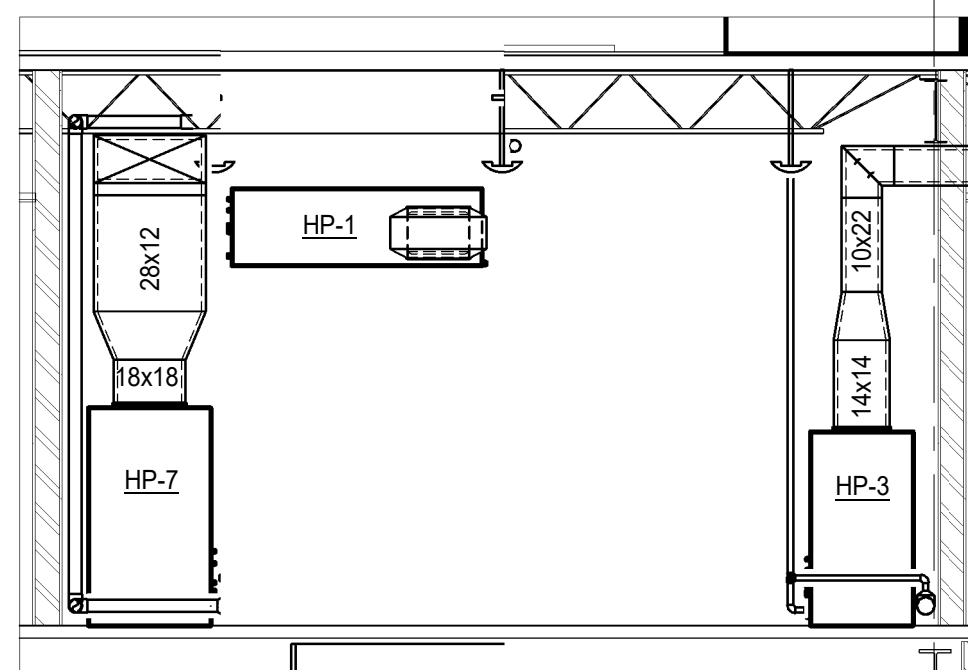
6 MECH B127 SECTION 2
M-102 M-401 1/4" = 1'-0"



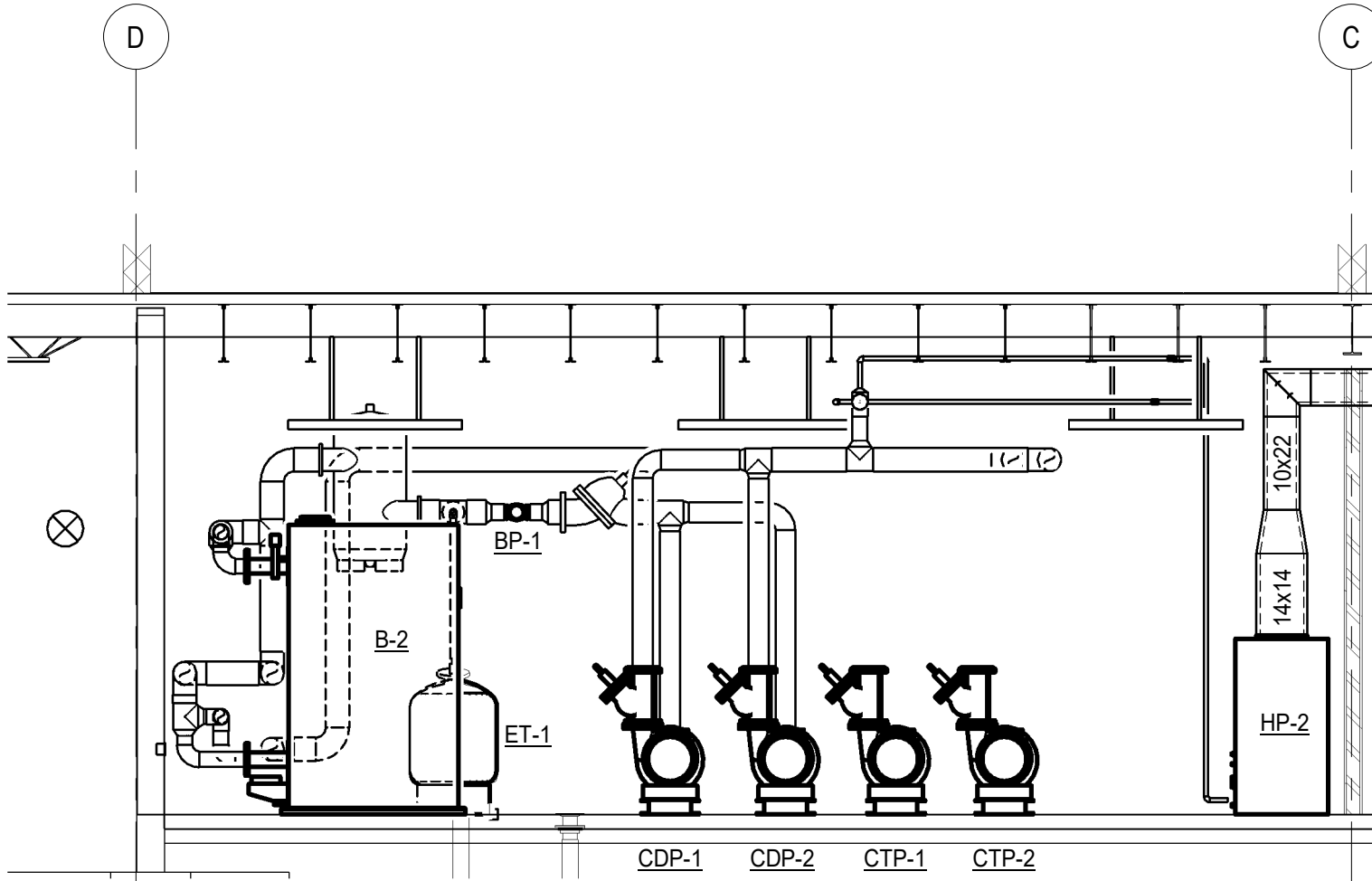
3 MECH A106 SECTION
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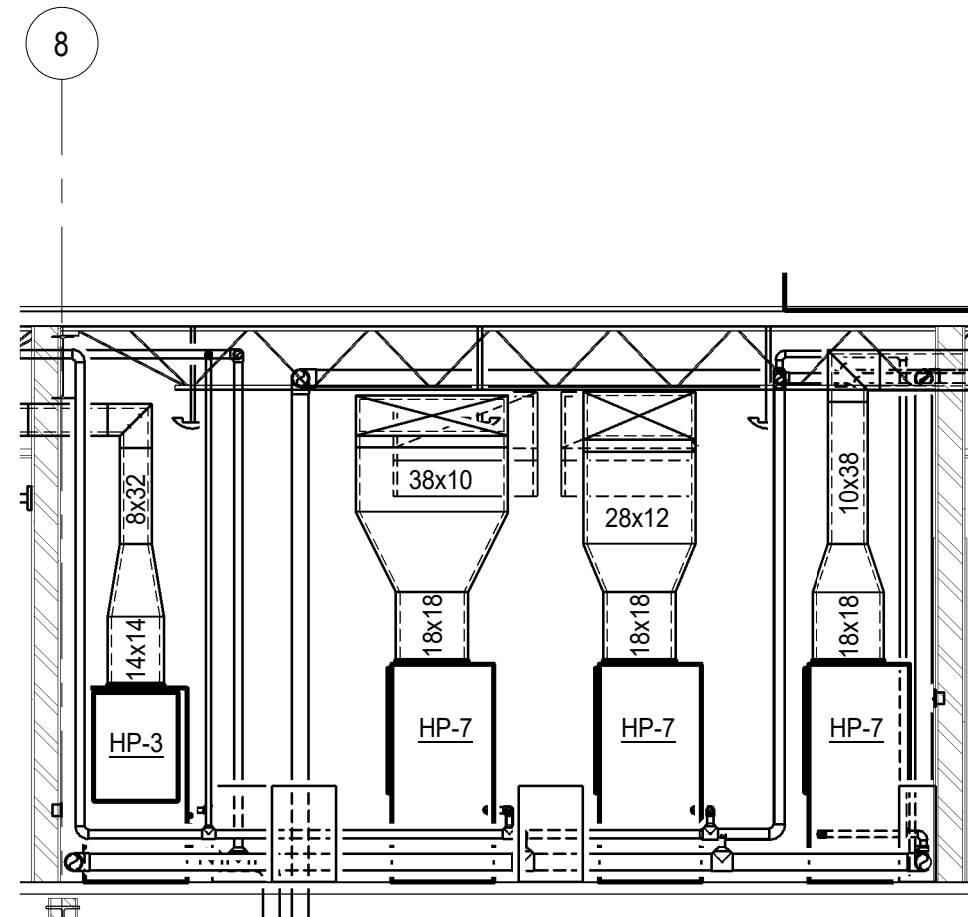
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M-103 M-401 1/4" = 1'-0"



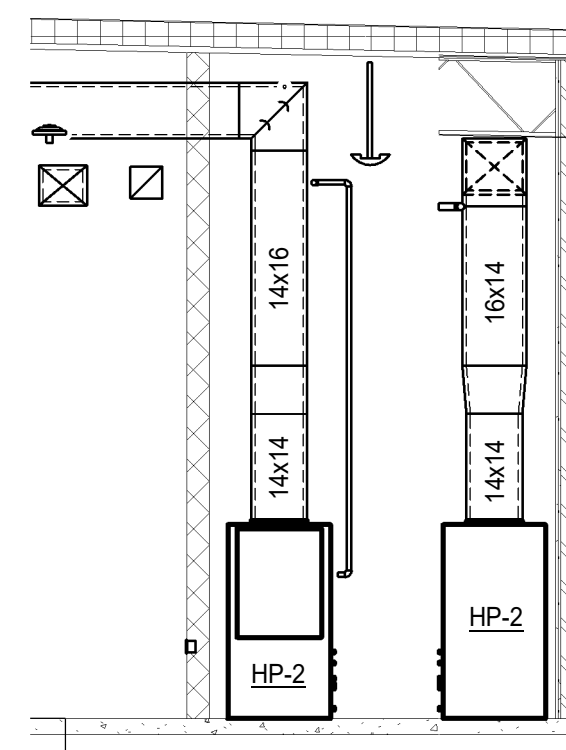
4 MECH A124 SECTION
M-101 M-401 1/4" = 1'-0"



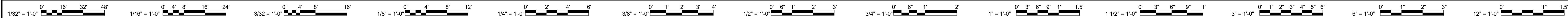
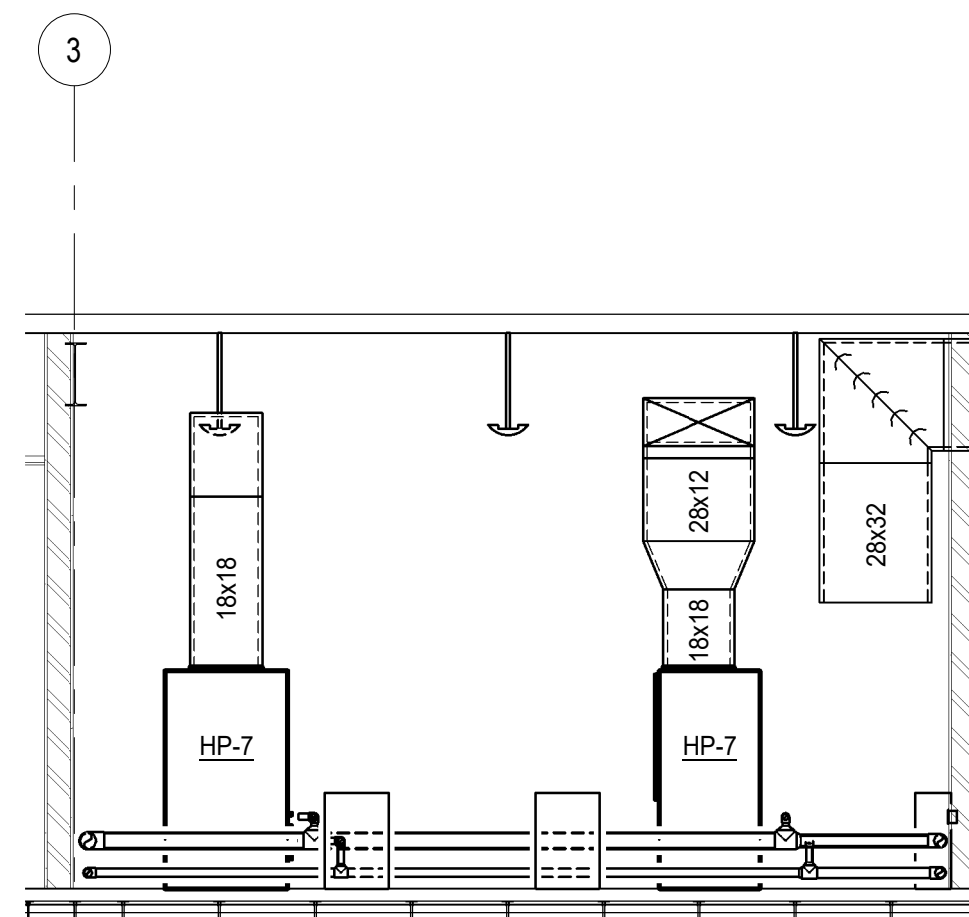
8 MECH A266 SECTION
M-103 M-401 1/4" = 1'-0"



5 MECH B127 SECTION 1
M-102 M-401 1/4" = 1'-0"



9 MECH A236 SECTION
M-103 M-401 1/4" = 1'-0"



PROJECT GLEN COVE ELEMENTARY SCHOOL ADDITIONS AND RENOVATIONS
ROANOKE COUNTY PUBLIC SCHOOLS
5901 COVE RD
ROANOKE, VA

DRAWING MECHANICAL SECTIONS AND ENLARGED PLANS

SHEET

M-401

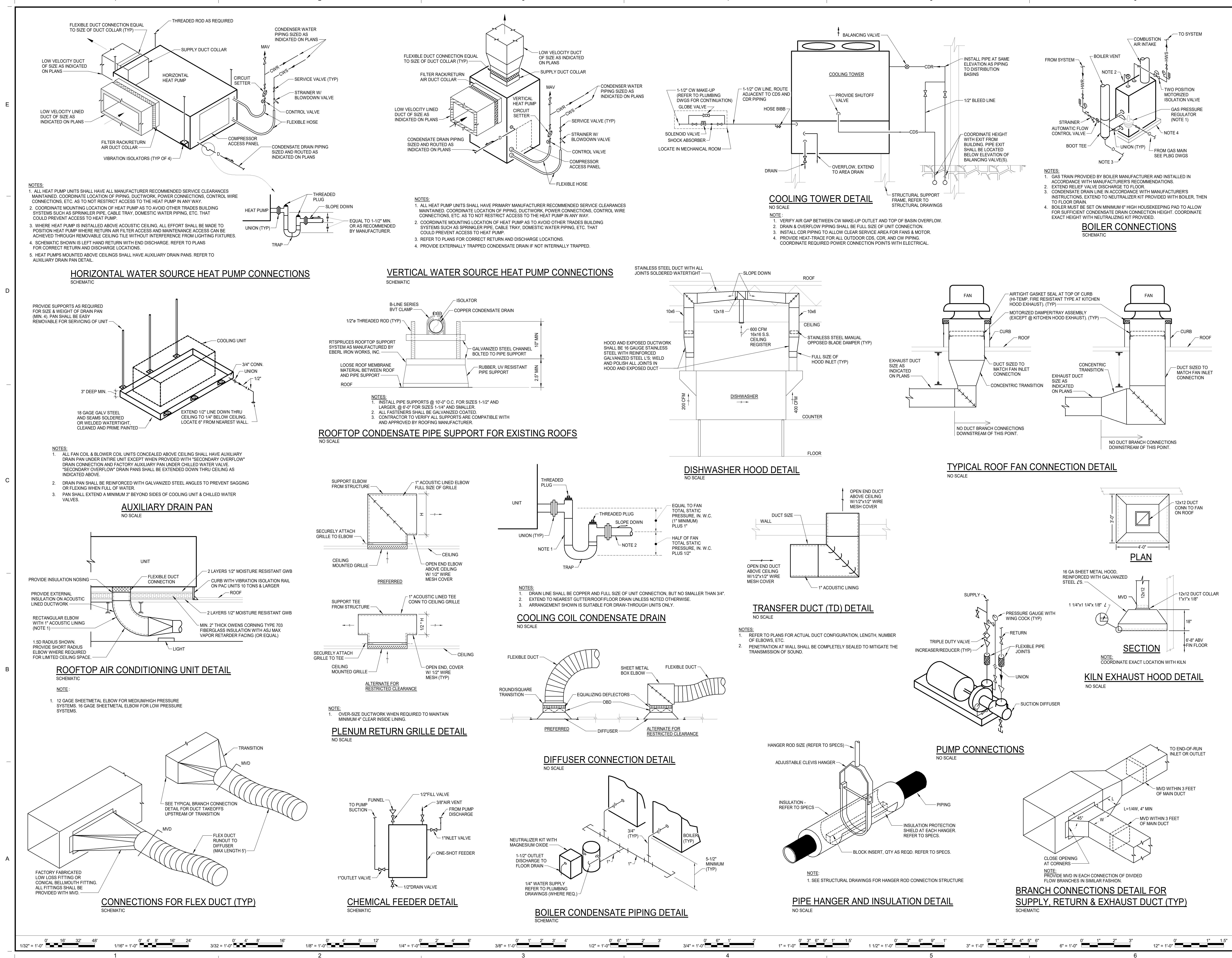
DATE 03/22/2024
PROJECT 23125-02
DESIGNED MHU
DRAWN MHU
CHECKED MHU

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D:MHU 23910 C:---

DESCRIPTION
BY
MARK DATE
REVISIONS



DESCRIPTION		BY		REVISIONS	
		MARK		DATE	

ASCENT
ENGINEERING GROUP

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03/22/2024
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PROJECT

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ARCHITECTS, PC

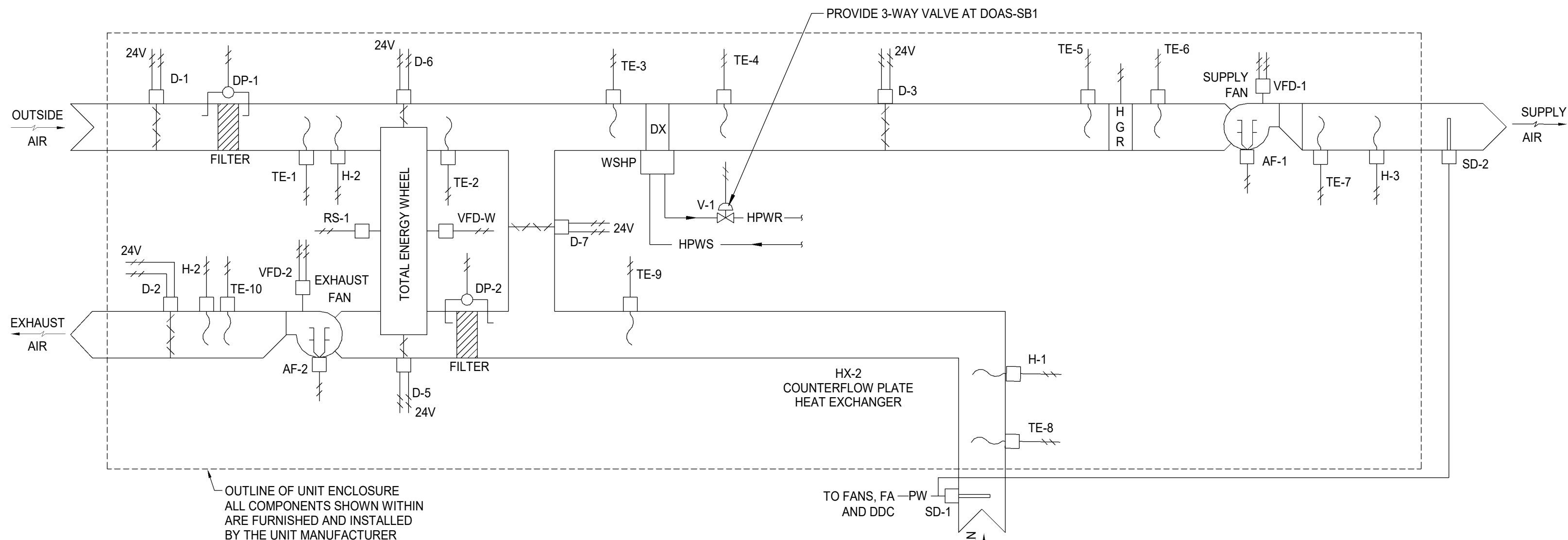
28 Church Ave SW
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NOT FOR CONSTRUCTION

PROJECT
GLEN COVE ELEMENTARY SCHOOL ADDITIONS AND RENOVATIONS
ROANOKE COUNTY PUBLIC SCHOOLS
5901 COVE RD
ROANOKE, VA

DRAWING
MECHANICAL DETAILS

SHEET
M-501



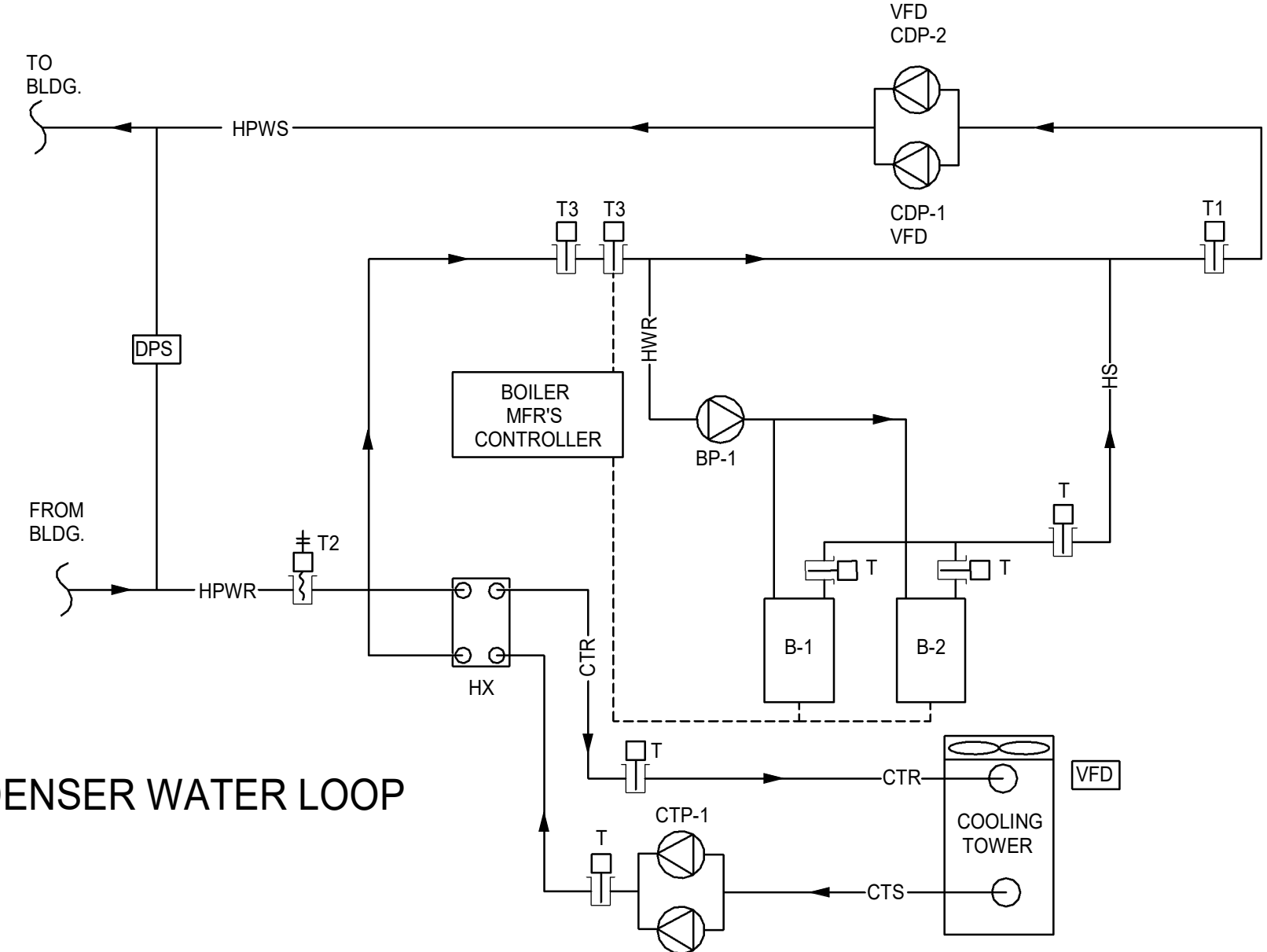
DEDICATED OUTDOOR AIR UNITS (DOAS-1, 2, 3, 4, 5)

- ALARMS AND SAFETIES:**
- PUMPS, PUMP VFDS, AND BOILER FAILURES SHALL BE ALARMED IN EMS.
- COOLING TOWER FAN SHALL BE HARDWIRED TO COOLING TOWER PUMP (CTP-1, CTP-2) SO THAT FAN CANNOT RUN UNLESS PUMP IS RUNNING.
- ALL HEAT PUMPS SHALL BE LOCKED-OUT WHENEVER THERE IS NO HEAT PUMP LOOP FLOW.
- BUILDING IMPENDING FREEZE ALARM SHALL BE GENERATED BY MONITORING BUILDING HEAT PUMP LOOP RETURN WATER TEMPERATURE. ALARM CONDITION SHALL BE WHENEVER OUTDOOR AIR TEMPERATURE IS BELOW 35°F (ADJUSTABLE) AND WHEN RETURN TEMPERATURE DROPS BELOW 50°F (ADJUSTABLE) FOR 40 MINUTES. THIS ALARM SHALL BE DISPLAYED IN THE EMS AND ALSO BE PROVIDED TO SECURITY DIVISION VIA HARDWARE CONNECTION TO THE SECURITY SYSTEM INSTALLED AT THE BUILDING VIA A CONTACT OUTPUT IN THE EMS. MCPS SECURITY DIVISION WILL CONNECT TO EMS PROVIDED RELAY AND MONITOR THIS OUTPUT THROUGH THE SECURITY SYSTEMS HARDWARE AND SOFTWARE.

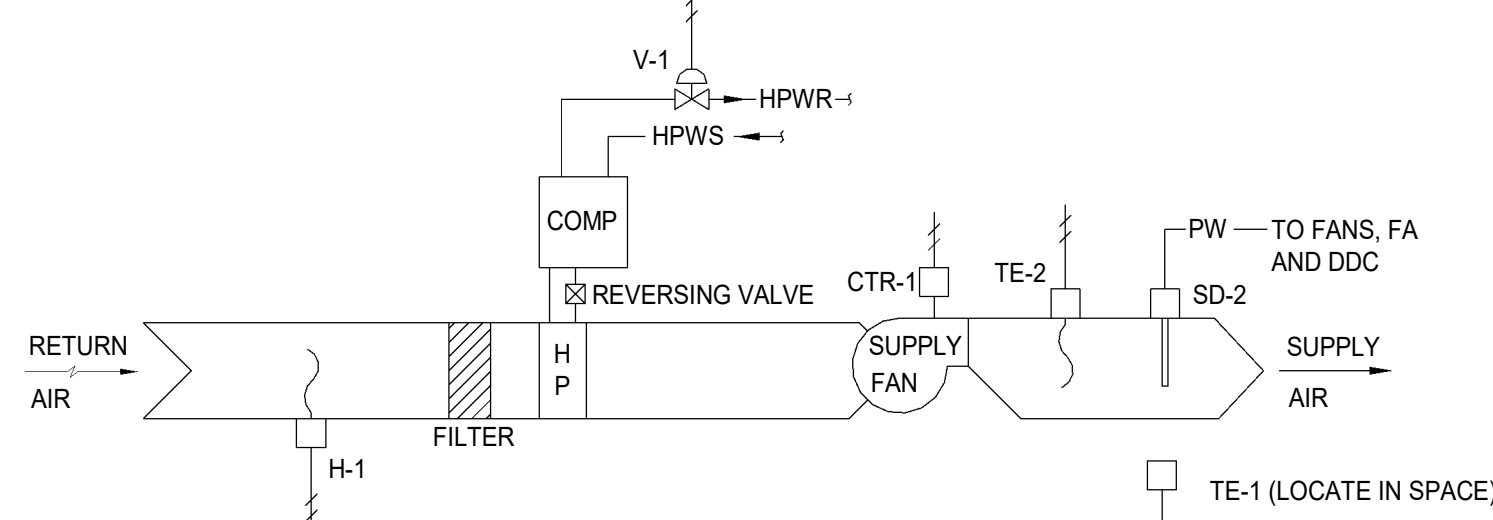
- HEAT ADDITION:**
- WHENEVER SYSTEM PUMP (CDP-1, CDP-2) IS RUNNING AND THE HEAT PUMP LOOP RETURN WATER (T2) IS BELOW 60°F, THE EMS SHALL ENABLE THE BOILER CONTROLLER/SEQUENCER. EMS SHALL DISABLE BOILER CONTROLLER/SEQUENCER WHEN HEAT PUMP LOOP RETURN WATER IS ABOVE 65°F (T2) OR WHEN HEAT PUMP LOOP TEMPERATURE (T1) EXCEEDS 80°F.
 - WHEN ENABLED, BOILER MANUFACTURER'S CONTROLLER SEQUENCES BOILERS' PUMPS AND BOILERS FIRING TO MAINTAIN HEAT PUMP LOOP RETURN WATER SETPOINT (65°F); RETURN WATER SENSOR CONTROLLING BOILERS IS FURNISHED BY BOILER MANUFACTURER.
 - EMS MONITORS SUPPLY WATER TEMPERATURE FROM EACH BOILER AND BOILER ALARMS VIA BACNET.
- HEAT REJECTION:**
- COOLING TOWER PUMPS (CTP-1, CTP-2) PUMPS SHALL OPERATE AS MAIN/STAND-BY. MAIN PUMP SELECTION SHALL BE ALTERNATED WEEKLY. STAND-BY PUMP SHALL START UPON IF MAIN PUMP FAILS TO OPERATE. STAND-BY SHALL SHUT OFF ONCE MAIN RESUMES NORMAL OPERATION. WHENEVER SYSTEM PUMP (CDP-1, CDP-2) IS OPERATING AND THE HEAT PUMP LOOP RETURN TEMPERATURE IS 85°F OR HIGHER, THE COOLING TOWER PUMP SHALL RUN; PUMP SHALL STOP WHEN HEAT PUMP LOOP RETURN TEMPERATURE DROPS BELOW 78°F. COOLING TOWER PUMP (CTP-1, CTP-2) SHALL NOT RUN IF SYSTEM PUMP (CDP-1, CDP-2) IS NOT RUNNING. PUMPS CTP-1 AND CTP-2 SPEED SHALL BE MODULATED SECONDARY TO COOLING TOWER FAN TO MAINTAIN TEMPERATURE.
 - COOLING TOWER: COOLING TOWER FAN SHALL BE OFF WHEN COOLING TOWER PUMP (CTP-1, CTP-2) IS OFF. BOTH VIA SOFTWARE AND HARDWARE INTERLOCKS. WHEN COOLING TOWER PUMP (CTP-1, CTP-2) IS RUNNING, THE TOWER FAN SHALL BE ENABLED WHEN LEAVING WATER TEMPERATURE IS ABOVE 85°F AND SHALL MODULATE SPEED TO MAINTAIN 85°F LEAVING WATER TEMPERATURE. ONCE ENABLED, FAN SHALL REMAIN ENABLED UNTIL PUMP TURNS OFF OR LEAVING WATER TEMPERATURE DROPS BELOW 82°F. WHEN PUMP SPEED IS AT MINIMUM, WATER TEMPERATURE SHALL BE RESET BASED ON OUTSIDE AIR CONDITIONS.
 - TOWER MAKE-UP WATER VALVE, VIBRATION CUT-OUT SWITCH, AND FAN HEATER ARE CONTROLLED BY MANUFACTURER'S CONTROLS.

- CONDENSER WATER LOOP**
- SYSTEM WATER PUMP (CDP-1, CDP-2):**
- SELECTION OF MAIN SYSTEM PUMP SHALL BE ALTERNATED WEEKLY; UPON FAILURE OF THE MAIN PUMP, THE STAND-BY PUMP SHALL RUN; STAND-BY PUMP SHALL SHUT OFF ONCE MAIN RESUMES NORMAL OPERATION. SHOULD BOTH PUMPS FAIL, ZONE 13 HEAT PUMPS AND RTU-AUX SHALL BE DISABLED.
 - SYSTEM PUMP SHALL RUN CONTINUOUSLY.
 - PUMP SPEED SHALL BE CONTROLLED TO MAINTAIN THE SYSTEM PRESSURE SETPOINT AT THE WORSE CASE OF THE SYSTEM PRESSURE SENSORS; PUMP SHALL RAMP SO NO SENSOR DROPS BELOW ITS PRESSURE SETPOINT, ALLOWING THE OTHER SENSOR TO POSSIBLY EXCEED ITS SETPOINT.

CONDENSER WATER LOOP



WATER SOURCE HEAT PUMPS



DEDICATED OUTDOOR UNIT (DOAS-1, DOAS-2, DOAS-3, DOAS-4, DOAS-5)

EQUIPMENT MANUFACTURER'S CONTROL SEQUENCES

UNIT SHALL RUN CONTINUOUSLY DURING THE OCCUPIED MODE AND BE OFF DURING THE UNOCCUPIED MODE UNLESS UNOCCUPIED HUMIDITY CONTROL IS REQUIRED.

UNOCCUPIED HUMIDITY CONTROL: THE UNIT IS OFF UNLESS THE SPACE HUMIDITY RISES ABOVE 60% RH (ADJ.). AT THIS POINT THE UNIT IS ENABLED AND OPERATES IN RECIRCULATION MODE. THE HEAT PUMP IS CONTROLLED TO MAINTAIN THE DX COIL LEAVING TEMPERATURE AT SET POINT. THE UNIT WILL CONTINUE TO OPERATE UNTIL THE SPACE HUMIDITY DROPS BELOW 55% RH (ADJ.).

WHEN THE UNIT IS STARTED, THE OUTSIDE AIR DAMPER AND EXHAUST AIR DAMPER SHALL OPEN. WHEN THEY ARE PROVEN OPEN BY END SWITCHES THE SUPPLY AND EXHAUST FANS SHALL START. THE ENERGY WHEEL BYPASS DAMPERS, D-5 AND D-6, AND RECIRCULATION DAMPER D-7 ARE CLOSED.

COOLING/DEHUMIDIFICATION: MECHANICAL COOLING SHALL BE DISABLED AT OUTDOOR AIR TEMPERATURES BELOW 55°F. THE HEAT PUMP COOLING / DEHUMIDIFICATION OUTPUT SHALL BE CONTROLLED TO MAINTAIN SPACE TEMPERATURE AND HUMIDITY THROUGH SUPPLY AIR DEW POINT. COMPRESSORS SHALL CYCLE AND STEP SUBJECT TO 50°F DX LEAVING COIL AIR LOW LIMIT AND / OR SUPPLY AIR 60°F HIGH LIMIT. REHEAT HX-2 DAMPER CONTROL: DAMPERS D-3 AND D-4 SHALL BE CLOSED WHEN THE UNIT IS OFF. WHEN THE UNIT IS RUNNING AND COOLING IS RESTORED, DAMPER D-4 SHALL MODULATE OPEN TO THE HEAT EXCHANGER AND DAMPER D-3 CLOSED TO MAINTAIN SUPPLY AIR TEMPERATURE SETPOINT. ONCE DAMPER D-4 HAS FULLY OPENED AND THE AIR TEMPERATURE AS SENSED BY T-7 IS BELOW 70°F, THE HOT GAS REHEAT SHALL MODULATE TO MAINTAIN DISCHARGE AIR TEMPERATURE. SUPPLY AIR TEMPERATURE SHALL BE RESET BASED ON OUTDOOR AIR TEMPERATURES. RESET SCHEDULE SHALL BE COMPLETELY ADJUSTABLE AND INVERSELY PROPORTIONAL BETWEEN 80 AND 65 DEGREES.

HEATING: HEATING SHALL BE DISABLED AT OUTDOOR TEMPERATURES ABOVE 70°F (ADJ.). AT OUTDOOR TEMPERATURES BELOW 55°F (ADJ.), THE REVERSING VALVE SHALL BE POSITIONED FOR HEAT AND COMPRESSORS SHALL CYCLE AND STEP TO MAINTAIN 70°F (ADJ.) SUPPLY AIR TEMPERATURE. THE SUPPLY AIR DEHUMIDIFICATION CYCLE SHALL OVERRIDE THE HEATING CYCLE TO PREVENT SUPPLY AIR DEW POINT FROM EXCEEDING 55°F.

ENERGY WHEEL DAMPER CONTROL: DAMPERS D-5 AND D-6 SHALL BE CLOSED WHEN THE UNIT IS OFF. WHEN THE UNIT IS RUNNING, DAMPERS D-5 AND D-6 SHALL BE NORMALLY CLOSED.

WINTER DEFROST MODE: DAMPERS D-5 AND D-6 SHALL MODULATE TO PREVENT THE EXHAUST LEAVING AIR TEMPERATURE FROM DROPPING BELOW 33°F.

ECONOMIZER MODE: ECONOMIZER OPERATION IS DISABLED WHEN OUTDOOR AIR ENTHALPY IS ABOVE 26 BTU/LB. OR WHEN OUTDOOR AIR TEMPERATURE IS BELOW 50°F. WHEN ECONOMIZER IS ENABLED AND OUTSIDE AIR TEMPERATURE IS BELOW SUPPLY AIR COOLING SETPOINT, DAMPERS D-5 AND D-6 SHALL MODULATE OPEN TO BY-PASS ENERGY WHEEL TO MAINTAIN SUPPLY AIR TEMPERATURE SETPOINT.

BY-PASS DAMPERS SHALL OPERATE INDEPENDENTLY.

CONDENSER WATER VALVE V-1 SHALL BE CONTROLLED BY THE UNIT CONTROLLER BASED ON HEAD PRESSURE. FLOW SWITCH IN WATER SUPPLY SHALL DISABLE THE COMPRESSORS IN THE EVENT OF NO WATER FLOW WHILE THE VALVE IS COMMANDED OPEN; THE DOAS FANS SHALL CONTINUE TO OPERATE, UNLESS DISABLED BY THE LOW DISCHARGE TEMPERATURE LIMIT.

CONDENSER COMPARTMENT ELECTRIC HEATER: HEATER SHALL BE ENABLED WHENEVER OUTSIDE AIR TEMPERATURES DROP TO 40°F AND SHALL CYCLE TO MAINTAIN COMPARTMENT TEMPERATURE SETPOINT. AN ALARM SHALL ENUNCIATE IN THE BAS IF COMPARTMENT TEMPERATURES DROP BELOW 35°F. HEATER SHALL HAVE HIGH TEMPERATURE LOCKOUT ABOVE 90°F.

ENERGY MANAGEMENT SYSTEM CONTROL SEQUENCES

CONSTANT TEMPERATURE DISCHARGE DEDICATED OUTDOOR AIR UNIT.

MANUFACTURER FURNISHED CONTROLS. EMS PROVIDED START/STOP VIA HARDWARE TO MANUFACTURER'S CONTROLLER AND CONTROLS THE ISOLATION VALVE. UNIT SHALL BE OFF DURING ZONE'S UNOCCUPIED MODE AND SHALL RUN CONTINUOUSLY DURING OCCUPIED MODE (SCHEDULED OR OVERRIDE).

EMS PROVIDES SPACE HUMIDITY SENSORS FOR DOAS. IN THE UNOCCUPIED MODE WHEN SPACE HUMIDITY EXCEEDS 70% THE EMS SHALL ENABLE THE ASSOCIATED DOAS TO OPERATE IN THE UNOCCUPIED MODE. DOAS SHALL BE DISABLED WHEN SPACE HUMIDITY FALLS BELOW 65%.

EMS MONITORS THE FOLLOWING POINTS THROUGH BACNET:

- SUPPLY FAN STATUS
- EXHAUST FAN STATUS
- OUTDOOR AIR DAMPER POSITION
- OUTDOOR AIR INTAKE TEMPERATURE
- RECIRCULATION DAMPER
- ENERGY WHEEL FACE AND BY-PASS DAMPER POSITIONS
- ENERGY WHEEL DISCHARGE AIR TEMPERATURE
- HEAT PUMP COIL DISCHARGE AIR TEMPERATURE
- HX-2 FACE AND BY-PASS DAMPER POSITION
- HX-2 DISCHARGE AIR TEMPERATURE
- COMPRESSOR STATUS
- REVERSING VALVE MODE (HEATING/COOLING)
- DEHUMIDIFICATION HOT GAS REHEAT STATUS
- SUPPLY AIR HUMIDITY
- SUPPLY AIR TEMPERATURE
- RETURN AIR TEMPERATURE
- RETURN AIR HUMIDITY
- EXHAUST AIR TEMPERATURE
- EXHAUST AIR HUMIDITY
- EXHAUST AIR DAMPER POSITION

THROUGH BACNET EMS PROVIDES THE FOLLOWING CONTROL:

- OCCUPIED/UNOCCUPIED MODE COMMAND
- SUPPLY AIR TEMPERATURE SETPOINT.
- SUPPLY AIR TEMPERATURE DEWPOINT.

WATER SOURCE HEAT PUMP

ENERGY MANAGEMENT SYSTEM CONTROL SEQUENCES

WATER SOURCE HEAT PUMPS SHALL BE CONTROLLED THROUGH THE EMS TO INCLUDE CONDENSER WATER VALVE. PACKAGED CONTROLS WITH BACNET INTERFACE IS NOT ACCEPTABLE.

HEAT PUMPS SHALL BE INDEXED OCCUPIED/UNOCCUPIED VIA START/STOP ZONE COMMANDS. DURING UNOCCUPIED MODES, HEAT PUMPS SHALL NORMALLY BE OFF. DURING OCCUPIED MODES, HEAT PUMP SUPPLY FANS SHALL RUN CONTINUOUSLY. EACH HEAT PUMP SHALL OPERATE AS FOLLOWS:

UNOCCUPIED:

- NIGHT SET-BACK/SET-UP: FAN AND COMPRESSOR SHALL CYCLE TO SATISFY SET-BACK/SET-UP TEMPERATURE; REVERSING VALVE SHALL BE POSITIONED FOR HEATING OR COOLING AS NEEDED.
- WARM-UP/COOL-DOWN: HEAT PUMPS SHALL PERFORM WARM-UP/COOL-DOWN INDIVIDUALLY TO SATISFY THEIR OCCUPIED SPACE TEMPERATURE SETPOINT, PERFORMING OPTIMIZED START INDIVIDUALLY TO ACHIEVE THE OCCUPIED SPACE TEMPERATURE AT THE START OF OCCUPANCY.
- OVERRIDE: INDIVIDUAL OVERRIDE OF THE UNOCCUPIED SPACE SHALL BE MADE BY MANUAL SELECTION AT THE SPACE TEMPERATURE SENSOR.

OCCUPIED: THE FAN SHALL RUN UPON A CALL FOR HEATING OR COOLING. COMPRESSOR SHALL CYCLE IN EITHER HEATING OR COOLING MODE TO MAINTAIN SPACE TEMPERATURES. REVERSING VALVE SHALL BE POSITIONED FOR HEATING OR COOLING AS NEEDED.

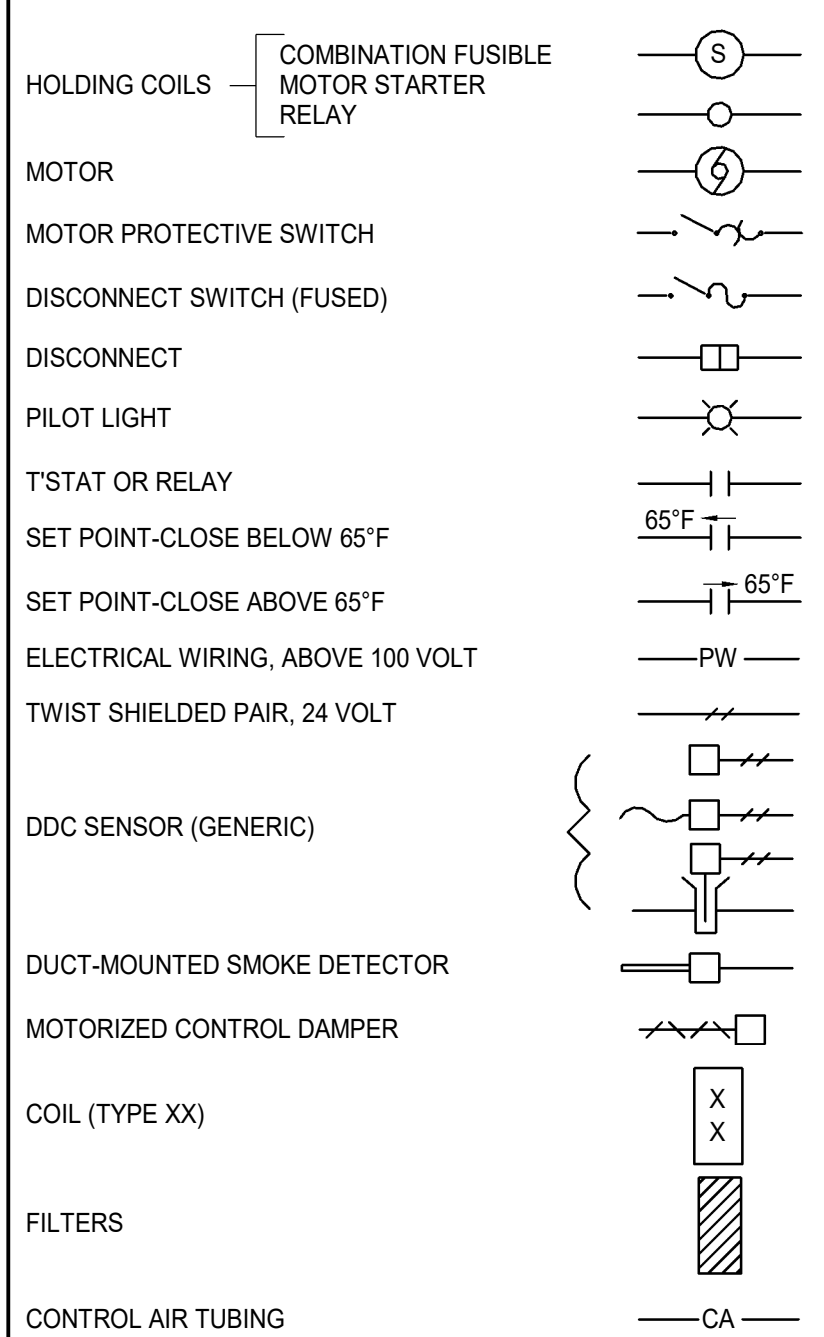
COMPRESSOR: UPON A CALL FOR COMPRESSOR OPERATION, THE WATER CONTROL VALVE SHALL BE COMMANDED OPEN FIRST. WHEN THE VALVE IS FULLY OPEN AND END SWITCH ON THE CONTROL VALVE SHALL ENABLE THE OPERATION OF THE COMPRESSOR. COMPRESSOR OPERATION SHALL BE CYCLED BASED UPON LOAD CONDITIONS AS SENSED BY THE SPACE TEMPERATURE SENSOR. COMPRESSOR OPERATION SHALL BE OVERRIDDEN BY A PRESET THREE MINUTE MINIMUM ON/OFF TIME DELAY IN ORDER TO MAINTAIN OIL RETURN WHEN THE UNIT IS EITHER INITIALLY ENERGIZED, MANUALLY RESET, SWITCHED BETWEEN MODES, OR CYCLED WITHIN A SINGLE MODE. WHEN THE DEMAND FOR COMPRESSOR OPERATION IS SATISFIED, THE COMPRESSOR SHALL STOP AND THE WATER CONTROL VALVE SHALL THEN CLOSE. POSITIVE PROOF OF COMPRESSOR OFF STATUS (CURRENT SWITCH) IS REQUIRED BEFORE VALVE CAN CLOSE.

REVERSING VALVE: THE REVERSING VALVE SHALL BE ENERGIZED IN THE COOLING MODE. ONCE THE VALVE IS ENERGIZED FOR COOLING IT SHALL STAY ENERGIZED UNTIL A HEATING CYCLE IS INITIATED. THE REVERSING VALVE OPERATION SHALL BE DELAYED AFTER COMPRESSOR SHUTDOWN TO REDUCE NOISE DUE TO REFRIGERANT MIGRATION. IN THE EVENT OF A POWER FAILURE THE REVERSING VALVE SHALL FAIL TO THE HEATING MODE.

TIMED STARTS: HEAT PUMPS SHALL PERFORM RANDOM START ON POWER UP TO PREVENT ALL UNITS IN THE BUILDING FROM ENERGIZING AT THE SAME TIME. THE FAN AND COMPRESSOR STARTS SHALL BE DELAYED FROM 3 TO 32 SECONDS WHEN POWER HAS EITHER BEEN RESTORED AFTER A LOSS OR OUTAGE, OR AFTER THE UNIT IS ENABLED. IF THERE IS NO CALL FOR COOLING OR HEATING, OR IF NO FAN OPERATION IS REQUIRED DURING THE DELAY, THE TIME DELAY SHALL BE ALLOWED TO TIME OUT. A RANDOM NUMBER GENERATOR IN SOFTWARE SHALL BE USED TO GENERATE THE DELAY.

- SAFETIES:** THE FOLLOWING SAFETIES SHALL BE PROVIDED, EITHER BY THE CONTROLS CONTRACTOR OR BY HEAT PUMP MANUFACTURER. CONTROLS CONTRACTOR SHALL VERIFY SAFETIES PROVIDED BY HEAT PUMP MANUFACTURER TO ELIMINATE REDUNDANCY AND TO ASSURE THAT ALL REQUIRED SAFETIES ARE PROVIDED.
- COMPRESSOR SHALL BE PREVENTED FROM OPERATING IF FAN COMMAND AND STATUS DO NOT MATCH AFTER 30 SECOND VERIFICATION DELAY.
 - COMPRESSOR SHALL BE OPERATED WITH MINIMUM 3 MINUTE ON AND 3 MINUTE OFF CYCLES TO MAINTAIN OIL RETURN FOR EXTENDED LIFE OF THE COMPRESSOR.
 - SPACE TEMPERATURE SENSOR FAILURE SHALL SHUTDOWN HEAT PUMP AND INITIATE A SENSOR FAILURE ALARM.
 - A CONDENSATE OVERFLOW SWITCH ALARM SHALL SHUT DOWN FAN AND COMPRESSOR AND INITIATE AN EMS ALARM.
 - HEAT PUMPS SHALL BE DISABLED IF SYSTEM PUMP IS NOT OPERATING.
 - EMS SHALL MONITOR UNIT FAILURE GENERAL ALARM.

CONTROL LEGEND



AIRFLOW MEASURING STATION	AF	FREEZE PROTECTION	FP
ANALOG INPUT	AI	FIRE ALARM SYSTEM	FS
ANALOG OUTPUT	AO	GAS HEATER	F.A.
CARBON DIOXIDE SENSOR	CO2	HEATING COIL	GH
CONTROL RELAY	CR	HOT GAS REHEAT COIL	HG
COOLING COIL	CC	HUMIDITY SENSOR	HE
CURRENT RELAY	CTR	PNEUMATIC ELECTRIC	PE
DIGITAL INPUT	DI	PHASE LOSS	PLP
DIGITAL OUTPUT	DO	PROTECTION	PLP
DIRECT DIGITAL CONTROL PANEL	DDC	START-STOP	S/S
DIRECT EXPANSION COIL	DX	SMOKE DETECTOR	SD
ELECTRIC COIL	EHC	TEMP SENSOR	TE
ELECTRIC PNEUMATIC FAN RELAY	EP		

ALL ITEMS SHOWN ON CONTROL DIAGRAMS AND WIRING 100 VOLTS OR LESS SHALL BE INCLUDED AS A PART OF SECTION 230900 EXCEPT POWER WIRING OVER 100 VOLTS, ITEMS MARKED ▲ OR ITEMS SPECIFIED TO BE FURNISHED WITH EQUIPMENT. WIRING OVER 100 VOLTS AND ITEMS MARKED ▲ SHALL BE FURNISHED AS A PART OF DIVISION 26. ALL OVERLOADS, HOA SWITCHES, AUXILIARY CONTACTS AND PILOT LIGHTS SHALL BE INTEGRAL WITH THE MOTOR STARTERS UNLESS SHOWN OTHERWISE.

ALL WIRING SHOWN ON ELECTRIC SEQUENCE CONTROLS SHALL BE OVER 100 VOLTS UNLESS NOTED OTHERWISE. RELAYS FROM THE CONTROL SYSTEM SHALL BE LOCATED ADJACENT TO THE CONTROLLED DEVICE (MOTOR OR MOTOR STARTER), AND MAY BE LOCATED WITHIN STARTER HOUSINGS WHERE SPACE IS AVAILABLE AND WHERE APPROVED BY NEC.

ALL SEQUENCES OF OPERATION, FLOW DIAGRAMS, AND POINTS LIST ARE COMPLEMENTARY. ALL CONTROL STRATEGIES SHALL BE SATISFIED EVEN IF SOME OF THE REQUIRED CONTROL POINTS, ALARM, OR SOFTWARE HAVE BEEN INADVERTENTLY LEFT OFF OF THE POINTS LIST OR FLOW DIAGRAM. SIMILARLY, CONTROL POINTS, ALARM, AND SOFTWARE STRATEGIES INDICATED ON THE POINTS LIST SHALL BE PROVIDED EVEN IF A WRITTEN SEQUENCE OR FLOW DIAGRAM DEVICE HAS BEEN INADVERTENTLY OMITTED.

CONTROL ITEMS MARKED THUS "VENTILATION-ON-OFF" SHALL HAVE PLATE ENGRAVED WITH THE WORDING CONTAINED WITHIN THE QUOTE " ". MARKS PLUS EQUIPMENT IDENTIFICATION.

*QTY AS REQUIRED/INDICATED ON PLANS.

**PIPT PORT PROVIDED BY DIV. 23. INSTALLED BY DIV. 23. INSTALL WITHIN 6" OF ASSOCIATED SENSOR.

MAIN SWITCHBOARD:

1. THE DDC SHALL MONITOR THE MAIN SWITCHBOARD FOR CURRENT POWER USAGE AND REPORT THAT VALUE ON A SCREEN. THE BAS SHALL ALSO ALARM ON ANY POWER OUTAGE.



FANS



WALL HEATERS

